

EJONS

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12th. INTERNATIONAL CONFERENCE ON

MATHEMATICS, ENGINEERING, NATURAL AND MEDICAL SCIENCES

**July 9-11, 2021
Paris, FRANCE**

FULL TEXTS BOOK

Edited by

Prof. Dr. Osman ERKMEN

Nurlan AKHMETOV

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MEDICAL SCIENCES**

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CONGRESS ID

12th. INTERNATIONAL CONFERENCE ON MATHEMATICS, ENGINEERING, NATURAL AND MEDICAL SCIENCES

DATE - PLACE

June 9-11, 2021 /Paris, FRANCE

ORGANIZATION

IKSAD

EDITORS

Prof. Dr. Osman ERKMEN

Nurlan AKHMETOV

EVALUATION PROCESS

All applications have undergone a double-blind peer review
process

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Malaysia, Algeria, Bosnia and Herzegovina, Ethiopia, India,
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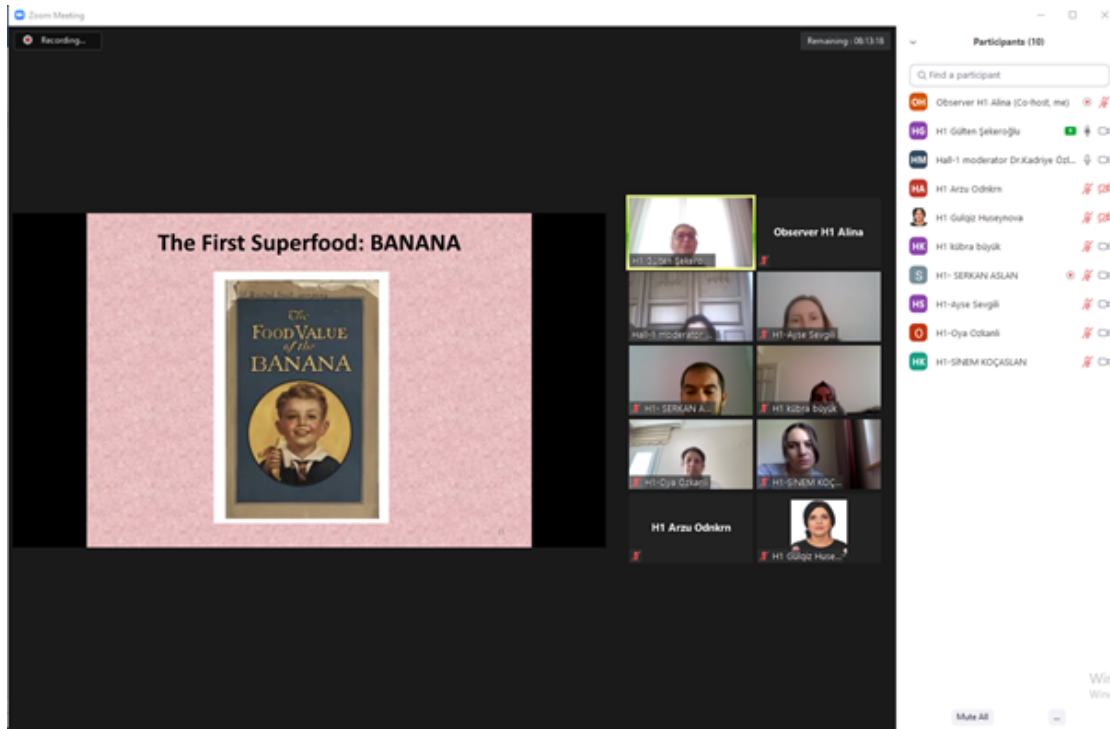
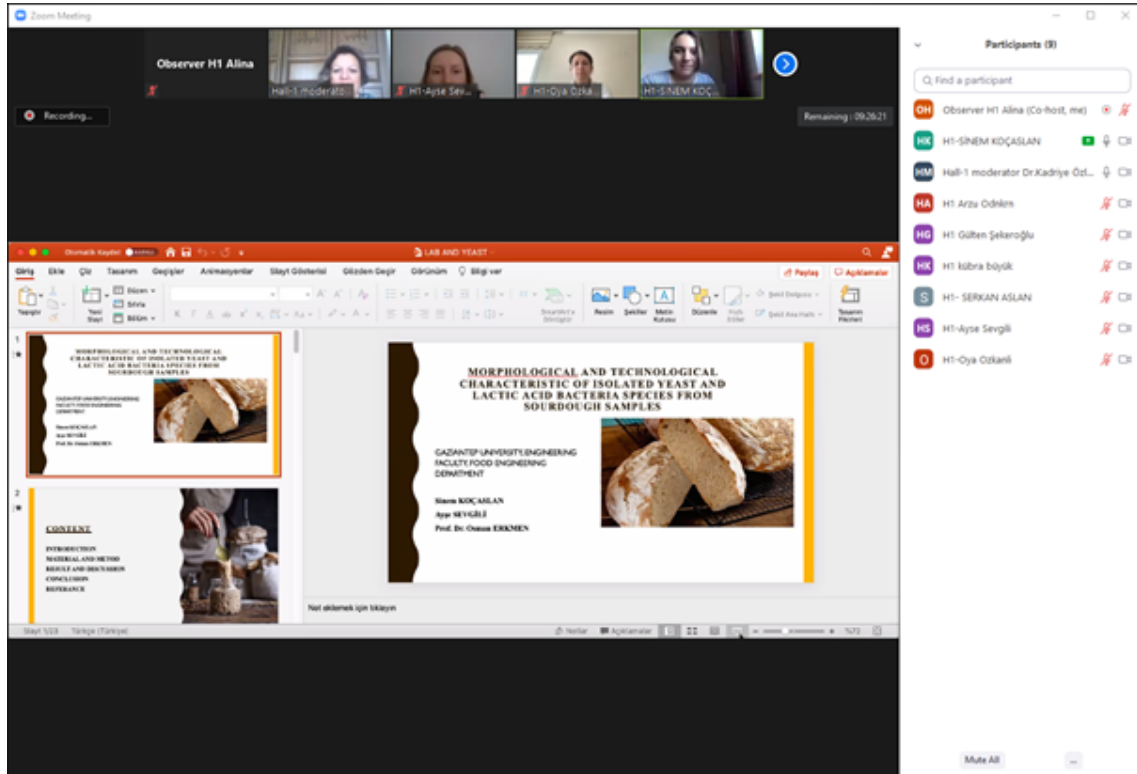


PHOTO GALLERY

This screenshot shows a Zoom meeting window with a presentation slide titled "EM POLLUTION - PowerPoint". The slide displays the electromagnetic spectrum with labels for gamma ray, X-ray, ultraviolet, visible, infrared, microwave, and radio. Below the spectrum, it notes that shorter wavelengths correspond to higher frequency and higher energy, while longer wavelengths correspond to lower frequency and lower energy. A wave diagram is shown at the bottom of the slide.

Participants (10)

- Observer H3 Alina (Co-host, me)
- H3 Tuba Öztürk
- H3 Dr. Öğr. Üyesi İlhan AKBULUT
- H3 kadiri mariya
- H3 moderator ABUBAKER
- H3 Umur UZ
- H3-Kibira ERDOĞAN
- H3-Öğr. Gör.İlker İHAN
- H3-3 : Dr. Yassine BOUCHAFRA
- S2H-3, Farsad salaheddine

This screenshot shows a Zoom meeting window with a presentation slide titled "البيانات الجغرافية - PowerPoint". The slide contains three bar charts showing the concentration of Cu, Pb, and Zn in an ore sample (25%) in mg/g. The x-axis for all charts is labeled "Element" and lists various elements. The y-axis is labeled "Concentration (mg/g)".

Figure 4.3. Concentration of Cu, Pb and Zn in the ore sample (25%) (mg/g)


Participants (11)

- Observer H3 Alina (Co-host, me)
- H3 moderator ABUBAKER
- H3 Dr. Öğr. Üyesi İlhan AKBULUT
- H3 kadiri mariya
- H3 Tuba Öztürk
- H3 Umur UZ
- H3-Kibira ERDOĞAN
- H3-Öğr. Gör.İlker İHAN
- H3-3 : Dr. Yassine BOUCHAFRA
- hab-3, Marjane SABRI
- S2H-3, Farsad salaheddine

PHOTO GALLERY

Conclusion

- Sexual dysfunction may lead to depression and other problems if not addressed properly in the early onset of the disease.
- Healthcare professionals should assess patients' sexuality and measure the degree of sexual impairment to optimize treatment.
- Holistic and multidisciplinary approach between neurologists, urologists, specialized nurses, and psychotherapists.
- Supplementary education and awareness to discuss sexual dysfunction in an open and comfortable environment.
- Special attention to conservative cultures.



- Fetal kalp hızı ve kontraktileteyi arttırmak için
 - salbutamol 3*8 mg (PO)
 - terbutalin 4*5 mg (PO)
- Antiinflamator etki ve hidropsu düzeltmek için
 - dexametazon 2*2.25 mg

- To increase fetal heart rate and contractility
 - salbutamol 3*8 mg (PO)
 - terbutaline 4*5 mg (PO)
- *To correct the anti-inflammatory effect and hydrops
 - dexamethasone 2*2.25 mg

PHOTO GALLERY

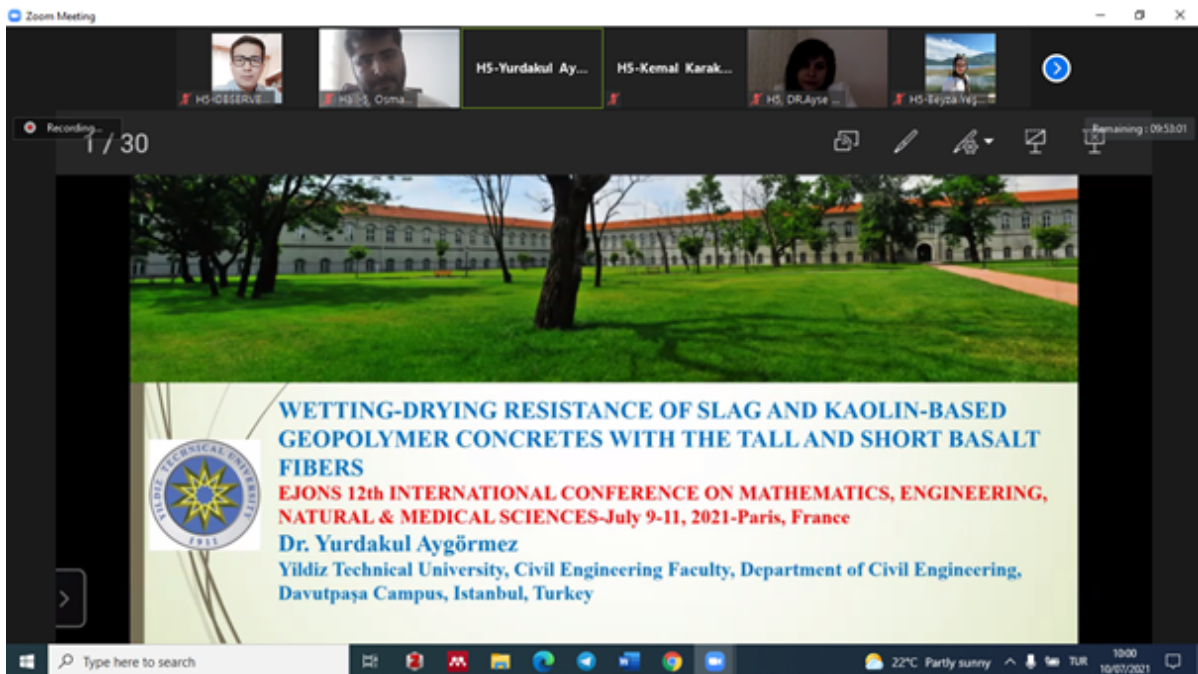
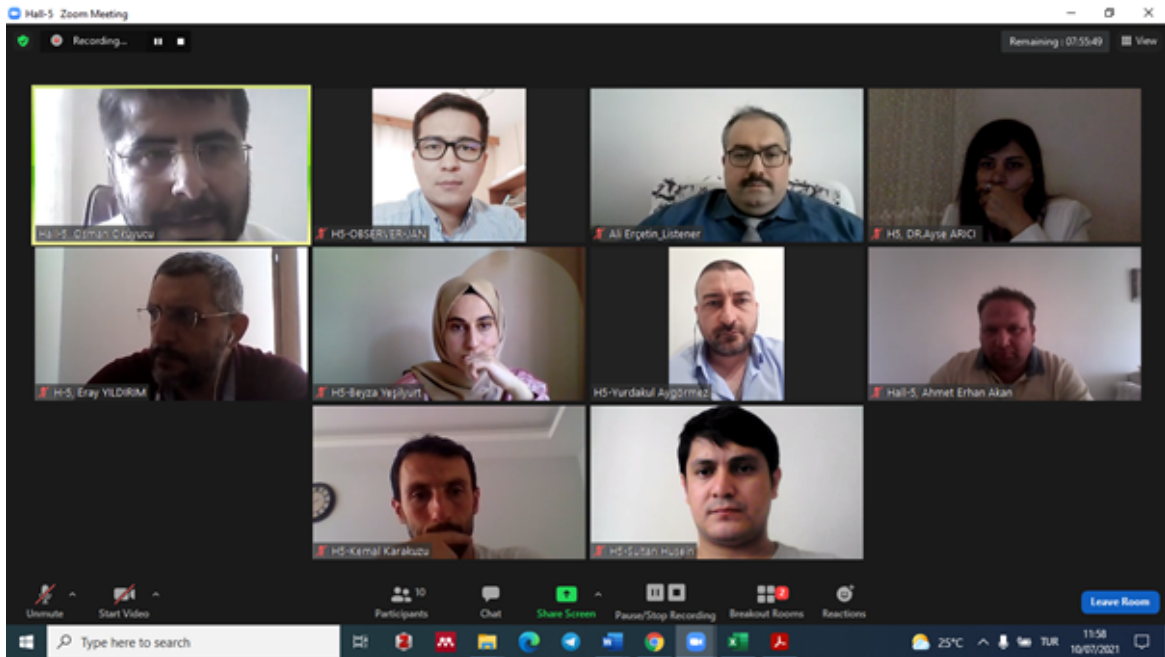


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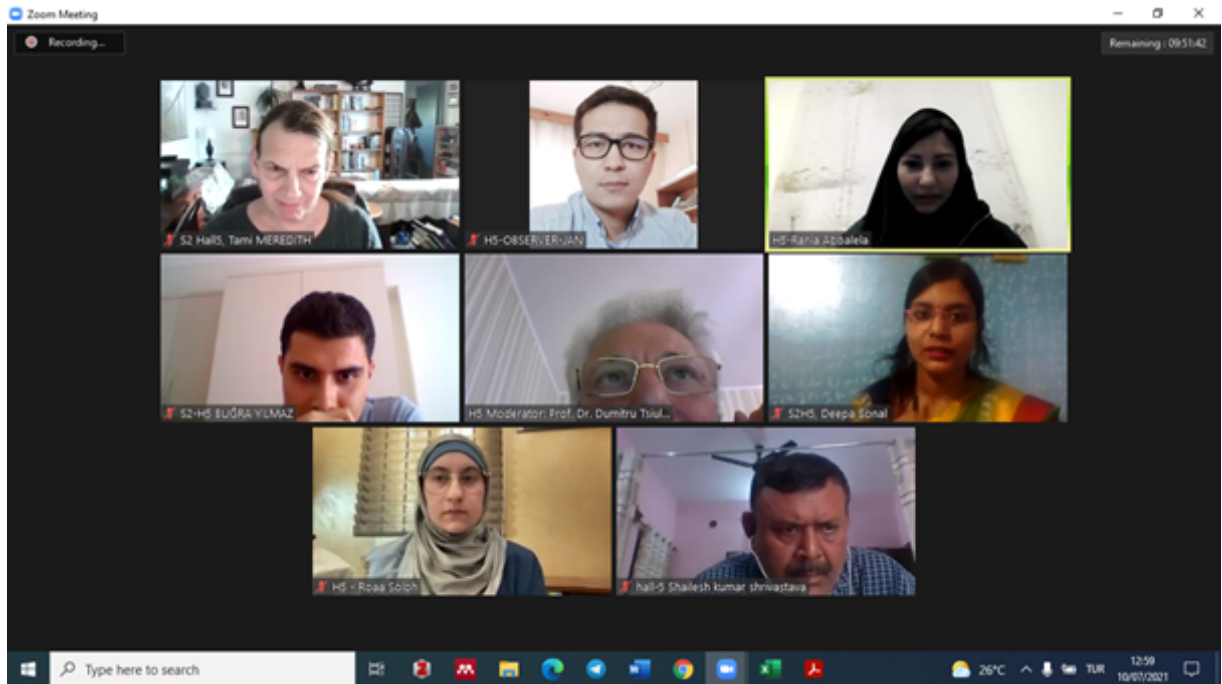
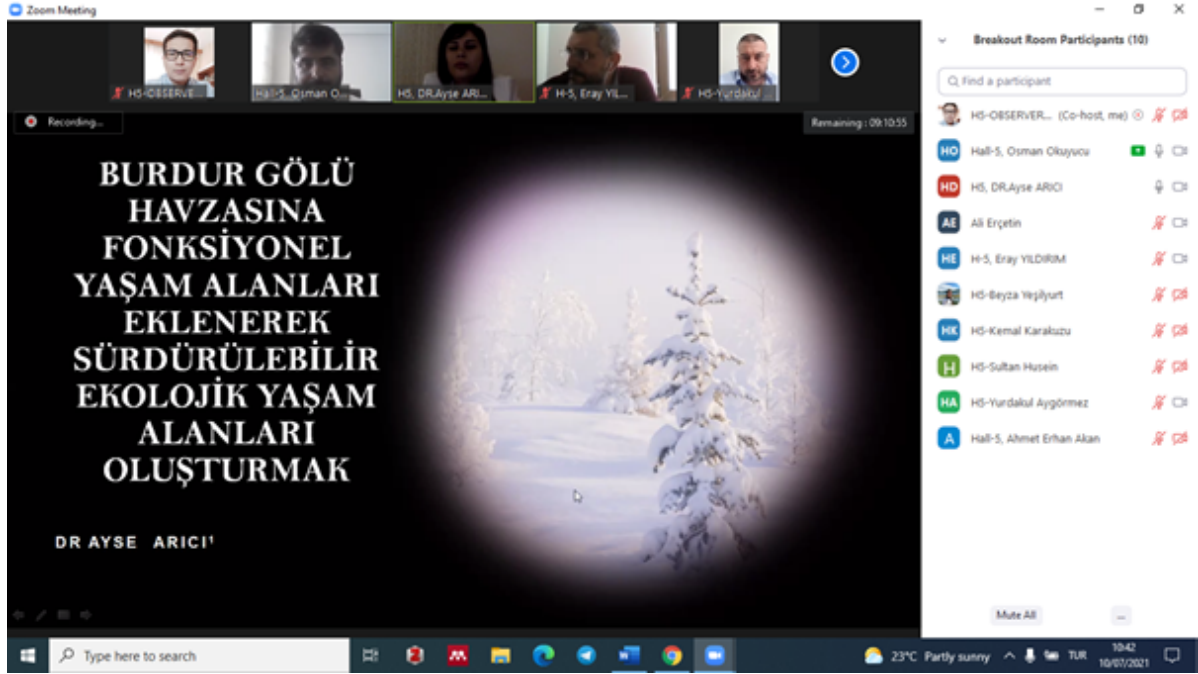


PHOTO GALLERY

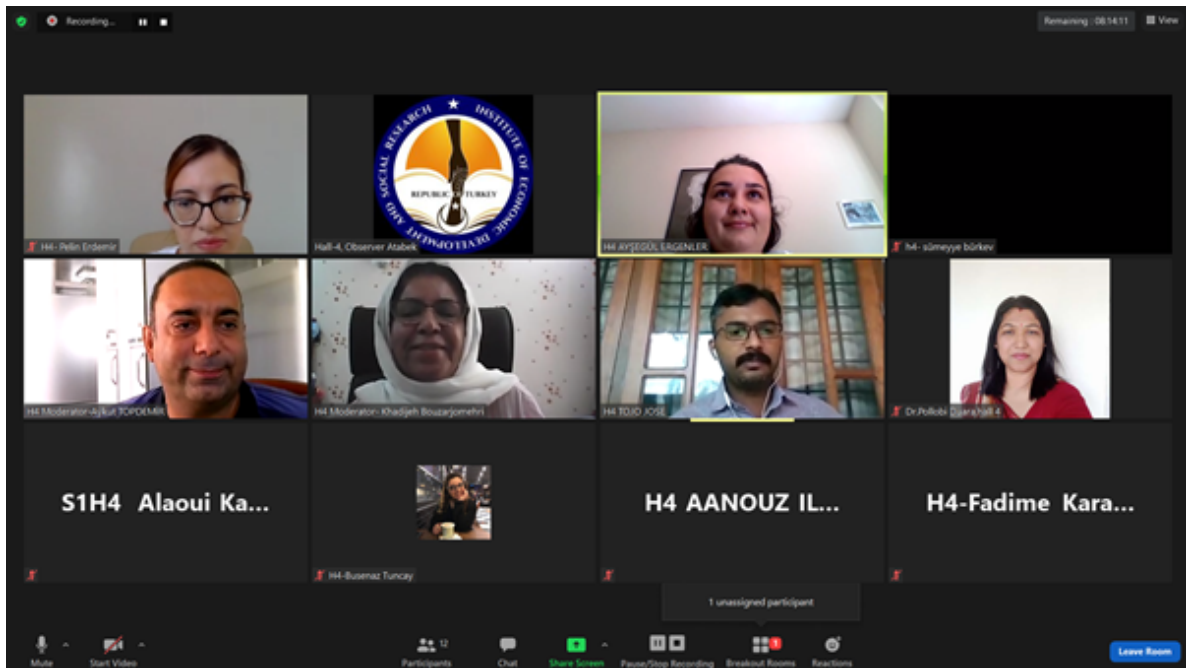
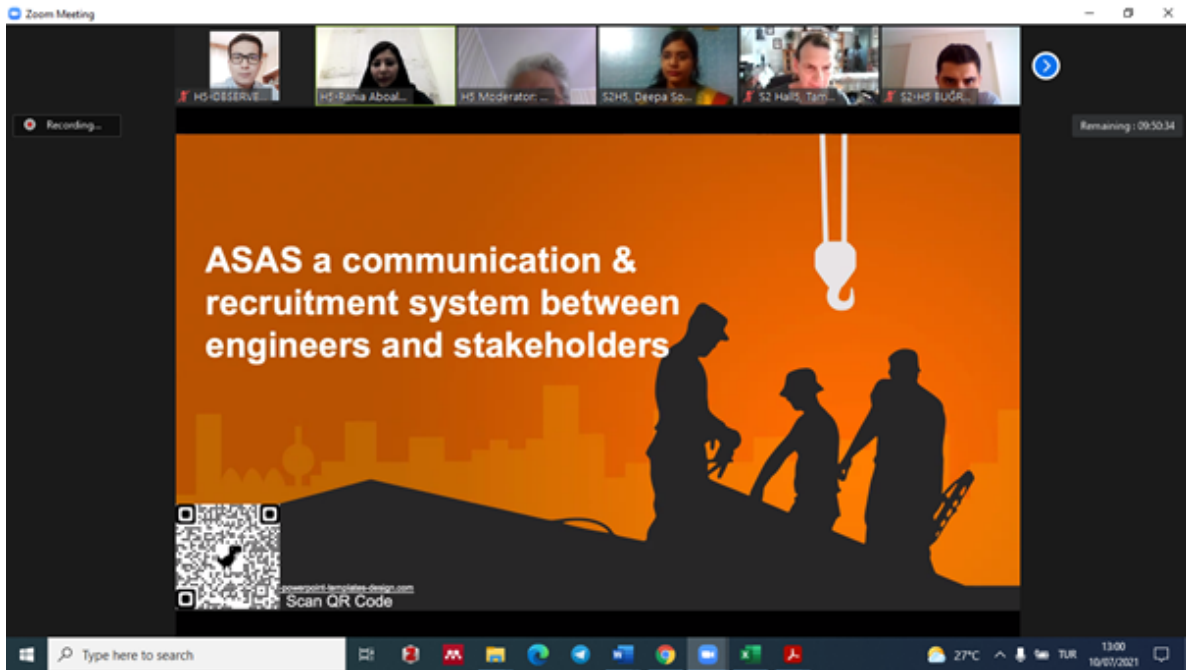


PHOTO GALLERY

Recording...

Remaining: 09:48:43

Talking: H4-MURAT SEN

Rotors

Rotors are defined as rotating structures combined with a shaft and different machine elements like disc, gear, propeller and belt-pulley placed on the shaft and housed with different kinds of bearings and bearing conditions.



3

Zoom Meeting

OBSERVER H4-...

H4-Caner S... H4-Ab Erçetin H4 Dr. Betül SA... H4-Feride Y... H4-MURAT...

Recording...

Remaining: 08:20:16

BİYOGAZ

Türkiye, başta badem kabuğu, mısır sapı, fındık kabuğu, vb. gibi zengin bir biyokütle potansiyeline sahiptir [10-12]. Dünyada fındık üretiminde lider olan Türkiye de sadece Giresun ilinde yıllık fındık kabuğu üretimi **102.000 tondur**. Şenol H., Giresun da ki fındık kabuğu ve fındık atıklarının biyogaz potansiyelini araştırmıştır. İlin yıllık biyogaz üretim potansiyelini 38,21 GW saat/yıl olarak bulmuştur [13]. Devamında, Şenol H., ve Zenk H., Türkiye de fındık üretimi yapılan tüm şehirlerin biyogaz potansiyelini incelemişlerdir. Tüm illerin potansiyel elektrik enerjisi kazanımını toplam **131,55 GW (Gigawatt)** saat olarak hesaplamışlardır [14]. Boubaker K. ve arkadaşları, yenilenebilir enerji çerçevesinde İtalya da edindikleri deneyimleri Türkiye'de benzer bir ortamda projelendirmeye çalışmışlardır. Çalışmalarında İtalya'nın Viterbo eyaletindeki küçük ölçekli biyokütle gazlaştırma sistemleri ve enerji santrallerinin geliştirilmesi programına atıfta bulunmuşlardır. Türkiye'de Doğu Karadeniz bölgesinde gazlaştırma ve yenilenebilir enerji üretimi için uygun olan farklı biyokütle hammaddelerine dikkat çekmişlerdir [15].

Aramak için buraya yazın

37°C 14:31 10.07.2021



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12th INTERNATIONAL CONGRESS ON MATHEMATIC, ENGINEERING AND NATURAL SCIENCES

July 9-11, 2021

Paris, France

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Meeting ID: 883 0047 5178

Passcode: 129173



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Önemli, Dikkatle Okuyunuz Lütfen

- ✓ Kongremizde Yazım Kurallarına uygun gönderilmiş ve bilim kurulundan geçen bildirimler için online (video konferans sistemi üzerinden) sunum imkanı sağlanmıştır.
- ✓ Online sunum yapabilmek için <https://zoom.us/join> sitesi üzerinden giriş yaparak "Meeting ID or Personal Link Name" yerine ID numarasını girerek oturuma katılabilirsiniz.
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- ✓ Bilgisayarınızda mikrofon olduğuna ve çalıştığına emin olun.
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- ✓ Katılım belgeleri kongre sonunda tarafınıza pdf olarak gönderilecektir
- ✓ Kongre programında yer ve saat değişikliği gibi talepler dikkate alınmayacaktır

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- ✓ The application works on tablets, phones and PCs.
- ✓ The participant must be connected to the session 15 minutes before the presentation time.
- ✓ All congress participants can connect live and listen to all sessions.
- ✓ Moderator is responsible for the presentation and scientific discussion (question-answer) section of the session.

Points to Take into Consideration - TECHNICAL INFORMATION

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- ✓ You should be able to use screen sharing feature in Zoom.
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exp. Hall-1, Awais Khan



Meeting ID: **883 0047 5178**
Passcode: **129173**

Session-1, Hall-1

10.07.2021

Moderator: Dr. Kadriye Ozlem SAYGI

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 09:00 – 11:30 // Ankara Local Time: 10:00 – 12:30

Title	Author(s)	Affiliation
PHYSICOCHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF SOURDOUGH	Ayşe Sevgili	Vocational School of Technical Sciences, Gaziantep University, 27310 Gaziantep, Turkey.
	Osman Erkmen	Department of Food Engineering, Faculty of Engineering, Gaziantep University, 27310 Gaziantep, Turkey.
EFFECT OF DIFFERENT COMBINATION LACTIC ACID BACTERIA AND YEASTS ON PHYSICOCHEMICAL, TEXTURE AND CALORIMETRIC PROPERTIES OF SOURDOUGH BREAD	Ayşe Sevgili	Vocational School of Technical Sciences, Gaziantep University, 27310 Gaziantep, Turkey.
	Osman Erkmen	Department of Food Engineering, Faculty of Engineering, Gaziantep University, 27310 Gaziantep, Turkey.
MORPHOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF ISOLATED YEAST AND LACTIC ACID BACTERIA SPECIES FROM SOURDOUGH SAMPLES	Sinem Koçaslan	Department of Food Engineering, Faculty of Engineering, Gaziantep University, 27310 Gaziantep, Turkey
	Ayşe Sevgili	Vocational School of Technical Sciences, Gaziantep University, 27310 Gaziantep, Turkey
	Osman Erkmen	Department of Food Engineering, Faculty of Engineering, Gaziantep University, 27310 Gaziantep, Turkey
THE EFFECTS OF SOURDOUGH ON THE OF MORPHOLOGICAL STRUCTURE OF BREAD	Kübra Büyük	Gaziantep University, Institute of Science, Food Engineering Department, Gaziantep, Turkey.
	Ayşe Sevgili	Vocational School of Technical Sciences, Gaziantep University, 27310 Gaziantep, Turkey.
	Osman Erkmen	Department of Food Engineering, Faculty of Engineering, Gaziantep University, 27310 Gaziantep, Turkey.
PRODUCTION, FOOD USE AND TOXIC EFFECTS OF NANO SILVER PARTICLES	Arzu ADUNKIRAN	Department of Hotel, Restaurant and Catering Services, Vocational School, Iğdır University, Iğdır, Turkey
	Mine KÖKTÜRK	Department of Organic Farming, College of Applied Sciences, Iğdır University, Iğdır, Turkey
	Memnune ŞENGÜL	Department of Food Engineering, Faculty of Agriculture Ataturk University, Erzurum, Turkey
CRANBERRY (VACCINIUM MACROCARPON) AND URINARY TRACT INFECTION	Serkan Aslan	School of Health Department of Nutrition and Dietetics, Tekirdağ, Turkey.
	İzzet Ülker	Faculty of Health Sciences Department of Nutrition and Dietetics, Erzurum, Turkey.
MICROALGAE FOR NUTRITION AND HEALTH	Serkan Aslan	School of Health Department of Nutrition and Dietetics, Tekirdağ, Turkey.
	İzzet Ülker	Faculty of Health Sciences Department of Nutrition and Dietetics, Erzurum, Turkey.
LC-MS/MS METHODOLOGY FOR DETERMINATION OF IMIDACLOPRID IN LEAFY VEGETABLES BY QuEChERS EXTRACTION	Kadriye Ozlem SAYGI	Tokat Gaziosmanpaşa University, Faculty of Arts and Sciences, Department of Chemistry, 60250 Tokat, Turkey
A NEW TREND: SUPERFOODS	Assist. Prof. Dr. Gülten ŞEKEROĞLU	Gaziantep University, Vocational School of Technical Sciences, Food Processing Department, Gaziantep, Türkiye
	Assist. Prof. Dr. Oya ÖZKANLI	Gaziantep University, Tourism Faculty, Gastronomy and Culinary Arts Department, Gaziantep, Türkiye
	Res. Asst. Dr. Dilek BÜYÜKBEŞE	Gaziantep University, Science and Art Faculty, Chemistry Department, Gaziantep, Türkiye

	Prof. Dr. Ahmet KAYA	Gaziantep University, Engineering Faculty, Food Engineering Department, Gaziantep, Türkiye
HEALTH BENEFITS AND USAGE OF CAROB FRUIT IN FOOD INDUSTRY AND GASTRONOMY	Assist. Prof. Dr. Oya ÖZKANLI	Gaziantep University, Tourism Faculty, Gastronomy and Culinary Arts Department, Gaziantep, Türkiye
	Res. Asst. Dr. Dilek BÜYÜKBEŞE	Gaziantep University, Science and Art Faculty, Chemistry Department, Gaziantep, Türkiye
	Assist. Prof. Dr. Gülten ŞEKEROĞLU	Gaziantep University, Vocational School of Technical Sciences, Food Processing Department, Gaziantep, Türkiye
<p style="text-align: center;">All participants must join the conference 15 minutes before the session time. Every presentation should last not longer than 10-12 minutes. Kindly keep your cameras on till the end of the session.</p>		

Session-1, Hall-2

10.07.2021

Moderator: Assoc. Prof. Dr. Nilgun ULUTASDEMIR

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 09:00 – 11:30 // Ankara Local Time: 10:00 – 12:30

Title	Author(s)	Affiliation
MENTAL HEALTH AND COGNITIVE BEHAVIORAL THERAPY	Assoc. Prof. Dr. Nilgun ULUTASDEMIR	Gümüşhane University, Faculty of Health Science Gümüşhane, TURKEY
	Research Assist. Sevda UZUN	Gümüşhane University, Faculty of Health Science Gümüşhane, TURKEY
	Lecturer Nursen KULAKAC	Gümüşhane University, Faculty of Health Science Gümüşhane, TURKEY
BREAST REDUCTION SURGERY COMPLICATIONS	Mustafa CAPAR	Avrasya Universty, Trabzon, Turkey
LIPOSUCTION	Mustafa CAPAR	Avrasya Universty, Trabzon, Turkey
DETERMINATION OF MOLECULAR MECHANISMS OF GENES ASSOCIATED WITH CYSTIC FIBROSIS	Gözde Öztan	Istanbul University, Istanbul Faculty of Medicine, Department of Medical Biology, Istanbul, Turkey.
AGE FEATURES OF THE STRUCTURE OF THE FACIAL NERVE	Gulnara Elkhan Kerimzade	Azerbaijan Medical University. Department of Human Anatomy and Medical Terminology
НЕКОТОРЫЕ МЕТОДЫ, ПРИМЕНЯЕМЫЕ ДЛЯ ЛУЧШЕЙ ДИФФЕРЕНЦИРОВКИ ПАРАГАНГЛИЕВ	Баширова Д.Б.	Кафедра анатомии человека и медицинской терминологии, Баку, Азербайджан
	Рзаева А.М.	Кафедра анатомии человека и медицинской терминологии, Баку, Азербайджан
EVALUATION OF HOME HEALTH SERVICES PROVIDED TO PATIENTS UNDER 18 YEARS OF AGE	Esra Kurt Canpolat	Adıyaman Eğitim ve Araştırma Hastanesi, Başhekimlik
INVESTIGATION OF THE EFFICACY OF CHIROPRACTIC MANIPULATION THERAPY IN SPORTS PERFORMANCE	Sefa Haktan HATIK	Sinop University, Türkeli Vocational School, Sinop, Turkey
	Berkay Eren Pehlivanoglu	Istanbul Rumeli University, Vocational School Of Health, Istanbul, Turkey
IMMUNOHISTOCHEMICAL EVALUATION OF THE EFFECTS OF DEXMEDETOMIDINE-FENTANYL COMBINATION ON THE RAT BRAIN	Ali Yücel KARA	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Fizyoloji Ana Bilim Dalı, İzmir, Türkiye.
	Deniz YILDIZ PEHLİVAN	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Fizyoloji Ana Bilim Dalı, İzmir, Türkiye.
	Gülçin DURDAĞI	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Fizyoloji Ana Bilim Dalı, İzmir, Türkiye.
	Selen AKYOL BAHÇECİ	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Histoloji ve Embriyoloji Ana Bilim Dalı, İzmir, Türkiye.
	Erdi KESELİK	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Histoloji ve Embriyoloji Ana Bilim Dalı, İzmir, Türkiye.
	Eser ÖZ OYAR	İzmir Kâtip Çelebi Üniversitesi, Tıp Fakültesi, Fizyoloji Ana Bilim Dalı, İzmir, Türkiye.
İSKEMİK İNME VAKALARINDA D VİTAMİNİ VE HOMOSİSTEİN DÜZEYLERİNİN AKUT DEĞİŞİMLERİNİN İNCELENMESİ	Prof. Dr. Hülya Çiçek	Gaziantep Üniversitesi Tıp Fakültesi, Tıbbi biyokimya AD, Gaziantep/Türkiye
	Kimyager Adnan İNCEER	Gaziantep Üniversitesi Sağlık Bilimleri Enstitüsü, Tıbbi biyokimya AD, Gaziantep/Türkiye
	Doç. Dr. Sırma GEYİK	Gaziantep Üniversitesi Tıp Fakültesi, Nöroloji AD, Gaziantep/Türkiye
	Dr. Öğr. Üyesi Elif İŞBİLEN	Gaziantep Üniversitesi Tıp Fakültesi, Tıbbi biyokimya AD, Gaziantep/Türkiye
	Uz. Dr. Hüseyin Gürbüz	Gaziantep Ersin Arslan Devlet Hastanesi Acil Tıp, Gaziantep/Türkiye
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Session-1, Hall-3

10.07.2021

Moderator: Dr. Binyam Zigta

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 09:00 – 11:30 // Ankara Local Time: 10:00 – 12:30

Title	Author(s)	Affiliation
SOLVABILITY OF A NONLINEAR FRACTIONAL BOUNDARY VALUE PROBLEM INVOLVING RIEMANN-LIOUVILLE DERIVATIVE	Habib Djourdem	Laboratory of Fundamental and Applied Mathematics of Oran (LMFAO), University of Oran1, Ahmed Benbella, Oran, Algeria.
EFFECT OF THERMAL RADIATION AND CHEMICAL REACTION ON MHD FLOW OF BLOOD IN STRETCHING PERMEABLE VESSEL	Dr. Binyam Zigta	Wolaita Sodo University, College of Natural and Computational Science, Department of Mathematics, P.O.Box 138, ETHIOPIA
LA CROISSANCE DES SOLUTIONS D'UNE CLASSE D'EQUATIONS DIFFERENTIELLES LINEAIRES D'ORDRE SUPERIEUR	Dr. FETTOUCH Houari	Laboratory of Pure and Applied Mathematics, University of Mostaganem, UMAB, Algeria
NUMERICAL STUDY OF PHYSIOLOGICAL BLOOD FLOW WITH STRETCHING CAPILLARY ON MHD MICROPOLAR FLUID	Dr. Binyam Zigta	Wolaita Sodo University, College of Natural and Computational Science, Department of Mathematics, P. O. Box 138, ETHIOPIA
LA CROISSANCE DES SOLUTIONS D'UNE CLASSE D'EQUATIONS DIFFERENTIELLES LINEAIRES DANS LE PLAN COMPLEXES	Dr. FETTOUCH Houari	Laboratory of Pure and Applied Mathematics, University of Mostaganem, UMAB, Algeria
CONGKAKMATIK: FAMILIARIZING STUDENTS WITH MATHEMATICAL OPERATIONS THROUGH AN ADAPTED VERSION OF CONGKAK	Haidil Sainal	Keningau Vocational College, Science and Mathematics Department, Keningau, Sabah
MODIFIED FINITE DIFFERENCE METHOD FOR SOLVING NONLINEAR SCHRÖDINGER EQUATION WITH LOG-NONLINEARITY IN ONE DIMENSION	Suleman Alfalqi	King Khalid University, Faculty of Sciences and Arts, Department of Mathematics, Mahayil, Saudi Arabia.
VALIDITY REGISTER IMPLEMENTED BY BLOCKCHAIN TECHNOLOGY FOR GOVERNMENT ORGANISATIONS	Cinthia Paola Pascual Cáceres	University of Alicante
	Dr. José Vicente Berná Martínez	University of Alicante
	Dr. Francisco Maciá Pérez	University of Alicante
	Dr. Iren Lorenzo Fonseca	University of Alicante
<p>All participants must join the conference 15 minutes before the session time.</p> <p>Every presentation should last not longer than 10-12 minutes.</p> <p>Kindly keep your cameras on till the end of the session.</p>		

Session-1, Hall-4

10.07.2021

Moderator: Assoc. Prof. Dr. Khadijeh Bouzarjomehri & Aykut Topdemir

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 09:00 – 11:30 // Ankara Local Time: 10:00 – 12:30

Title	Author(s)	Affiliation
HEALTHY DIET BOOST IMMUNITY AND PREVENTS VIRAL INFECTIONS WITH SPECIAL EMPHASIS ON COVID-19	K.R.Padma	Assistant Professor, Department of Biotechnology, Sri Padmavati Mahila Visva Vidyayalam (Women's) University, Tirupati, AP.
PERENNIAL WEEDS OF MOULOUYA POTATO: DIVERSITY-DISTRIBUTION AND THREAT IN THE CULTURE	Alaoui Karima Chafik Zouheir Khoulati Amine Saalaoui Ennouamane Mikdame Hind Kharmach Ez-Zahra	Laboratory of Bioresources, Biotechnology, Ethnopharmacology and Health, Faculty of Science, University Mohamed Premier, Oujda 60000, Morocco Laboratory of Plant Biology and Microorganism, Faculty of Science, University Mohamed Premier, Oujda 60000, Morocco Laboratory of Engineering, Materials, Modeling and Environment, Faculty of Sciences Dhar El Mahraz, B.P. 1796, Atlas, 30000. Fez Morocco
STUDIES ON REPRODUCTION OF ENDEMIC SPECIES AND THEIR ADAPTATION TO NATURAL CONDITIONS AT FIRAT UNIVERSITY PLANT TISSUE CULTURE LABORATORY AND GREENHOUSE	Aykut Topdemir	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
	Tuba Okutan	Firat University, Faculty of Science, Department of Biology, Elazig, Turkey
	Pelin Erdemir	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
	Sümeyye Bürkev	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
	Busenaz Tuncay	Gazi University, Faculty of Science, Department of Biology, Ankara, Turkey
	Fadime Karabulut	Firat University, Faculty of Science, Department of Biology, Elazig, Turkey
THE EFFECTS OF DIFFERENT APPLICATIONS ON THE BREAKING OF SEED DORMANCY IN ENDEMIC <i>Ajuga xylorrhiza</i> KIT TAN	Aykut Topdemir	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
	Busenaz Tuncay	Gazi University, Faculty of Science, Department of Biology, Ankara, Turkey
	Pelin Erdemir	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
	Tuba Okutan	Firat University, Faculty of Science, Department of Biology
	Fadime Karabulut	Firat University, Faculty of Science, Department of Biology, Elazig, Turkey
	Sümeyye Bürkev	Firat University, Faculty of Engineering, Department of Bioengineering, Elazig, Turkey
A STUDY ON THE WETLANDS OF MAJULI ISLAND	Dr. Pollobi Duara	H.O.D, Department of Zoology, Majuli College
THE FAMILY BORAGINACEAE AND ITS ETHNOBOTANICAL REFLECTIONS: KERALA PERSPECTIVE	Tojo Jose	Centre for Research and Evaluation, Bharathiar University, Coimbatore, Tamil Nadu, India
THE EFFECT OF TRANSPORT PROCESS ON THE MICRONUCLEI FREQUENCY IN ERYTHROCYTES OF THE COMMON CARP <i>CYPRINUS CARPIO L.</i>	Funda TURAN	Faculty of Marine Science and Technology, University of Iskenderun Technical, Iskenderun, Hatay, Turkey
	Aysegül ERGENLER	Faculty of Marine Science and Technology, University of Iskenderun Technical, Iskenderun, Hatay, Turkey
NANOTOXICOLOGICAL EFFECTS OF GRAPHENE BASED MATERIALS ON AQUATIC ORGANISM	Aysegül ERGENLER	Faculty of Marine Science and Technology, University of Iskenderun Technical, Iskenderun, Hatay, Turkey
	Funda TURAN	Faculty of Marine Science and Technology, University of Iskenderun Technical, Iskenderun, Hatay, Turkey
ANTIMICROBIAL ACTIVITY MOLECULAR DOCKING AND ADMET PROPERTIES OF THE ESSENTIAL OIL OF <i>SALVIA LAVANDULIFOLIA</i>	Ilham AANOZ Khalil EL KHATABI Aziz BOUYMAJANE Maryame Sabiri Tahar LAKHLIFI Mohammed BOUACHRINE	Molecular Chemistry and Natural Substances Laboratory, Faculty of Science, Moulay Ismail University of Meknes, Morocco EST Khenifra, Sultan Moulay Sliman University, Khenifra, Morocco Department of Biology, Team of Microbiology and Health, Laboratory of Chemistry-Biology, Applied to the Environment, Moulay Ismail University, Faculty of Sciences, Morocco
THE ROLE OF SOCIAL CAPITAL ON THE RESILIENCE OF RURAL SETTLEMENTS	Ehsan Abdi	Masters student in rural Geography of Ferdowsi university of Mashhad. Mashhad. Iran.

AGAINST FLOOD RISK (STUDY AREA OF MIAN JAM RURAL DISTRICT, TORBAT-E JAM CITY, KHORASAN RAZAVI PROVINCE. IRAN)	Khadijeh Bouzarjomehri	Associate Professor in Rural Geography, Ferdowsi University of Mashhad. Mashhad. Iran
	Maryam Ghasemi	Assistant Professor in Rural Geography, Ferdowsi University of Mashhad. Mashhad. Iran
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Session-1, Hall-5

10.07.2021

Moderator: Assist. Prof. Dr. Osman OKUYUCU

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 09:00 – 11:30 // Ankara Local Time: 10:00 – 12:30

Title	Author(s)	Affiliation
WETTING-DRYING RESISTANCE OF SLAG AND KAOLIN-BASED GEOPOLYMER CONCRETES WITH THE TALL AND SHORT BASALT FIBERS	Yurdakul AYGÖRMEZ	Yildiz Technical University, Faculty of Civil Engineering, Civil Engineering Department, Istanbul, Turkey.
AN OVERVIEW OF PROJECT MANAGEMENT PROFESSIONALIZATION FROM CROATIAN PERSPECTIVE	Ph.D. Marija Šiško Kuliš	HEP Production Ltd. Croatia
	Senad Hodžić	High International school Cazin, Bosnia and Herzegovina
INVESTIGATION OF THE SUSTAINABILITY OF RURAL BUILDINGS: THE CASE OF CANKIRI	Ayse ARICI	International Vision University, Faculty of Engineering and Architecture, Civil Engineering Department, Gostivar, Northern Macedonia.
CREATING SUSTAINABLE ECOLOGICAL LIVING SPACES BY ADDING FUNCTIONAL LIVING SPACES TO THE BURDUR LAKE BASIN	Ayse ARICI	International Vision University, Faculty of Engineering and Architecture, Civil Engineering Department, Gostivar, Northern Macedonia.
EFFECT OF FIBER TYPE AND UTILIZATION RATE ON PERMEABILITY PROPERTIES AND FREEZE-THAW RESISTANCE OF MORTAR MIXTURES	Öznur Biricik	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University, Nilüfer-Bursa, Turkey
	Yahya Kaya	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University, Nilüfer-Bursa, Turkey
	Sultan Husein Bayqra	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University, Nilüfer-Bursa, Turkey
	Ali Mardani-Aghabaglou	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University, Nilüfer-Bursa, Turkey
EFFECT OF USING SHRINKAGE-REDUCING ADMIXTURE ON THE FLOWABILITY AND SHRINKAGE PROPERTIES OF KHORASAN MORTAR	Tuğçe İsağça	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University
	Kemal Karakuzu	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University
	Süleyman Özen	Department of Civil Engineering, Faculty of Engineering and Natural Science, Bursa
	Adem Doğangün	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University
	Ali Mardani-Aghabaglou	Department of Civil Engineering, Faculty of Engineering, Bursa Uludag University
USE OF WASTE TIRES IN SELF-COMPACTING CONTROLLED LOW-STRENGTH MATERIAL	Osman OKUYUCU	Tekirdağ Namık Kemal University, Çorlu Engineering Faculty, Tekirdağ-Çorlu, Turkey
USE OF ZEOLITE IN FLOWABLE FILL MIXES	Osman OKUYUCU	Tekirdağ Namık Kemal University, Çorlu Engineering Faculty, Tekirdağ-Çorlu, Turkey
INVESTIGATION OF THE RELATIONSHIP BETWEEN TEMPERATURE AND GELLING TIME IN SOIL SILICATE GROUTING	Eyüphan AVCI	Bursa Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, BURSA/TURKEY
	Eray YILDIRIM	Bursa Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, BURSA/TURKEY
EVALUATION OF DIFFERENT PHOTOVOLTAIC PANEL TECHNOLOGIES FOR TEKIRDAG PROVINCE	Dr. Ahmet Erhan AKAN	Namık Kemal University, Çorlu Vocational School, Department of Machine and Metal Technologies, Tekirdag, Turkey.
PHOTOGRAMMETRY IN HISTORICAL BUILDING ANALYSIS	Beyza Nur YEŞİLYURT	Necmettin Erbakan University, Social Sciences Institute, Konya, Turkey
	Assist. Prof. Dr. M. Ergün HATIR	Faculty of Fine Arts, Department of Interior Architecture and Environmental Design, Necmettin Erbakan University, Konya, Turkey
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Session-2, Hall-1

10.07.2021

Moderator: Prof. Dr. Ahmet KILIC

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 12:00 – 14:30 // Ankara Local Time: 13:00 – 15:30

Title	Author(s)	Affiliation
THE EVALUATION OF THE BIOLOGICAL AND SPECTROSCOPIC PROPERTIES OF THE DIFFERENT BIOACTIVE BORON COMPOUNDS	Levent BEYAZSAKAL	MSc. Harran University, Science and Art Faculty, Chemistry Department
	Ahmet KILIC	Prof. Dr. Harran University, Science and Art Faculty, Chemistry Department
THEORETICAL CALCULATION OF SPECIFIC HEAT CAPACITY OF TUNGSTEN-TECHNETIUM ALLOY	Melek GOKBULUT	Department of Optician Program, Erbaa Vocational School of Health Services, Gaziosmanpasa University, Tokat, Turkey
	Elif SOMUNCU	Department of Optician Program, Ulubey Vocational High School, Usak University, Usak, Turkey.
HYDROLOGIC MODELING OF A HIGHLY MANAGED WATERSHED USING SWAT	M. Matin Saddiqi M. Ekrem Karpuzcu	Istanbul Technical University, Environmental Engineering Department, Istanbul, Turkey; University College Dublin, Chemical and Bioprocess Engineering Department, Dublin, Ireland; Istanbul Technical University, Environmental Engineering Department, Istanbul, Turkey;
INVESTIGATION OF in Vitro INHIBITORY EFFECTS OF SOME CARNOZOLE AND CARNOSIC ACID DERIVATIVES BASES ON ACETYLCHOLINESTERASE, BUTYRYLCHOLINESTERASE AND CARBONIC ANHYDRASE ISOENZYMES	Zeynep KOKSAL	Istanbul Medeniyet University, Engineering and Natural Sciences, Chemistry, Istanbul, Turkey
INVESTIGATION OF ELECTROCHEMICAL PERFORMANCE OF PZT MATERIALS IN Li-ION AND Na-ION BATTERIES	M. Taha Demirkan Mehbare Dogrusoz Rezan Demir-Cakan	Department of Material Science and Engineering, Department of Chemical Engineering, Institute of Nanotechnology, Gebze Technical University, KOCAELI, TURKEY
SYNTHESIS, CHARACTERIZATION AND ANTIMICROBIAL ACTIVITY OF Fe(II) AND Mn(II) COMPLEXES WITH SCHIFF BASE DERIVED FROM NAPHTHALDEHYDE AND P-CHLOROANILINE	Ibrahim A.K.	Department of pure and Industrial Chemistry, Bayero University, Kano. Nigeria.
	Na'aliya J	Department of pure and Industrial Chemistry, Bayero University, Kano. Nigeria.
A SIMPLE NEW SYNTHESIS METHOD OF COPPER MOLYBDATE CuMoO ₄ NANOPARTICLES AND THEIR CATALYTIC PERFORMANCE	Hicham Oudghiri Hassani Mohamed Akouibaa Souad Rakass Mostafa Abboudi Brahim El Bali Mohammed Lachkara Fahd Al Wadaani	Engineering Laboratory of Organometallic, Molecular Materials and Environment (LIMOME), Faculty of Sciences, Chemistry Department, Sidi Mohamed Ben Abdellah University, 30000 Fez, Morocco; Laboratory of Applied Organic Chemistry (LCOA), Chemistry Department, Faculty of Sciences and Techniques, Sidi Mohamed Ben Abdellah University, Po. Box 2202, Imouzzar Road 30000 Fez, Morocco; Chemistry Department, College of Science, Taibah University, Al-Madinah Al-Munawarah 30002, Saudi Arabia; Independent Scientist, Oujda, Morocco
STUDY OF INTERACTIONS BETWEEN POLY(VINYL ALCOHOL) AND BOVINE SERUM ALBUMIN IN SOLUTION	Maria Bercea	"Petru Poni" Institute of Macromolecular Chemistry, 41-A Grigore Ghica Voda Alley, 700487 Iasi, Romania
	Ioana-Alexandra Plugariu	"Petru Poni" Institute of Macromolecular Chemistry, 41-A Grigore Ghica Voda Alley, 700487 Iasi, Romania
RHEOLOGICAL BEHAVIOR OF BOVINE SERUM ALBUMIN IN SOLUTION (Poster)	Ioana-Alexandra Plugariu	"Petru Poni" Institute of Macromolecular Chemistry, 41-A Grigore Ghica Voda Alley, 700487 Iasi, Romania
	Maria Bercea	"Petru Poni" Institute of Macromolecular Chemistry, 41-A Grigore Ghica Voda Alley, 700487 Iasi, Romania
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Session-2, Hall-2

10.07.2021

Moderator: Hajar Sadeq

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 12:00 – 14:30 // Ankara Local Time: 13:00 – 15:30

Title	Author(s)	Affiliation
DIAGNOSIS OF RUPTURE OF ANCHOR STAPLE PINS THAT HAVE UNDERGONE THE PHENOMENON OF CORROSION	Hajar Sadeq Abdelkader Nasser Abdelhamid Kerkour El Miad	Mohammed First University Oujda, Faculty of Science Oujda, Laboratory of Materials, Wave, Energy and Environment (LaMOn2E), Oujda, Morocco
New Ethylenediamine Crosslinked 2D-Cellulose Adsorbent for Nanoencapsulation Removal of Pb (II) and Cu (II) Heavy Metal Ions: Synthesis, Characterization Application and RSM-modelling	Issam Jilal Soufian El Barkany Zahra Bahari Youssef El Ouardi Mohamed Loutou Hassan Amhamdi Mohamed Abou-Salama Amin Salhi Abderrahmane El Idrissi Katri Laatikainen	Laboratory of Molecular Chemistry, Materials and Environment (LMCME), Department of Chemistry, Faculty Multidisciplinary Nador, Mohamed 1st University, P. B. 300, Nador 62700, Morocco. LIMOME Laboratory, Dhar El Mehraz Faculty of Sciences, Sidi Mohamed Ben Abdellah University, B.P. 1796 Atlas, Fes 30000, Morocco Laboratory of Separation Technology, Lappeenranta University of Technology, P.O. Box 20, FI-53851 Lappeenranta, Finland. Applied Chemistry Unit, Sciences and Technologies Faculty, Abdelmalek Essaadi University, 32 003 Al Hoceima, Morocco Laboratory Applied Chemistry and Environmental (LCAE-URAC18), Faculty of Sciences of Oujda, Mohamed1stUniversity, 60000 Oujda, Morocco
THE EFFECT OF ETHANOL/ WATER ON POLYPHENOLS CONTENT, ANTIOXYDANT ACTIVITIES OF THE SOLID RESIDUES FROM HYDRO DISTILLATION OF ROSEMARY	Imane ZIANI	University Mohammed Premier, Faculty of Sciences, Chemistry Department, Oujda, Morocco
	Hamza BOUAKLINE	University Mohammed Premier, Faculty of Sciences, Chemistry Department, Oujda, Morocco
	Abdesselam TAHANI	University Mohammed Premier, Faculty of Sciences, Chemistry Department, Oujda, Morocco
	Ali EL BACHIRI	University Mohammed Premier, Faculty of Sciences, Chemistry Department, Oujda, Morocco
QUALITY ASSESSMENT OF RIVERS AND WELLS WATER USED FOR LOCUST BEANS 'IRU' (PAKIA BIGLOBOSA) PROCESSING IN ABEOKUTA METROPOLIS, NIGERIA	Taiwo, A. G.	Moshood Abiola Polytechnic, Science Laboratory Technology Department, P.M.B. 2210, Ojere-Onikolobo road, Abeokuta
	Eleyowo, I. O.	The Gateway (ICT) Polytechnic, Saapade, General Studies Department, Isara Remo, Ogun State, Nigeria.
	Ibikunle, O.	The Gateway (ICT) Polytechnic, Saapade, General Studies Department, Isara Remo, Ogun State, Nigeria.
STUDY OF THE INTERACTIONS BETWEEN SODIUM MONTMORILLONITE AND SODIUM ALGINATE AS ANIONIC POLYMER	BRAHMI MOHAMED	University Mohammed Premier, Faculty of Sciences, Laboratory of Environment and Applied Chemistry (LCAE), Oujda, Morocco
	ESSIFI KAMAL	University Mohammed Premier, Faculty of Sciences, Laboratory of Environment and Applied Chemistry (LCAE), Oujda, Morocco
	ELBACHIRI ALI	University Mohammed Premier, Faculty of Sciences, Laboratory of Environment and Applied Chemistry (LCAE), Oujda, Morocco
	TAHANI ABDESSALAM	University Mohammed Premier, Faculty of Sciences, Laboratory of Environment and Applied Chemistry (LCAE), Oujda, Morocco
THE EFFECT OF DRYING PROCESS ON THE BIOACTIVE COMPOUNDS OF P. LENTISCUS L. LEAVES EXTRACTS AND ESSENTIAL OIL	Hamza bouakline	University Mohammed Premier, Faculty of Sciences, chemistry department, Oujda, Morocco.
	Imane ziani	University Mohammed Premier, Faculty of Sciences, chemistry department, Oujda, Morocco.
	Abdesselam tahani	University Mohammed Premier, Faculty of Sciences, chemistry department, Oujda, Morocco.
	Ali EL bachiri	University Mohammed Premier, Faculty of Sciences, chemistry department, Oujda, Morocco.
PHYSICO-CHEMICAL PROPERTIES AND CHEMICAL COMPOSITION OF PHOENIX DACTYLIFERA L. SEED OIL	Yasmina Halabi Chaimae Nasri Hicham Harhar Abdelkbir Bellaouchou Mohamed Tabyaoui	Laboratory of Materials, Nanotechnology, and Environment, Mohammed V University, Faculty of Science, 4 Av. Ibn Battouta, B.P 1014 Rabat, Morocco

SYNTHESIS, CRYSTAL STRUCTURE AND CATALYTIC/ADSORBENT ACTIVITIES OF $[\text{Ni}(\text{N}_2\text{H}_5)_2(\text{C}_2\text{O}_4)_2] \cdot \text{H}_2\text{O}$	Mohamed Akouibaa	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Hicham oudghiri hassani	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Najlaa Hamdi	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Rachid Ouarsal	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Souâd Rakib	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Mohamed Khaldi	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
	Brahim El Bali	Independent scientist, Oujda, Morocco
	Mohammed Lachkar	University Sidi Mohamed Ben Abdellah, Faculty of Sciences, Fez, Morocco
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Session-2, Hall-3

10.07.2021

Moderator: Aydın Türkyilmaz & Abubaker Hussin Alsharif

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 12:00 – 14:30 // Ankara Local Time: 13:00 – 15:30

Title	Author(s)	Affiliation
DEFECTIVE ONE-DIMENSION PERIODIC SYSTEM FOR FILTERING AND DEMULTIPLEXING	Yassine Bouchafra Youssef Ben-Ali Ilyass El Kadmiri Zakarea Rahou D. Bria	"Laboratoire des Matériaux, Ondes, Energie et Environnement, Equipe des Ondes, Acoustique, Photonique et Matériaux, Faculté des Sciences, Université Mohamed Premier, Oujda, Maroc.
ONE-DIMENSIONAL DEFECTIVES PERIODIC COMB-LIKE BASED ON QUANTUM WIRES FOR GUIDING AND FILTERING	Siham Machichi Yassine Bouchafra Youssef Ben-Ali Ilyass El Kadmiri Driss Bria	"Laboratoire des Matériaux, Ondes, Energie et Environnement, Equipe des Ondes, Acoustique, Photonique et Matériaux, Faculté des Sciences, Université Mohamed Premier, Oujda, Maroc.
ELECTROCHEMICAL AND CORROSION INHIBITION PROPERTIES OF THREE NEW FERROCENE DERIVATIVES	Mariya Kadiri	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
	Riham Sghyar	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
	Majid Driouch	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
	Mouhcine Sfaira	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
	Abdeslem bentama	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
	Elmestafa Elhadrami	Sidi Mohamed Ben Abdellah University, chemistry department, Fes, Morocco
PHYTOCHEMICAL SCREENING AND TOTAL PHENOLIC AND FLAVONOIDS CONTENTS OF DIFFERENT SOLVENT EXTRACTS FROM AERIAL PART OF <i>Pulicaria mauritanica</i>	Maryame Sabiri Mohammed Barbouchi Kaoutar Elamrani Ali Amechrouq	Molecular Chemistry and Natural Substances Laboratory, Moulay Ismail University, Faculty of Sciences, B.P. 11201, Zitoune, Meknes, Morocco
OPTIMIZING AND MODELING THE ANAEROBIC DIGESTION OF LANDFILL LEACHATE BY USING PLACKETT BURMAN DESIGN	Salaheddine FARSAD Zakaria ANFAR Saaïda LHANAFI Abdellah AIT ELFAKIR Asmae AMJLEF Noureddine ELALEM	Laboratory of Materials and Environment, Ibn Zohr University, Agadir 80000, Morocco.
THE EFFECTS AND MANAGEMENT OF ENVIRONMENTAL POLLUTION ORIGINATING FROM ELECTROMAGNETIC FIELDS	Tuba Öztürk	Tekirdag Namık Kemal University, Çorlu Faculty of Engineering, Environmental Engineering, Tekirdag, Turkey.
INVESTIGATION OF OIL POLLUTION IN THE SEA IN LIBYA	Abubaker Hussin Alsharif	Kastamonu University Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Turkey
	Aydın Türkyilmaz	Kastamonu University Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Turkey
COMPARATIVE ANALYSIS OF COAL MINING DISASTERS IN TURKEY	İLKER İNAN	Istanbul Gelisim University, Vocational School, Mechatronics Department, İstanbul, Turkey
	Ç. İLHAN AKBULUT	Dogus University, Vocational School, Justice Department, İstanbul, Turkey
	UMUT UZ	Istanbul Gelisim University Vocational School Mechatronics Department İstanbul Turkey
	KÜBRA ERDOĞAN	Istanbul Gelisim University Vocational School Mechatronics Department İstanbul Turkey
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Session-2, Hall-4

10.07.2021

Moderator: Dr. Ali Erçetin

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 12:00 – 14:30 // Ankara Local Time: 13:00 – 15:30

Title	Author(s)	Affiliation
MODAL ANALYSIS FOR SOLID AND HOLLOW POWER ULTRASONIC HORN USING FEM	Ziad Shakeeb Al Sarraf Majed Medhat Saeed	Department of Mechanical Engineering, Faculty of Engineering, University of Mosul, Mosul, IRAQ
SHIFTING RESONANCE AND ANTI-RESONANCE FREQUENCIES OF A SHAFT-DISK-BEARING ROTOR SYSTEM TO DESIRED VALUES BY USING FREQUENCY RESPONSE FUNCTIONS	Murat Şen	Firat University, Engineering Faculty, Mechanical Engineering Department, Elazığ, Turkey.
	Orhan Çakar	Firat University, Engineering Faculty, Mechanical Engineering Department, Elazığ, Turkey.
EXAMINATION OF THE EFFECTS OF BLOCKAGE POSITIONS ON MASS DISTRIBUTIONS IN PEM FUEL CELL	İbrahim Halil HAZAR	Firat University, Engineering Faculty, Mechanical Engineering, Elazığ, Turkey
INVESTIGATION OF THE EFFECTS OF CHANNEL BLOCKAGE TYPES ON PERFORMANCE IN PEM FUEL CELL	İbrahim Halil HAZAR	Firat University, Engineering Faculty, Mechanical Engineering, Elazığ, Turkey
FLOW OPTIMIZATION OF A GLOBE CHECK VALVE WITH NUMERICAL METHOD	Nevzat Tugay SAYAR	Ege University, Faculty of Engineering, Department of Mechanical Engineering, 35100 Bornova, İzmir, Turkey
	Erbil İYİM	Valf Sanayi A.Ş., Organize Sanayi Bölgesi, Kurtuluş Cad. No: 1, Manisa, Turkey
	Aydoğan ÖZDAMAR	Ege University, Faculty of Engineering, Department of Mechanical Engineering, 35100 Bornova, İzmir, Turkey
INVASIVE WEED OPTIMIZATION ALGORITHM FOR SOLVING MULTI-OBJECTIVE U-SHAPED DISASSEMBLY LINE BALANCING PROBLEM	Pengfei Yao	Department of Mechanical and Industrial Engineering Northeastern University Boston, MA, 02115, USA.
	Surendra M. Gupta	Department of Mechanical and Industrial Engineering Northeastern University Boston, MA, 02115, USA.
SOLUTION OF VARYING FREQUENCY AND TIE LINE POWER OF GENERATING STATION	Ashish Dhamanda	Gurukula Kangri (Deemed to be University) Haridwar, UK, India
DETERMINING THE FLOW RATE OF A THERMOSTATIC EXPANSION VALVE BY NUMERICAL METHOD	Caner SEVER	Ege University, Faculty of Engineering, Department of Mechanical Engineering, 35100 Bornova, İzmir, Turkey
	Erbil İYİM	Valf Sanayi A.Ş., Organize Sanayi Bölgesi, Kurtuluş Cad. No: 1, Manisa, Turkey
	Aydoğan ÖZDAMAR	Ege University, Faculty of Engineering, Department of Mechanical Engineering, 35100 Bornova, İzmir, Turkey
THE EFFECT OF THE CHANGE OF Mg ₂ Sn PHASE RATIO ON THE SURFACE MORPHOLOGY AND CORROSION BEHAVIOUR OF SA21-xSn MAGNESIUM ALLOYS	Dr. Ali Erçetin	Bingöl University, Faculty of Engineering and Architecture, Department of Mechanical Engineering, Bingöl, Turkey.
VALUE OF BIOMASS AS A HAZELNUT SHELL	Dr. Betül ŞAHİN	TRABZON ÜNİVERSİTESİ, BEŞİKDÜZÜ MYO, MAKİNE VE METAL TEKNOLOJİLERİ BÖLÜMÜ, MAKİNE PROGRAMI, TRABZON/BESİKDÜZÜ, TÜRKİYE

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Session-2, Hall-5

10.07.2021

Moderator: Prof. Dr. Dumitru Tsiulyanu

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 12:00 – 14:30 // Ankara Local Time: 13:00 – 15:30

Title	Author(s)	Affiliation
ASAS A COMMUNICATION SYSTEM BETWEEN ENGINEERS AND STAKEHOLDERS	Rania Anwar Aboalela Ahlam Mazmomi Amal Alharbi Marajel Albeladi	Information System Department, Faculty of Computing and Information Technology
AN EMPIRICAL APPROACH FOR EXPLORING NON-SOCIAL LANGUAGE USE	Tami MEREDITH	Dalhousie University, Faculty of Computer Science, Halifax, Canada
	Maryanne FISHER	Saint Mary's University, Faculty of Science, Department of Psychology, Halifax, Canada
USING SMART AGRICULTURE TECHNIQUES FOR IMPROVING CROP PRODUCTION	DEEPA SONAL	Department of Computer Science, V.K.S. University, Arrah-802301, India
	SHAILESH KUMAR SHRIVASTAVA	Scientist-F & Head, DGRC, NIC, STPI Campus, Patna-800013, India
	BINAY KUMAR MISHRA	Director, Department of Computer Science, V.K.S. University, Arrah-802301, India
3D MESH MATCHING USING SURFACE DESCRIPTOR AND INTEGER LINEAR PROGRAMMING	Roaa SOLOH	Lebanese University, LIA Laboratory, Doctoral School of Sciences & Technology, Beirut, Lebanon.
	Abdallah EI CHAKIK	Beirut Arab University, Faculty of Sciences, Department of Computer Science, Tripoli, Lebanon
	Hassan ALABBOUD	Lebanese University, Faculty of Economics and Business administration, Tripoli, Lebanon
	Ahmad SHAHIN	Lebanese University, LIA Laboratory, Doctoral School of Sciences & Technology, Tripoli, Lebanon
	Adnan Yassine	Normandie Université, UNIHAVRE, ISEL, 76600 Le Havre, France.
TRANSFORMATION FROM PIM MODEL TO PSM MODEL IN MDA: CASE UML TO SALES FUNNEL	Ouzayr RABHI	MATSI Laboratory, EST, Mohammed First University, Oujda, Morocco
	Ibtissam ARRASSEN	Laboratory for Computer Science Research Faculty of Sciences, Mohammed First University, Oujda, Morocco
A COMPENDIUM OF RIGHT TO PRIVACY IN DIGITAL AGE USING SOCIAL NETWORKING SITES	Abhilasha Sisodia	LL.M (University of Pune), Pursuing Ph.D. Assistant Professor; School of Law (SOL); Galgotias University; Greater Noida. Flat No.501, Tower 2, Unitech Horizon, Sector – PI 2, Greater Noida, Pin- 201310.
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EFFICIENCY AND LIMITATION ANALYSIS OF HIGH TEMPERATURE SUPERCONDUCTOR CABLES	Buğra Yılmaz	University of Firat, Faculty of Engineering, Department of Electrical and Electronics Engineering, Elazig, Turkey.
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AMORPHOUS CHALCOGENIDES BASED MICROCELLS FOR THE FAST TOXIC GAS ALARM-TRIGGERING	Dumitru Tsiulyanu	Technical University, Faculty of Electronics and Telecommunication, Department of Physics, Chisinau, Moldova.
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GENDER RECOGNITION WITH SONGS	Muzaffer Aslan	Bingol University, Engineering and Architecture Faculty, Electrical-Electronics Engineering Department, Bingol, Turkey.
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Session-3, Hall-1

10.07.2021

Moderator: Dr. Barış Sever

Meeting ID: 883 0047 5178 / Passcode: 129173

Paris Local Time: 15:00 – 17:30 // Ankara Local Time: 16:00 – 18:30

Title	Author(s)	Affiliation
SEXUAL DYSFUNCTION IN PATIENTS WITH MULTIPLE SCLEROSIS: A BRIEF REVIEW	Aline A. Yacoubian, MS; Jad Degheil, MD; Nassib Abou Heidar, MD; Rami Nasr, MD	Division of Urology, Department of Surgery, American University of Beirut Medical Center, Riad El-Solh 1107 2020, Beirut, Lebanon. Division of Pediatric Urology, Department of Surgery, Children's Hospital of Eastern Ontario, University of Ottawa, Ontario, Canada
PREVALENCE OF SUPERNUMERARY DIGITAL FLEXION CREASES IN A NIGERIAN POPULATION	Jaiyeoba-Ojigbo Jennifer Efe John Onyekachi Samuel Eto Gift Oke	Delta State University, Faculty of Basic Medical Sciences, Department of Human Anatomy, Abraka, Nigeria
OSTEOPOROSIS AND EDUCATION	Radka Tomova Mariana Nikolova Svetla Asenova Miglena Slavova	Medical University – Pleven, Faculty of Pharmacy, Department of Chemistry and Biochemistry, Pleven, Bulgaria Shumen University "Konstantin Preslavski", Faculty of Natural Sciences, Department of Chemistry, Shumen, Bulgaria Conceive Clinic – London, United Kingdom Institute of Electrochemistry and Energy Sources, Bulgarian Academy of Science, Sofia, Bulgaria Todor Kableshkov University of Transport, Faculty of Transport Management, Department of Machine Elements and Chemistry, Sofia, Bulgaria
PHARMACEUTICAL FORMULARY LIST OF DRUGS	Mukhitova D.T. Temirgalieva E.M. Seytkazy N.T. Aset G.K.	Kazakh National Medical University named after S.D. Asfendiyarov, Almaty, RK Department of Clinical Pharmacology
THE MACRO-MICROSCOPIC PECULIARITIES OF THE HUMAN URINARY BLADDER GLANDS	Huseynova Gulriz Agagasan Nasirova Zarifa Jahangir	Department of Human Anatomy and Medical Terminology, Azerbaijan Medical University, Baku, Azerbaijan
INVESTIGATION of THE STRUCTURE-ACTIVITY RELATIONSHIPS with MOLECULAR DOCKING for FAMILIAR ANTIEPILEPTIC DRUGS and K+ CHANNELS	Esra Nur KÖMÜRÇÜ	Kastamonu University, Faculty of Engineering, Department of Genetic and Bioengineering, Kastamonu, Turkey
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	Prof. Dr. Bayram KIRAN	Kastamonu University, Faculty of Engineering, Department of Genetic and Bioengineering, Kastamonu, Turkey
CONTRIBUTIONS TO THE KNOWLEDGE OF WATER BEETLES (COLEOPTERA: HYDROPHILIDAE, HELOPHORIDAE) FAUNA IN BEYŞEHİR LAKE (KONYA), TURKEY	Ayçin AKÜNAL	Selçuk University, Department of Emergency and Disaster Management, Konya, Turkey
TREATMENT OF FETAL COMPLETE ATRIOVENTRICULAR BLOCK	Dr. Barış Sever	Izmir University of Health Sciences, Tepecik Training and Research Hospital, Department of Obstetrics and Gynecology, Division of Perinatology, Izmir, Turkey
MORPHOLOGY AND PECULIARITIES OF THE MICROVASCULAR BED OF THE NERVOUS PLEXUSES OF THE LARGE INTESTINE	Ramila Babayeva	Azerbaijan Medical University, Department of Human Anatomy and Medical Terminology, Baku, Azerbaijan.
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Session-3, Hall-2

10.07.2021

Moderator: Prof. Joanne K. Singleton

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Paris Local Time: 15:00 – 17:30 // Ankara Local Time: 16:00 – 18:30

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	M. Sevba COLAK	University of Ankara, Faculty of Agriculture, Department of Agricultural Engineering, Ankara, Turkey.
PRECONCENTRATION AND DETERMINATION OF SOME TRACE ELEMENTS IN THERMOMINERAL WATERS IN CENTRAL ANATOLIA REGION	Cigdem ER CALISKAN	Kirsehir Ahi Evran University, Faculty of Agriculture, Department of Field Crops, Kirsehir, Turkey;
	Harun CIFTCI	Kirsehir Ahi Evran University, Faculty of Medicine, Department of Medical Biochemistry, Kirsehir, Turkey; Cankiri Karatekin University Rectorate, Çankiri, Turkey
VARIATION IN GENOTYPES REACTION TO DROUGHT AND RELATED PHYSIOLOGICAL AND AGRONOMIC PARAMETERS IN RAPESEED (<i>Brassica napus</i> L.)	Imane Saghour el Idrissi	Research Unit of Agronomy and Plant Physiology, National Institute of Agricultural Research, Regional Agricultural Research Center of Meknes, PO. Box 578, Meknes 50000, Morocco.
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BACTERIOLOGICAL EVALUATION OF EGGS IN NATURAL CONDITION AND DURING STORAGE (COLD) AND BIOCHEMICAL TESTS FOR SALMONELLA SPP. TO KORÇA POULTRY	Dr. Sulltanë Ajçe	Fan. S. Noli University, Agriculture Faculty, Department of Agronutrition, Korça, Albania
EFFECT OF SUPPLEMENTING PROTEASE ENZYME TO JAPANESE QUAIL DIETS ON GROWTH PERFORMANCE AND CARCASS TRAITS	Nguyen Thao Nguyen Khang Vu Dang Khang Thi Kim Nguyen	Faculty of Agriculture, Cantho University, Vietnam
AGROFORESTRY TRANSITION AS AN ALTERNATIVE TO ECOLOGICAL MANAGEMENT IN CAATINGA BRASILEIRA, PIAUI, BRAZIL	Davi Leal dos Santos Barbosa Daniel de Moura Silva Karoline de Sousa Almeida Eduardo Lima de Sousa Júnior Bruna de Freitas Iwata	Instituto Federal do Piauí, Graduandos em Tecnologia em Gestão Ambiental, Teresina-PI, Brasil. Universidade Estadual do Piauí, Graduando em Engenharia Agronomica, Picos-PI, Brasil. Instituto Federal do Piauí, Dra. Ciência do Solo, Docente dos cursos de Tecnologia em Gestão Ambiental e Mestrado profissional em Análise e Planejamento Espacial, Teresina-PI, Brasil.
COMPOSTING AQUATIC MACROPHYTES (<i>JUNCUS EFFUSUS</i>) LIKE ALTERNATIVE FOR MECHANICAL CONTROL OF MANAGEMENT IN SURFACE WATER	Davi Leal dos Santos Barbosa Karoline de Sousa Almeida Eduardo Lima de Sousa Júnior Bruna de Freitas Iwata	Instituto Federal do Piauí, Graduandos em Tecnologia em Gestão Ambiental, Teresina-PI, Brasil. Instituto Federal do Piauí, Dra. Ciência do Solo, Docente dos cursos de Tecnologia em Gestão Ambiental e Mestrado profissional em Análise e Planejamento Espacial, Teresina-PI, Brasil.
CANINES ASSISTING IN HEALTH: SUPPORTING THE CULTURAL COMMUNITY OF INDIVIDUALS WITH DISABILITIES TEAMED WITH A SERVICE DOG	Joanne K. Singleton	Pace University, Professor, College of Health Professions, NY, NY

PAWS & BREATHE®, ANIMAL ASSISTED STRESS REDUCTION	Joanne K. Singleton	Pace University, Professor, College of Health Professions, NY, NY
THE EFFECT OF CURCUMIN ON SOME OXIDATIVE STRESS PARAMETERS, LIVER ENZYMES AND CYTOKINES IN RATS GIVEN AFLATOXIN B1 ORALLY	Durmus HATİPOĞLU	Selcuk University, Faculty of Veterinary Medicine, Department of Physiology, Konya, Turkey
	Ercan KESKİN	Selcuk University, Faculty of Veterinary Medicine, Department of Physiology, Konya, Turkey
THE GENETIC CHARACTERISTICS OF CANINE DISTEMPER VIRUS ISOLATED FROM INFECTED DOGS AT CAN THO CITY IN THE MEKONG DELTA VIETNAM	Tran Thi Thao Tran Ngoc Bich Nguyen Khanh Thuan Dang Thi Tham Van My Tien	Department of Veterinary Medicine, College of Agriculture, Can Tho University
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Session-3, Hall-3

10.07.2021

Moderator: Assist. Prof. Dr. E. Copuroglu

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Title	Author(s)	Affiliation
COUNTING CUBE: TEACHING PRESCHOOL CHILDREN ON BASIC NUMERACY USING A SPECIALLY MODIFIED DICE GAME	Erynna Syeffera Lucas	Keningau Vocational College, Early Childhood Education, Keningau, Sabah Institute
	Werollisa Elna Wilber	Keningau Vocational College, Early Childhood Education, Keningau, Sabah Institute
A STUDY ON AWARENESS OF SMALL FIRMS ON CUSTOMER SATISFACTION WITH COST SAVINGS IN REVERSE LOGISTICS	Raghavendra B.S.	Accenture, Financial analyst, Bangalore, India
	Dr. Chandan Chavadi	Presidency College, Professor and Dean CMS, Bangalore, India
	Dr. Ravikeerthi J V	Presidency College, Associate Professor CMS, Bangalore, India
USE OF VIOLENCE AND SEX CONTENT IN THE PROMOTION OF CRIME WEB SERIES IN INDIA: MIX METHOD TO UNDERSTAND THE MARKETING STRATEGY AND ITS EFFECTS	Ms. CP Rashmi	Assistant Professor (HOD), Department of Journalism and Mass Communication, IES University, Bhopal Research Scholar, School of Media, Film and Entertainment, Sharda University, Greater Noida
	Mr. Lalitank Jian	Assistant Professor, Department of Journalism and Mass Communication, IES University, Bhopal
HOUSES AND LAMS (FUNCTIONAL DIFFERENCE BETWEEN HOUSES AND LAMS)	Aysel Hüseynzadə Amil qızı Prof. Hacıyeva Səbinə	Azərbaycan Memarlıq və İnşaat Universiteti
WAYS OF DEVELOPMENT OF LANKARAN ARCHITECTURE	Aysel Hüseynzadə Amil qızı Prof. Hacıyeva Səbinə	Azərbaycan Memarlıq və İnşaat Universiteti
THE MAIN DIRECTIONS OF EXPORT PROMOTION AND IMPORT SUBSTITUTION POLICY IN AZERBAIJAN	Allahverdiyeva Samira	Ph.D. Candidate from Western-Caspian University
PERSONALITY TRAITS PREDICTING DEPRESSION AND ANXIETY AND PREVENTIVE MEASURES ASSOCIATED WITH COVID-19	Betül Cömertoğlu	Işık University, Faculty of Science and Literature, Department of Psychology, İstanbul, Turkey.
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DETERMINATION OF NUTRITIONAL LEVELS AND PHYSICAL ACTIVITY HABITS OF PHYSICAL EDUCATION AND SPORTS TEACHERS IN THE COVID-19 PROCESS	Assoc. Prof. Dr. Süreyya Yonca SEZER	Munzur University
	Baha Engin ÇELİKEL	Firat University
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COMPARISON VALUES ON THE HEAT CAPACITY OF PUN NUCLEAR FUEL BY THE USE OF INTEGER AND NONINTEGER N-DIMENSIONAL DEBYE PARAMETER	E. Copuroglu	Gaziosmanpasa University, Faculty of Science and Art, Department of Physics
	B.A. Mamedov	Gaziosmanpasa University, Faculty of Science and Art, Department of Physics
DEMONSTRATING HEAT CAPACITY VARIATION OF THN NUCLEAR FUEL FOR INTEGER AND NONINTEGER N-DIMENSIONAL DEBYE PARAMETER	B.A. Mamedov	Gaziosmanpasa University, Faculty of Science and Art, Department of Physics
	E. Copuroglu	Gaziosmanpasa University, Faculty of Science and Art, Department of Physics
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ÖZET

Kuraklık, yaygın bir doğal felaket olup tüm insanlığı etkileyen küresel bir sorundur. Dünyanın dört bir yanında hızla artan nüfus, yoğun sanayi ve tarım faaliyetleri ile birlikte küresel ısınmanın yarattığı baskılar, iklim sistemleri üzerinde dengesizliklere yol açmaktadır. Bu dengesizlikler ise iklimin doğal döngüsü içerisinde var olagelmış olan kuraklık olaylarının sıklığı ve yoğunluğunu artırmaktadır. Tüm doğal felaketler içerisinde kuraklıklar, sosyal ve çevresel alanlar üzerinde en büyük yıkıcı etkiye sahip olma potansiyeli taşıyan afettir. Özellikle sürdürülebilir temiz su temini ve gıda güvenliği için ciddi bir tehdit oluşturan kuraklıkların değerlendirilmesi, dünya genelinde tatlı su kaynaklarının planlaması ve yönetimi için temel öneme sahiptir. Kuraklıkların değerlendirilmesi, kuraklık olayı ile ilişkilendirilen çeşitli meteorolojik ve/veya hidro-meteorolojik değişkenin gözlemine içermektedir. Dünya genelinde bu değişkenlere ait sağlıklı verilere erişim çoğunlukla mümkün olmamaktadır. Geçtiğimiz on yıllarda yaşanan teknolojik gelişmeler, iklimsel parametrelerin değişimini farklı yollarla gözleme imkânı vermiştir. Diğer taraftan, değişen veri kaynakları, kuraklıkların değerlendirilmesi amacıyla kullanılan kuraklık indekslerinin geliştirilmesinin de yolunu açmıştır. Tüm bu gelişmeler küresel, kıtasal ve bölgesel düzeyde araştırmaları süren kuraklık olaylarının; izleme, değerlendirme ve tahmininde kullanılan metot, metodoloji ve yaklaşımları etkilemiştir.

Literatürde yeralan kuraklık çalışmaları, kuraklığın nedenleri ve oluşumlarını inceleyen çalışmalar, kuraklıkların süre, sıklık ve şiddetinin karakterize edilmesi ve kuraklıkların tahmini çalışmaları, kuraklığın sosyal, ekonomik ve çevresel etkilerini doğrudan veya dolaylı olarak anlamaya ve tanımlamaya yönelik çalışmalar ve kuraklık risk yönetimi çalışmaları olmak üzere dört farklı kategoride toplanmaktadır. Bu çalışmada; kuraklığın tanımı ve kategorileri, nedenleri ve etkileri, kuraklıkların değerlendirilmesinde kullanılan indeksler ele alınmış, Dünya ve Türkiye'deki kuraklık izleme-değerlendirme ve tahmini çalışmaları incelenmiş, ayrıca literatürde yer alan kuraklık izleme-değerlendirme ve tahmini ile ilgili çalışmalardan elde edilen bilgiler ışığında değişen ve gelişen teknolojinin gelecekteki kuraklık izleme çalışmaları için kullanılma olanakları ve potansiyellerine yer verilmiştir.

Anahtar Kelimeler: Kuraklık analizi, kuraklık tahmini, teknolojik gelişmeler.

ABSTRACT

Drought is a widespread natural disaster and a global problem affecting all humanity. The pressures created by global warming together with the rapidly increasing population, intensive industrial and agricultural activities all over the world cause imbalances on the climate systems. These imbalances have been increasing the frequency and intensity of drought events that have existed in the natural cycle of the climate. Of all natural disasters, droughts are disasters with the potential to have the greatest devastating impact on social and environmental areas. Especially the evaluation of droughts that pose a serious threat to sustainable clean water supply and food security is essential for the planning and management of freshwater resources worldwide.

Assessment of drought needs observation of various meteorological and/or hydro-meteorological variables associated with the drought event. It is often not possible to access healthy data of these variables worldwide. In the past decades, technological developments have made it possible to observe the changes in climatic parameters in different ways. On the other hand, changing data sources have paved the way for the development of drought indices used to evaluate droughts. All these developments have affected the methods, methodologies and approaches used in the monitoring, evaluation and forecasting of drought events, which are under investigation at global, continental and regional levels.

Drought studies in the literature are collected in four different categories. These studies; examining the causes and occurrences of drought, characterizing the duration, frequency and severity of droughts, and forecasting droughts, aimed at understanding and defining the social, economic, and environmental impacts of drought directly or indirectly of studies, and drought risk management studies. In this study, the literature was examined, the drought of the definition and categories, causes and effects, indices used for the evaluation of drought, in the world and Turkey drought monitoring and evaluation as well as studies relating to the drought forecast. The possibilities and potentials of using the changing and developing technology for future drought monitoring studies were mentioned in light of the information obtained from the literature.

Keywords: Drought analysis, drought forecast, technological developments.

1. GİRİŞ

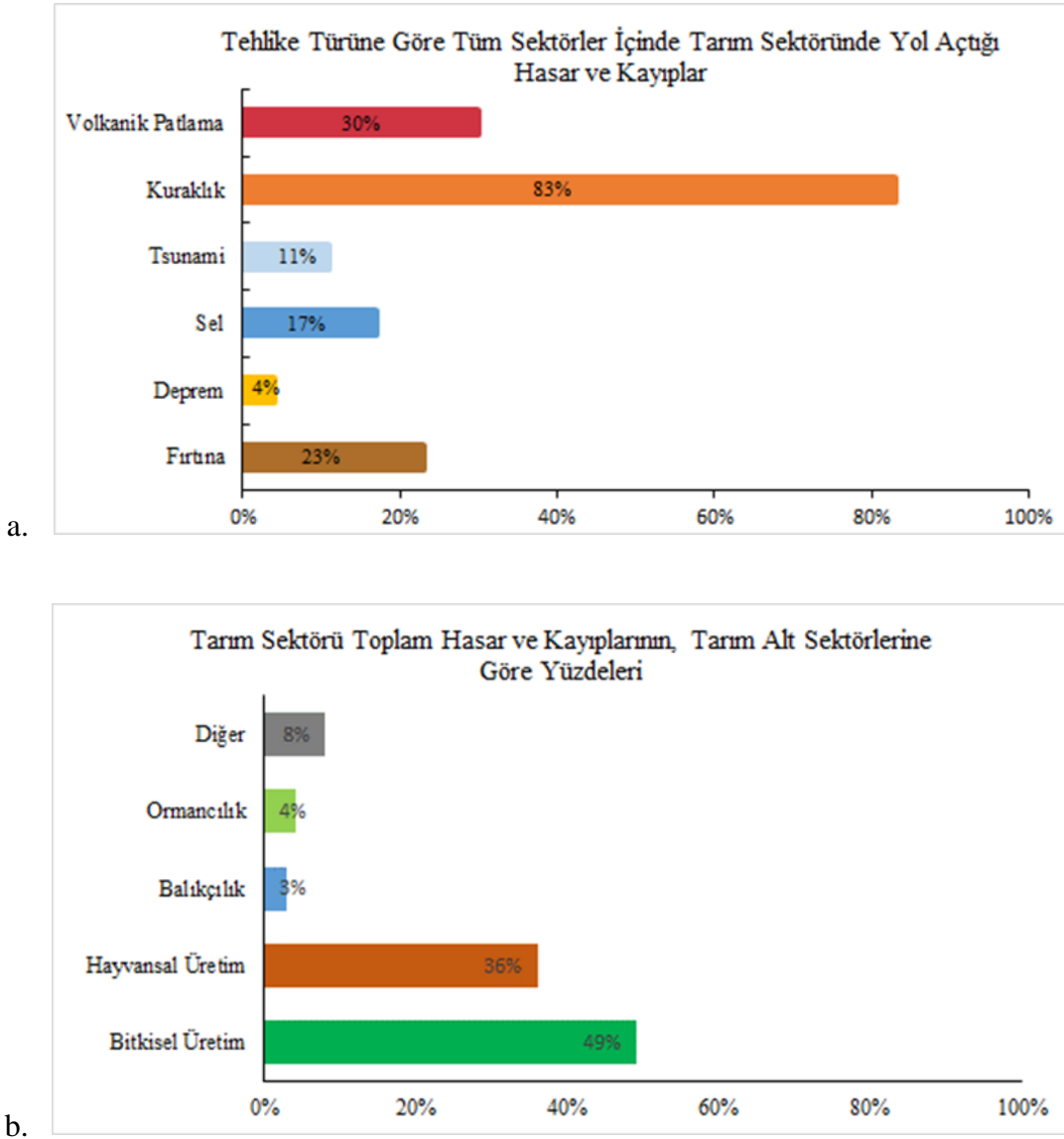
Kuraklığın birden fazla tanımı yapılmış olup, evrensel olarak kabul edilmiş bir tanımı yoktur. Farklı tanımların ortaya çıkmasında, disiplin veya disiplinler arası bakış açıları etkili olurken, kuraklıkla ilişkilendirilen iklimsel değişkenlerin bölgeye özgü farklılaşması da bu tanımları değiştirmektedir (Dai, 2011). Diğer taraftan kuraklık olayı, kolay izleme ve değerlendirilme ve yönetimi amacıyla dört farklı kategoride ele alınmaktadır (Dai, 2011). Bunlar; Meteorolojik kuraklık, Tarımsal kuraklık, Hidrolojik kuraklık ve Sosyo-ekonomik kuraklık olarak adlandırılmaktadır. Kuraklığın yaygın olarak kabul görmüş olan bu dört kategorisine ek olarak, literatürde Ekolojik kuraklık olarak adlandırılan yeni bir kuraklık sınıfı da önerilmiştir (Crausbay, Ramirez vd., 2017).

Meteorolojik kuraklık, beklenenden veya normalden daha düşük yağışların meydana geldiği dönem olarak tanımlanır (WMO, 1997). Fakat meteorolojik kuraklığın anlamı bölgeden bölgeye farklılık göstermektedir. Bunun sebebi yağışlarda azalmalara neden olan atmosferik koşulların her bölge için değişkenlik göstermesidir (Wilhite vd., 2014). Örneğin Arap ülkelerinin bazı bölgelerinde yağışsız geçen 2 yıl veya daha fazla süre, ABD’de 48 saat içinde 2.5 mm’den az yağış ölçülmesi, İngiltere de ise günlük toplam yağış miktarının 0.25 mm’den düşük olan 15 ardışık gün meteorolojik kuraklık olarak tanımlanmaktadır. Tarımsal kuraklık, ortalamanın altında yağışlar, yoğun ancak daha seyrek yağışlar veya normalin üzerinde buharlaşmanın neden olduğu kuru toprakların olduğu bir dönemdir ve bu etkilerin tümü bitki gelişiminin azalmasına ve bitkisel üretimde düşüklere yol açmaktadır (Wilhite ve Glantz, 1985). Hidrolojik kuraklık, akiferler, göller ve rezervuarlar gibi su depolama yapılarında su miktarının veya seviyesinin istatistiksel ortalamanın altına düşmesi olarak tanımlanır (Wilhite ve Glantz, 1985). Sosyoekonomik kuraklık, şiddetli kuraklık koşullarının etkilediği tarım, su kaynakları, turizm, ekosistemler vb. alanların ekonomik malların arz ve talebindeki dengesizliklere yol açmasıyla; temel insan refahının etkilendiği dönemdir (Eriyagama vd., 2008). Ekolojik kuraklık, ekosistemler üzerinde ciddi tahribatlar yaratan, ekosistemlerin yaşam döngüsü ile beraberinde doğal/yaban ve insan hayatını etkileyen dönemsel su eksikliği olarak tanımlanmaktadır (Crausbay, Ramirez vd., 2017). İlk üç kuraklık kategorisi fiziksel, hidrometeorolojik veya biyolojik parametrelerle tanımlanırken, dördüncü kuraklık kategorisi kuraklığın toplum üzerindeki etkisine (AMS, 2013) ve yeni önerilen beşinci kuraklık kategorisi ise kuraklıkların ekosistemler üzerindeki bütüncül etkisine odaklanmaktadır (Crausbay, Ramirez vd., 2017).

Kuraklığın oluşumunda doğal etmenler, iklim değişikliği ve antropojenik etkiler söz konusudur. Bunlardan ilki, iklim koşullarının meydana getirdiği doğal etmenlerdir. Dünya üzerindeki farklı iklimler, farklı atmosferik ve topoğrafik koşulları da beraberinde getirmektedir. Değişen atmosferik ve topoğrafik koşullar, yağış özellikleri ve sıcaklık dağılımlarını belirgin şekilde etkilemektedir ve bu doğal etki ile belirli bölgeler sürekli nemli iken bazı bölgeler ise sürekli kuru iklim koşullarına sahip olmaktadır. Kuru iklim koşullarının olduğu bölgeler kuraklıklara karşı daha savunmasızdır (WWF, 2010). Kuraklığın oluşumu üzerinde etkili olan ikinci etmen ise iklim değişikliğidir. İklim değişikliğine neden olan küresel ısınma etkisi ile artan sıcaklıklar, su ve toprak kütlelerinden olan buharlaşmayı artırmakta, düzensiz yağışları ve kar yağışlarının yağmur olarak düşmesi ve erken kar erimesi gibi durumları yaratmaktadır. Değişen bu iklim koşulları ise kuraklıkların daha sık meydana gelmesine neden olmaktadır (IPCC Özel Raporu, 2019). Antropojenik etkiler kuraklığa yol açan insan faaliyetleri kaynaklı nedenlerdir. Fosil yakıtların kullanılması, ormansızlaşma, arazi kullanımındaki değişiklikler ve sanayi süreçleri ile atmosfere salınan sera gazlarının atmosferdeki birikimi gibi insan faaliyetleri, sanayi devriminden günümüze hızla artmaktadır. Bu etkiler doğrudan küresel ısınmayı artırıcı etkiye sahip olup, dolaylı olarak kuraklığın gidişatını, hızını ve yönünü belirlemekte ve kuraklığın etkilerini şiddetlendirmektedir.

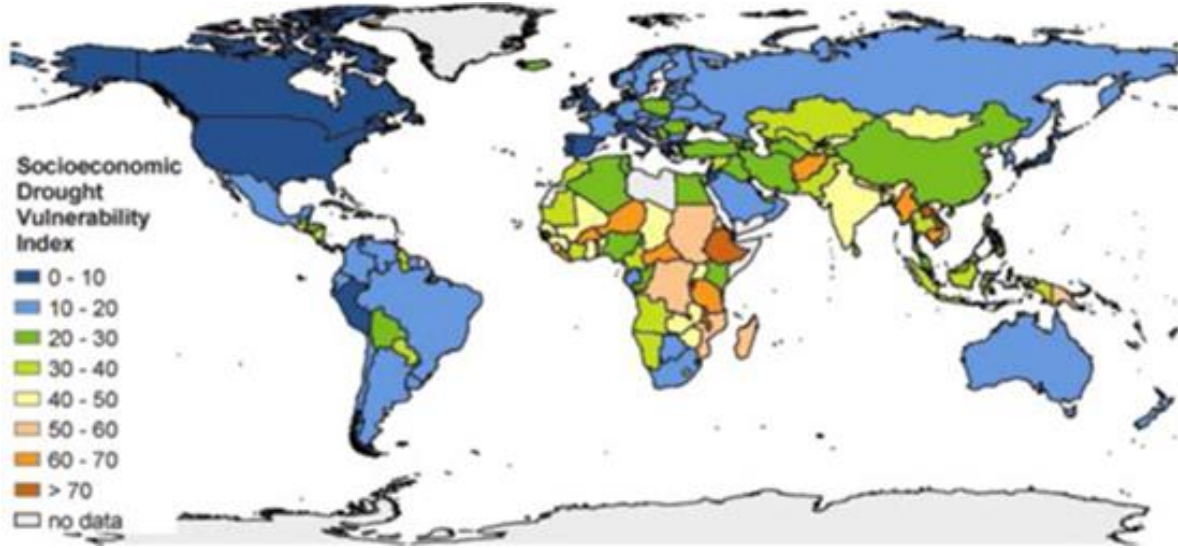
Kuraklığın doğrudan ve dolaylı etkileri su eksikliği ile ilişkilendirilmektedir (Şen 1998; Mishra ve Singh, 2010). Su eksikliği, doğrudan ve kısa vadede artan su taleplerinin karşılanamaması, ekolojik ve hidrolojik döngüde dengesizliklere yol açarken, dolaylı olarak, uzun vadede ciddi çevresel, sosyo-ekonomik ve toplumsal etkilere yol açmaktadır (Wilhite 2000, White ve Walcott 2009). Kuraklık, yağışlara ve bir o kadar da su talebi ve su tüketimine bağlı olarak yıldan yıla kümülatif olarak artış gösterebilir (WWF, 2010). Kuraklık ve kuraklığın kümülatif etkileri su eksikliği, su stresi, su kıtlığı, mutlak su kıtlığı, arazi bozulması ve çölleşme gibi süreçleri de ortaya çıkarabilmektedir (FAO, 2012; WMO, 1997; UNCCD, 1994). Su eksikliği, belirli bir yerde ve belirli bir zamanda uygun kalitede su temini

sıkıntısını ifade etmektedir (FAO,2012). Su stresi, su kıtlığı veya eksikliğinin neden olduğu etkilerdir (FAO,2012). Su kıtlığı, geçerli kurumsal düzenlemeler ve altyapı koşulları altında, belirli bir alanda mevcut arz ile ifade edilen tatlı ve temiz su talebi arasındaki açıktır (FAO, 2012). Mutlak su kıtlığı, kullanılabilen tüm tatlı su kaynaklarının kullanıldığı düzeydir (FAO, 2012). Arazi bozulması, arazinin başlıca kullanımları ve ekonomik bir kaynak olarak değeri dâhil olmak üzere, toprağın toplam üretim potansiyelinin azalmasıdır (FAO).Çölleşmeiklim değişiklikleri ve insan faaliyetlerinden kaynaklanan kurak, yarı kurak ve kuru alt nemli alanlardaki arazi bozulmasıdır (UNCCD, 1994).



Şekil 1. Doğal afetlerin tarım (a) ve tarım alt sektörleri (b) üzerindeki etkisi

Kuraklıkların neden olduğu hasar ve kayıpların yüzde 80'inden fazlası tarım sektörüne ait olup, hayvancılık ve bitkisel üretimi etkilemektedir (Şekil 1) ve özellikle küçük çiftlik sahipleri ve kırsal toplumların en yoksul üyeleri için gıda ve geçim kaynakları üzerinde ciddi sonuçlar doğurmaktadır (FAO, 2017). Diğer taraftan özellikle gelişmekte olan ve ülke ekonomisinin büyük bir kısmını tarımsal üretimin oluşturduğu ülkeler kuraklığın sosyal, fiziksel ve ekonomik etkilerine karşı oldukça savunmasızdır (Eriyagama vd., 2008) (Şekil 2).



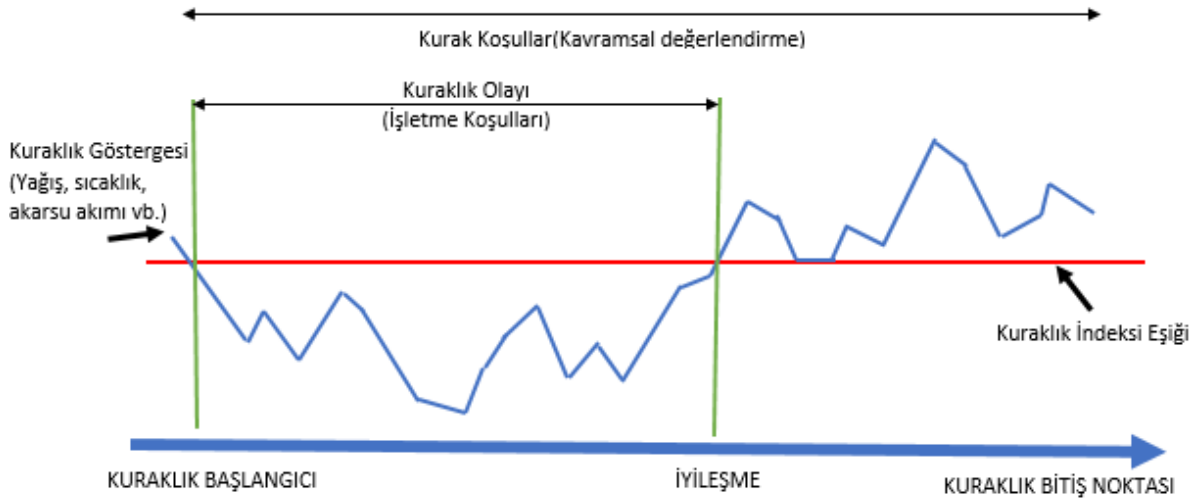
Şekil 2. Sosyo-ekonomik kuraklık indeksine göre ülkelerin tarımsal üretime dayalı ekonomik bağımlıkları

2. KURAKLIK İNDEKSLERİ

Kuraklık indeksleri, dünya çapında kuraklık koşullarını ölçmek ve kuraklık şiddetini değerlendirmek ve genel olarak kuraklıkların karakterize edilmesi için yaygın olarak kullanılmaktadır (Dai, 2011; WMO, 2012). Kuraklık göstergeleri, kuraklık koşullarını tanımlamak için kullanılan değişkenler veya parametrelerdir. Örneğin yağış, sıcaklık, akarsu akımı, yeraltı suyu ve rezervuar seviyeleri, toprak nemi ve kar miktarı. Kuraklık indeksleri ise, göstergeler dâhil olmak üzere iklimsel veya hidrometeorolojik girdiler kullanılarak değerlendirilen, kuraklık şiddetinin hesaplanmış sayısal temsilleridir (WMO ve GWP, 2016). Belirli bir dönemde bir arazi veya akarsuda meydana gelen niteliksel kuraklık durumunun ne zaman başladığını, ne zaman sona erdiğini ve etkilenen coğrafi bölgeyi belirlemek için bir şiddet eşiği belirleyerek ölçmeyi amaçlarlar (Şekil 3).

Kuraklığın ifadesi için çok sayıda indeks geliştirilmiştir, ancak hiçbirinin diğerlerine göre gereği önceliği yoktur, yalnızca bazıları belirli koşullarda daha iyi performansa sahiptir. Farklı kuraklık endeksleri arasında, Palmer Kuraklık Şiddet İndeksi (PDSI), Mahsullere Özgü Kuraklık İndeksi (CSDI), Yüzey Suyu Temini İndeksi (SWSI) ve Standardize Yağış İndeksi (SPI) su kaynakları yönetiminde yaygın olarak kullanılmaktadır (Hayes, 2011).

Ayrıca meteorolojik, tarımsal ve hidrolojik kuraklıkları izlemek için küresel olarak uygulanabilecek kuraklık indeksleri araştırmaları sürerken, 2009 yılında düzenlenen WMO kongresinde küresel meteorolojik kuraklıkların izlenmesinde, SPI standart küresel kuraklık indeksi olarak önerilmiştir (WMO, 2012). WMO ve GWP'nin 2016 yılında yaptığı bir çalışma ile geliştirilen kuraklık indeksleri gösterge tipleri ve kullanım kolaylıklarına göre meteorolojik, toprak nemi, hidrolojik, uzaktan algılama ve birleştirilmiş/modellenmiş olmak üzere beş grup altında sınıflandırılmıştır (WMO ve GWP, 2016)



Şekil 3. Kuraklıkların değerlendirilmesinde kuraklık indekslerinin kullanımı

3. KURAKLIK İZLEME-DEĞERLENDİRME ve TAHMİNİ ÇALIŞMALARI

Kuraklık izleme sistemleri, çok sayıda parametrenin zamana bağlı değişiminin sürekli izlenmesine dayanmaktadır. Etkileri, ciddi boyutlara ulaşabilen kuraklık olaylarına karşı savunmasızlığı azaltmanın yolu kuraklık izleme sistemleri ile sağlanabilmektedir (Pozzi vd., 2013). Yeryüzü gözlem araçları, uzaktan algılama teknolojisi ve iklim algılama sistemlerinin hızlı gelişmeleriyle, çok sayıda yüksek uzaysal, zamansal ve radyometrik çözünürlüklere sahip veri ile dünya üzerinde meydana gelen kuraklık olayları için önemli gözlemler sağlamaktadır (Hao vd., 2014). Genel olarak, kuraklık izleme sistemleri küresel sistemler, kıta sistemleri, bölgesel sistemler olmak üzere üç kategoride incelenebilir (Balti vd., 2020). Küresel kuraklık izleme sistemleri, uzun vadeli iklimsel kayıtları sağlama zorluğu nedeniyle genel olarak uydu görüntüleri aracılığıyla toplanan uzaktan algılama verilerini kullanmaktadır (Yong vd., 2015). Ayrıca toprak nemi ve yeraltı suyu gibi izlenmesi zor parametreler ile ilgili verilerin sağlanamaması veya yaklaşımlara dayalı modeller ile geliştirilmeleri sebebiyle küresel olarak izlenen kuraklık kategorisi genellikle meteorolojik kuraklıktır (Pozzi vd., 2013). Arazi yüzeyi modellerine dayalı olarak geliştirilen kıtasal kuraklık monitörleri, farklı kıtalarda meydana gelen kuraklıkları; uzun yıllar dağılımına göre karşılaştırıldığı yağış, toprak nemi, yüzey akışı gibi parametreleri birleştirilmiş kuraklık izleme indekslerine dayalı olarak izlenmektedir. Dünya da kara sistemleri üzerinde etkili olan farklı iklim özelliklerine sahip birçok bölge bulunmaktadır. Bu nedenle, bölge koşulları özelliklerinin daha iyi temsiliyi sağlayan detaylı veri setleri ve indeksler ile oluşturulmuş bölgesel kuraklık izleme sistemleri geliştirilmiştir. Bu sistemler genellikle bölgeye özgü hidrolojik döngünün farklı bileşenlerinin farklı zaman ölçeklerinde detaylı olarak izlenmesi ve tahmin edilmesi üzere uzun süreli hidrolojik ve meteorolojik veri ile kurulmaktadır. Bazı bölgelerde ise yeterli gözlem altyapısı ve veri kaydı bulunmaması nedeniyle daha az parametrenin izlendiği kuraklık izleme sistemleri de bulunmaktadır.

Tablo 1. Küresel kuraklık izleme sistemleri.

Sistem	Gösterge	Zaman Ölçeği	Çözünürlük	Referans
Küresel Kuraklık İzleme Portalı	SPI	Aylık	-	www.drought.gov/gdm/
Küresel Entegre Kuraklık İzleme ve Tahmin Sistemi (GIDMaPS)	SPI, SSI, MSDI	Aylık	0.5°, 2/3° x 1/2°, I°, 2.5°	http://drought.eng.uci.edu/
SPEI Küresel Kuraklık İzleme Monitörü	SPEI	Aylık	0.5°	Vicente-Serrano vd., (2010); http://sac.csic.es/spei/
NOAA/NESDIS Küresel Bitki Örtüsü Sağlığı Ürünü	VCI, TCI, VHI, NDVI	Haftalık	4 - 6 km	www.star.nesdis.noaa.gov/smcd/emb/vci/VH/vh_browse.php
Küresel Karasal Kuraklık Şiddet İndeksi	DSI	8 günlük, Yıllık	0.05°,0.5°	www.ntsug.umt.edu/project/dsi
Multi Model GDIS	Toprak Nem Yüzdesi, SWE	Aylık	0.5°	Nijssen vd., (2014)
GPCC Kuraklık İndeksi Ürünü	GPCC-DI	Aylık	I°	ftp://ftp.dwd.de/pub/data/gpcc/html/gpcc_di_doi_download.html
Princeton'un Küresel Mevsimsel Hidrolojik Tahmin Sistemi	Toprak Nem Yüzdesi ve Akış	Aylık	I°	http://hydrology.princeton.edu/

Tablo 2. Kıtasal kuraklık izleme sistemleri.

Sistem	Kıta	Gösterge	Zaman Ölçeği	Çözünürlük	Referans
Güney Asya Kuraklık İzleme Sistemi (SADMS)	Güney Asya	Entegre Kuraklık Şiddeti İndeksi, SPI, Toprak Nem İndeksi, VCI, TCI, PCI	Haftalık	500 m	http://dms.iwmi.org/
Avustralya Ulusal Kuraklık Haritası	Avustralya	RI, SWI, Planlı Büyüme İndeksi(PGI), Kuraklık Yön İndeksi (DDI)	Günlük	-	https://map.drought.gov.au/
Avrupa Kuraklık Gözlemevi	Avrupa	Kuraklık Eğilimi, SPI, Toprak Nemi, Fapar, CDI	Günlük, 10 Günlük, Aylık	-	http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000
Afrika Kuraklık İzleme ve Tahmin Monitörü	Afrika	SPI, Toprak Nem Yüzdesi, Akış, NDVI	Haftalık, Aylık	0.25°	http://stream.princeton.edu/AWCM/WEBPAGE/interface.php?locale=en
Kuzey Amerika Kuraklık Monitörü	Kuzey Amerika	Kategorik	Aylık	-	www.drought.gov/na/dm/

Tablo 3. Bölgesel kuraklık izleme sistemleri.

Sistem	Bölge	Gösterge	Zaman Ölçeği	Çözünürlük	Referans
Amerika Birleşik Devletleri Kuraklık Monitörü (USDM)	ABD	Kuraklık indeksleri, toprak nemi, hidrolojik iklimsel modellenmiş ve uzaktan algılanan girdiler	Haftalık	-	http://droughtmonitor.unl.edu/
Princeton ABD Kuraklık İzleme ve Tahmin Sistemi	ABD	Yağış Yüzdesi, Toprak Nemi, Akış, Kar Suyu Eşdeğeri	Aylık	0.125°	http://hydrology.princeton.edu/forecast/current.php
NLDAS Kuraklık İzleme ve Mevsimlik Kuraklık Tahmini	ABD	Yağış Anomali Yüzdesi, Evapotranspirasyon, Akış ve Kar Suyu Eşdeğeri	Günlük, Haftalık, Aylık	0.125°	www.emc.ncep.noaa.gov/mmb/nldas/drought
Evaporatif Stres İndeksi	ABD, K. Amerika,	Evaporatif Stres İndeksi (ESI)	Haftalık, Aylık	0.098°	https://hrrsl.ba.ars.usda.gov/drought/

G.Amerika						
Hindistan Deneysel Kuraklık Monitörü	Hindistan	SPI, SSI, SRI	Aylık	0.25°	Shah ve Mishra (2015)	
Almanya Kuraklık Monitörü	Almanya	Kuraklık kategorisi bazlı SMI	Günlük	4 km	www.ufz.de/droughtmonitor	
Çin Kuraklık İzleme Sistemi	Çin	Kuraklık kategorisi, CI, SPI	Günlük	-	http://cmdp.ncc-cma.net/en/	
Türkiye Kuraklık İzleme Sistemi	Türkiye	SPI (En az 30 yıllık veri seti ile oluşturulmuştur.)	Aylık	-	http://kuraklikizle.mg.gov.tr/	

Aşırı meteorolojik olaylar arasında, kuraklıklar oldukça yavaş gelişen ve genellikle uzun süre devam eden bir döngüye sahip olması nedeniyle tahmini oldukça zordur. Kuraklık tahmininin performansı mevsimlere, bölgelere ve tahmin edilecek zaman ölçeğine (kısa- orta- uzun) göre değişmektedir. Diğer taraftan kuraklık tahminleri, tahmin edilecek kuraklık kategorilerine göre değişen farklı girdi değişkenlerinin seçilmesini gerektirmektedir. Genel olarak yağış açıkları ile ilişkilendirilen meteorolojik kuraklık tahmini için girdi değişkeni olarak yağış verisi, hidrolojik kuraklık tahmini için girdi değişkeni akarsu akımları, rezervuar ve göl seviyesi verileri, yeraltı suyu seviyeleri, toprak nemi eksiklikleri ile ilişkilendirilen tarımsal kuraklık tahmini için girdi değişkeni olarak bitkisel ürün verimini etkileyen toprak nemi verileri ile yağış, sıcaklık ve toprak nemi kombinasyonları ve kuraklık türüne özgü indeksler ile gerçekleştirilmektedir. Kuraklık göstergeleri ve indekslerini içeren verilere dayalı tahmin modelleri, kuraklık olaylarını tahmin etmek için sıklıkla kullanılmaktadır. Genel olarak bu modeller üç alt ana başlık altında toplanmaktadır. Bunlar, istatistiksel modellere dayalı kuraklık tahmini çalışmaları, yapay zekâ tabanlı kuraklık tahmini çalışmaları, hibrit modellere dayalı kuraklık tahmini çalışmalarıdır.

Kuraklık tahmininde regresyon modelleri, zaman serisi modelleri ve olasılık modelleri olmak üzere üç farklı istatistiksel model kullanılmaktadır. Regresyon modelleri, iki veya daha fazla nicel değişken, değeri tahmin edilecek bir bağımlı değişken ve bağımsız değişkenler arasındaki ilişkinin araştırılması esasına dayanmaktadır. Literatürde regresyon modelleri arasından lojistik regresyon ve loglineer regresyon kuraklık tahmini çalışmaları için sıklıkla değerlendirilmiştir. Lojistik regresyon modeli günlük yağış, sıcaklık ve rüzgar hızı verileri ile meteorolojik kuraklığın belirlenmesinde (Stagge vd., 2015) ve aylık yağış serilerinde istatistiksel boyut indirgeme ile birlikte meteorolojik kuraklığın tahmininde (Tatlı, 2015; Meng vd., 2016) kullanılmıştır. Hidrolojik kuraklığın belirlenmesinde aylık yağış verileri loglineer regresyon ile modellenmiştir (Li vd., 2016). Regresyon modelleri, öngörücüler ile tahmin arasındaki ilişkinin doğrusal olduğu varsayımı yapmaktadır. Bu nedenle uzun süreli kuraklık tahmini için sınırlayıcı bir metottur. Zaman serisi modelleri, kuraklığa neden olan hidro-meteorolojik değişkenler zamana bağlı olarak değişmektedir. Bu nedenle hidrolojik zaman serilerinin analizinde zaman serisi modelleri sıkça kullanılmaktadır. Otoregresif

Hareketli Ortalama (ARIMA) ve Mevsimsel Otoregresif Hareketli Ortalama (SARIMA) stokastik zaman serisi modelleri kuraklık izleme ve tahmini için yaygın olarak kullanılmaktadır. Zaman serisi modelleri, meteorolojik, tarımsal ve hidrolojik kuraklıklar aylık yağış zaman serisinin ARIMA ile analizinde (Mishra vd., 2007) ARIMA ve SARIMA ile analizinde (Durdu, 2010), hidrolojik kuraklık için aylık akım zaman serisi AR yaklaşımı ile analizinde (Ochoa ve Rivera, 2008), hidrolojik kuraklık aylık yağış, sıcaklık, akım verileri ve uzaktan algılama indeksi ile oluşturulmuş zaman serisinin analizinde SARIMA (Abebe ve Foerch, 2008) kullanılmıştır. Zaman serisi modelleri, parametre kestirimi, aday modeller arasından en iyi modeli seçmek, kişinin tanımlama, tahmin ve kontrollerine bağlı olması nedeniyle sınırlayıcıdır. Olasılık modelleri, karmaşık yapıları nedeniyle kuraklık tahmini ve ayrıca kuraklığa neden olan hidro-meteorolojik değişkenlerle ilişkili belirsizlikleri ölçmek için kullanılmaktadır. Kuraklık tahmini için genellikle Markov Zinciri modelleri kullanılmıştır. Bu model kuraklığın zaman içindeki değişimini, olası bir eğilimi tespit etmek veya kuraklık sınıfları arasındaki geçiş olasılıklarını anlamak için uygulanan matematiksel bir yöntemdir (Banik vd., 2002). Olasılık modelleri, aylık SPI verileri ile tarımsal ve hidrolojik kuraklıkların belirlenmesinde Markov Zinciri (Paulo ve Pereira, 2007), bölgesel kuraklığın tahmini için yağış verilerinin olasılık dağılımının ve analizinin Markov Zinciri ile modellenmesinde (Chen ve Yang, 2012; Alam vd., 2014) , aylık akım verilerinin Yarı Markov Zinciri ile modellenerek hidrolojik kuraklık tahmininde (Nnaji vd., 2016), yağış ve akış verileri Markov Zinciri ile analiz edilerek, tarımsal ve hidrolojik kuraklık sürelerinin tahmininde (Zhang vd., 2017) kullanılmıştır.

Yapay Zekâ (YZ), çoğu disiplin ve disiplinler arası uygulamalardaki kullanım esnekliğiyle son yıllarda önemli metodolojilerden biri haline gelmiştir. Hidrolojik değişkenler arasındaki ilişkilerin ve olayların tahmininde genellikle, veri setlerinden kalıplar çıkaran YZ'nin alt dalı olan makine öğrenmesi ve veriler arasındaki ilişkiyi kara kutu yaklaşımına göre öğrenen ve bir makine öğrenmesi yöntemi olan derin öğrenme kullanılmaktadır. Literatürde, kuraklık tahmini için YZ tabanlı birkaç yöntem önerilmiştir. Yapay sinir ağları (YSA-ANN) su kaynakları ile ilgili modellerin regresyon, sınıflandırma ve tahmini uygulamalarında sıkça kullanılan oldukça güçlü makine öğrenmesi yöntemlerindedir. ANN yaklaşımı, yağış zaman serisini kullanarak, kuraklık indeksi değerlerinin tahmin edilmesinde (Morid ve diğerleri, 2007), hidrolojik kuraklığın aylık ölçekte tahmini için meteorolojik veriler ile Palmer Hidrolojik Kuraklık İndeksinin modellenmesinde (Cutore vd., 2009), günlük toprak nem içeriği, yağış, sıcaklık ve buharlaşma verileri kullanarak tarımsal kuraklığın modellenmesinde (Deng vd., 2010), bir bölgedeki kuraklığın yağış verileri ve SPI'ne dayalı olarak modellenmesinde (Sattari vd., 2011), aylık sıcaklık ve yağış verilerini kullanarak meteorolojik, tarımsal ve hidrolojik kuraklıkların Çok Katmanlı Algılayıcı mimarisi ile modellenmesinde (Ali vd., 2017), akım verileri ve akım kuraklık indeksi kullanarak bir akarsudaki hidrolojik kuraklığın ileriye dönük tahmininde (Erogluer ve Apaydın, 2020) ve benzer çalışmalarda sıklıkla kullanılmıştır. Rastgele Orman (RF), Karar Ağaçları (DT), Bulanık Mantık (FL), Destek Vektör Makinesi (SVM) ve Destek Vektör Regresyonu (SVR) kuraklık tahmini çalışmalarında sıkça kullanılan diğer YZ tabanlı yaklaşımlardır. RF yöntemi, aylık SPI zaman serilerinin tahminine dayalı bir kuraklık tahmin modeli oluşturulmasında (Chen vd., 2012), uzaktan algılama verileri ve indekslerini kullanarak kısa ölçekli kuraklık tahmin modelinin geliştirilmesinde (Park vd., 2016) kullanılmıştır. DT yöntemi, bir nehir havzasında SPI ile mevsimsel kuraklığın analizinde (Yürekli vd., 2012), SPEI' i tahmin etmek için (Sureh vd., 2019) ve yağış, sıcaklık, nispi nem ve rüzgar hızı verileri ile kuraklık analizinde (Sattari vd., 2012) kullanılmıştır. FL yöntemi, aylık yağış verileri ile meteorolojik kuraklık analizinde (Keskin vd., 2009), meteorolojik ve tarımsal kuraklığın aylık yağış, sıcaklık verisi ve PDSI ile tahmin edilmesinde (Ozger vd., 2011) ve meteorolojik değişkenler kullanılarak saatlik, günlük, haftalık ve aylık akış tahmin modelinin geliştirilmesinde

(Agboola vd., 2013) kullanılmıştır. SVM ve SVR yöntemleri, tarımsal kuraklığın tahmininde toprak nem içeriği, yağış, buharlaşma ve sıcaklık verilerini kullanan toprak su modelinin geliştirilmesinde (Deng vd., 2011), rezervuar kuraklıklarının tahmininde (Chiang ve Tsai, 2012; 2013), bir nehir havzasının uzun dönem yağış ve SPI'ne dayalı tarımsal ve hidrolojik kuraklığın tahmininde (Belayneh ve Adamowski, 2012) ve benzer çalışmalarda kullanılmıştır.

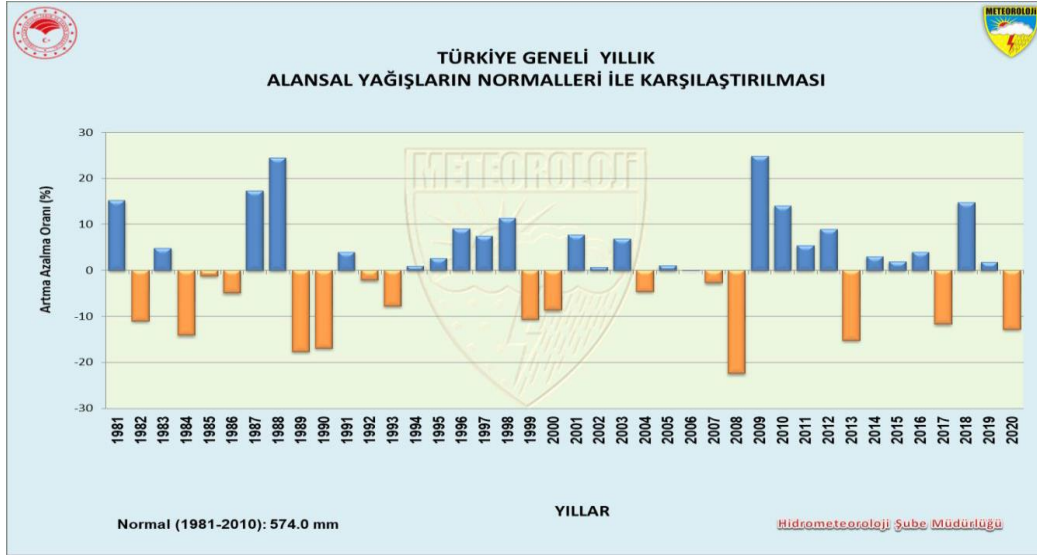
Son yıllarda ortaya çıkan diğer bir modelleme yaklaşımı da hibrit modellemedir (Sharma, 2006). Hibrit modeller genel olarak iki farklı şekilde oluşturulmaktadır; İlki farklı türden YZ tabanlı modelin birleştirilmesi ile oluşturulan hibrit modeller ve ikincisi ön işleme teknikleri ile modifiye edilmiş YZ tabanlı hibrit modellerdir. Hibrit modelleme yaklaşımı, farklı türdeki modellerin farklı üstünlükleri bir araya getirilerek veya veri üzerinde yapılan bazı ön işleme teknikleri ile tahmin performansının önemli ölçüde iyileştirilmesi hedeflenmektedir. Birleştirilmiş farklı modeller ile oluşturulan hibrit modeller, stokastik zaman serisi modeli ARIMA ve YZ tabanlı bir model olan ANN'nin birleştirildiği ARIMA-ANN hibrit modeli nehir havzası kuraklığının SPI'ne dayalı tahmininde (Mishra vd., 2007), FL ve ANN birleştirilmesiyle oluşturulmuş ANFIS hibrit modeli Türkiye koşullarında SPI'nin tahmininde (Bacanlı vd., 2009) ve ANFIS farklı bölgeler ve farklı kuraklık kategorilerinin tahmininde uygulanmış (Keskin vd., 2009; Dastorani vd., 2010; Farokhnia vd., 2011; Woli vd., 2013) yüksek bir performans sergilemiştir. Ön işleme teknikleri ile oluşturulmuş hibrit modeller, Dalgacık Dönüşümü (WT) ön işleme tekniği ile FL birleştirilmesi ile oluşturulan W-FL hibrit modeli PDSI tahmininde (Ozger vd., 2011), WT ile ANN birleştirilmesi ile oluşturulmuş W-ANN uzun süreli kuraklıkların tahmininde (Ozger vd., 2012) ve benzer çalışmalarda kuraklıkların tahmininde başarıyla uygulanmıştır.

3. TÜRKİYE KURAKLIK İZLEME-DEĞERLENDİRME ve TAHMİNİ ÇALIŞMALARI

Dünya Meteoroloji Örgütü'nün yaptığı bir çalışmaya göre Türkiye'nin de bulunduğu 74 ülkenin kuraklıktan etkilendiği tespit edilmiştir. Yine 87 ülkeden 59'unda su kıtlığı sorunu yaşanmaktadır. Afrika ile Türkiye ve Orta Doğu ülkelerini de kapsayan Asya Kıtası'nın batısı, artan su kıtlığı sorununa en çok hassas bölgelerin başında gelmektedir.

Türkiye'de 25 akarsu havzası bulunmakta olup, bu havzalara düşen yıllık ortalama alansal yağış miktarı (1981-2010) 574 mm'dir. Bu miktar yıllık ortalama 450 milyar m³'lük bir yağış hacmine denk gelmektedir. Bu suyun 172 milyar m³'ü akışa geçerek çeşitli büyüklükteki akarsular aracılığıyla denizleri ve kapalı havzalardaki gölleri beslemektedir. Türkiye'nin yeraltı suyu rezervi ise 23 milyar m³ ve bu miktarın 18 milyar m³ emniyetle kullanılabilir durumdadır. Teknik ve ekonomik olarak kullanılabilir yerüstü suyu miktarı yıllık 94 milyar m³ olan ülkemizin kullanılabilir durumdaki yeraltı ve yerüstü suyu potansiyeli yıllık 112 milyar m³'tür (DSİ, 2014). Yıllık kullanılabilir toplam su miktarının; 40 milyar m³'ü tarımsal sulama amaçlı, 7 milyar m³'ü içme-kullanma suyu olarak ve 7 milyar m³'ü sanayide olmak üzere toplam 54 milyar m³'ü kullanılmaktadır.

Türkiye'de yağışlar, 2008'den sonra 4 yıl, 2013'ten sonra 3 yıl, 2017'den sonra ise 2 yıl normalin altında gerçekleşmiştir. 2008 yılı, 1981 yılından günümüze kadar görülen en kurak yıl olurken, 2020 yılı en kurak 6. yıl olmuştur (MGM, 2021). Türkiye Geneli yıllık yağışlarının normali altında kalma periyodunun son yıllarda kısaldığı Şekil 4'de gözlenmektedir (MGM, 2021).



Şekil 1. Türkiye geneli yıllık toplam alansal yağışlarının normalleri ile karşılaştırılması

Türkiye Tarım ve Orman Bakanlığı'na bağlı genel bütçeli bir kuruluşu olan Meteoroloji Genel Müdürlüğü (MGM)'nin kuraklık konusundaki çalışmaları kapsamında kuraklık izleme sistemleri ve değerlendirmeleri yer almaktadır (MGM, 2012). MGM tarafından geliştirilen Kuraklık İzleme Sistemi 3.0 ise meteorolojik kuraklığın uzun dönemde ve farklı periyotlarda izlenebilmesi amacıyla hazırlanmıştır. Meteoroloji Genel Müdürlüğü'nün en az 30 yıllık kesintisiz yağış verisine sahip olan istasyonları için değerlendirme yapılmıştır. Bu veriler her ay sonunda güncellenmektedir. Programda uluslararası bir metot olan Standart Yağış İndeksi kullanılmıştır. SPI Metodu, kuraklığın 1, 3, 6, 9, 12 ve 24 aylık periyotlarda izlenmesine imkân vermektedir. Birbirinden kesin sınırlarla ayırmak mümkün olmamakla birlikte, 1, 3 ve 6 aylık analiz meteorolojik kuraklığı, 9 ve 12 aylık analizler tarımsal kuraklığı, 12 ve 24 aylık analizler ise hidrolojik kuraklığı görmek için kullanılmaktadır.

MGM'nin stratejik hedefleri kapsamında “Kuvvetli hava olayları ve meteorolojik karakterli afetler öncesinde yapılan tahmin ve erken uyarı ürünleri geliştirilmesi” ve kuraklık tahmin ve erken uyarı sisteminin geliştirilmesi yer almaktadır. Kuraklık konusunda bir diğer stratejik hedef “Meteorolojik olaylarla ilgili atmosfer model çalışmaları ve indeks uygulamaları”nın geliştirilmesi olarak belirlenmiş olup, bu kapsamda iklim, iklim değişikliği ve meteorolojik karakterli doğal afetlerin izlenmesi kapsamında halen kullanılmakta olan yöntemlere ek olarak yeni iklim, kuraklık ve çölleşme indekslerinin kullanımına başlanması planlanmaktadır (MGM, 2012).

2017-2023 Türkiye Ulusal Kuraklık Yönetimi Strateji Belgesi ve Eylem Planı

Ülkemizde hazırlanan Ulusal Kuraklık Yönetimi Strateji Belgesi ve Eylem Planı ile kurumların sorumlu olduğu alanlarla ilgili tedbirler ve önceliklere ilişkin gerçekleştirilen faaliyetler belirlenmektedir. Ek olarak, illerin kendi dinamiklerine ve özel koşullarına uygun her il için “İl Kuraklık Eylem Planı” hazırlanarak, bu planda yer alacak eylemlerin aktif olarak uygulanmasını da öngörmektedir. Bu eylem planı çerçevesinde;

- Havza esaslı sürdürülebilir kuraklık yönetimi için sonuç odaklı ve somut hedeflerle desteklenmiş bir politika belirlenmesi,
- Hedeflerin sorumlu kuruluşlarla birlikte tanımlanması,

- Kuraklıkla ilgili halkın bilgilendirilmesi, kamu kesimi, özel sektör, sivil toplum kuruluşları ile bilimsel kurumların koordineli ve katılımcı bir yaklaşımla hareket etmesinin teşviki ve desteklenmesi amaçlanmaktadır.

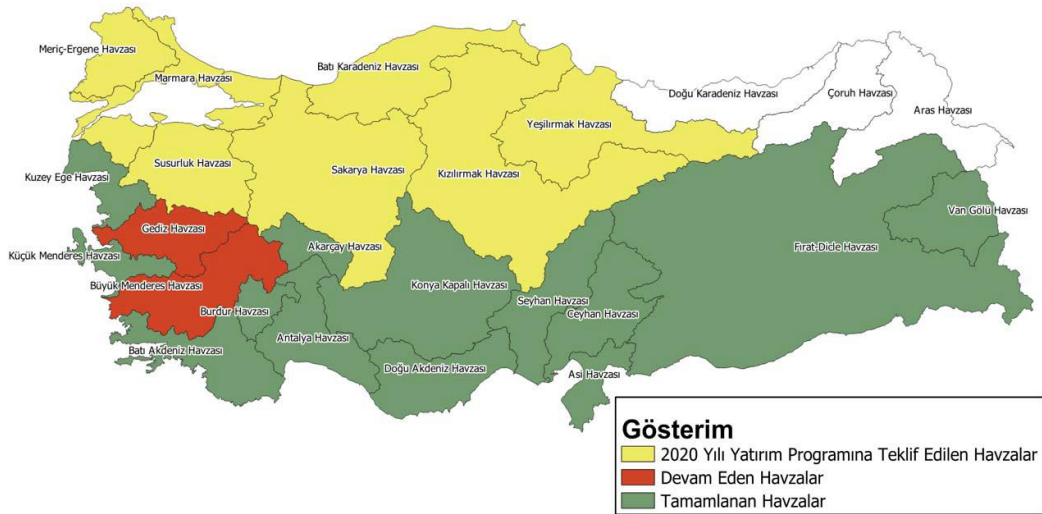
2018-2022 Türkiye Tarımsal Kuraklıkla Mücadele Stratejisi ve Eylem Planı

Tarımsal kuraklıkla ülke çapında mücadele etmek adına kısa, orta ve uzun vadeli önlemler alınmakta, kuraklığın etkilerini sürdürülebilir olarak azaltmak için eylem planları devreye sokulmaktadır. Türkiye Tarımsal Kuraklıkla Mücadele Stratejisi ve Eylem Planı 2008-2012 tarihleri arasında uygulanmış, 2013 yılında 2013-2017 yıllarını kapsayacak şekilde revize edilmiştir. Son olarak 2018-2022 Tarımsal Kuraklıkla Mücadele Stratejisi ve Eylem Planı hazırlanmıştır.

Birleşmiş Milletler Çölleşmeyle Mücadele Sözleşmesi (BMÇMS), 1994 yılında Paris'te kabul edilmiş ve 1996 yılında yürürlüğe girmiştir. Türkiye ise 1998 yılında sözleşmeye taraf olmuştur. Türkiye, üyeliğinin bir gereği olarak BMÇMS kapsamında gerçekleştirmekle yükümlü olduğu çalışmaları 2005 yılında “Çölleşmeyle Mücadele Türkiye Ulusal Eylem Programı” kapsamında uygulamaya başlamış ve 2008-2018, 2015-2023 ve son olarak 2019-2030 Çölleşmeyle Mücadele Ulusal Stratejisi ve Eylem Planı hazırlanmıştır.

Tarım ve Orman Bakanlığı, Su Yönetimi Genel Müdürlüğü'nce 25 havzada Kuraklık Yönetim Planlarının hazırlanması hedeflenmektedir. Bu planlar çerçevesinde, kuraklık gösterge ve indekslerinin seçilerek, eşik değerlerinin belirlenmesi, su bütçesi çalışmaları, kuraklık risk haritalarının çıkarılması, sektörel etkilenebilirlik analizleri ve kuraklık yönetim planlarının oluşturulması sürecini içermektedir. Havza Kuraklık Yönetim Planı ile yaşanması muhtemel kuraklık sebebiyle meydana gelecek havza yüzey suyu ve yeraltı suyu bütçesindeki değişime bağlı olarak içme-kullanma suyunun, tarımsal sulamanın, enerji üretiminin ve sucül ekosistemin ne şekilde etkileneceği de belirlenecek ve alınması gereken tedbirler de ortaya konmaktadır. Bu maksatla Kuzey Ege, Küçük Menderes, Batı Akdeniz, Doğu Akdeniz, Burdur, Antalya, Konya, Akarçay, Seyhan, Ceyhan, Asi, Dicle-Fırat ve Van Gölü Havzası olmak üzere 13 havzanın Kuraklık Yönetim Planları hazırlanmıştır. 2023 yılına kadar tüm havzalar için Kuraklık Yönetim Planlarının tamamlanması planlanmaktadır (Şekil 5).

KURAKLIK YÖNETİMİ PROJELERİ



Şekil 5. Türkiye Havza Kuraklık Yönetim Planları

4. TARTIŞMA, SONUÇ VE ÖNERİLER

Bu çalışmada kuraklığın tanımı ve kategorileri, nedenleri ve etkileri, kuraklıkların değerlendirilmesinde kullanılan indeksler, kuraklık izleme-değerlendirme sistemleri ve kuraklık tahmininde kullanılan yöntemler ile ilgili genel bir literatür çalışması yapılmıştır. Ek olarak Türkiye'deki kuraklıklar ve ülkemizin bu alanda yürüttüğü çalışmalara da yer verilmiştir. Literatürde yer alan kuraklık izleme-değerlendirme ve tahmini ile ilgili çalışmalardan elde edilen bilgiler ışığında hazırlanan sonuç ve önerilere bu bölümde yer verilmiştir.

Kuraklık izleme - değerlendirme sistemleri, kara yüzeyi su ve enerji akışlarının değişimini simüle eden Kara Yüzeyi Modelleri (LSM) ve Genel Dolaşım Modelleri (GCM)'lerin ve uzaktan algılama teknolojisinin kullanımı ile gelişim göstermiştir. Diğer taraftan geliştirilen küresel, kıtasal ve bölgesel kuraklık bilgi sistemlerinin çoğunun iyileştirilmesi gerekmektedir. Bu sistemlerde kullanılan tek tip kuraklık indeksi yerine kuraklıkların küresel, kıtasal ve bölgesel alanlardaki bitki örtüsü ve hidrolojik koşulları da ele alan entegre kuraklık göstergeleri ile izlenmesi daha etkili olacaktır. Su kaynaklarının sürdürülebilir yönetiminde meteorolojik, hidrolojik, tarımsal kuraklığın doğru tahmini oldukça önemlidir. Kuraklık tahmininde kullanılan modelleme yaklaşımları incelendiğinde geleneksel modelleme yaklaşımlarının yerini YZ tabanlı ve hibrit modelleme yaklaşımları almıştır. YZ tabanlı modeller genel olarak SPI, SPEI ve PDSI indekslerini başarılı bir şekilde tahmin etmiştir. Hibrit modeller farklı ayrı modellerin avantajlarını kullanarak veya ön işleme teknikleriyle modellerin iyileştirilmesiyle oluşturulduğundan geleneksel ve tek tip modellere kıyasla daha iyi sonuçlar elde edilmiş ve genel olarak kısa ve orta vadeli kuraklıkların tahmininde kullanımları önerilmektedir.

Ülkemizde meydana gelen kuraklık olaylarının tarihine bakıldığında geçmişten günümüze kadar çok sayıda kuraklık yaşandığı ve bazılarının ciddi boyutlara ulaşmış olduğu açık bir şekilde görülmektedir. Türkiye'de tarım, özellikle yağışlarla beslenen kuru koşullar altında kuraklıklara karşı ilk ve en savunmasız sektördür. Türkiye'de, su kullanımının yüzde 74'ünden fazlasını oluşturan tarımsal sulama uygulamaları ile toplam 5,5 milyon hektarlık bir alan sulanmaktadır. Sulamanın çoğu yüzey sulama yöntemleriyle yapılırken sulanan alanın sadece yüzde 6'sı yağmurlama ve damlama yöntemleriyle yapılmaktadır. Tarım, ülkemizdeki işgücünün yüzde 27'sini istihdam ederken ve Gayri Safi Milli Hasıla'nın yüzde 9'unu oluşturmaktadır. 2007-2008'de kuraklık nedeniyle tarım sektörüne verilen zarar yaklaşık 2 milyar ABD doları olmuş ve ciddi şekilde etkilenen 435.000 çiftçi, hububat ve mercimekte büyük üretim kayıpları yaşamıştır. Güneydoğu Anadolu Bölgesi'nde üretim kayıplarının buğday ve diğer tahıllarda yüzde 90, kırmızı mercimekte yüzde 60 olduğu tahmin edilmektedir. Diğer taraftan Ankara, İstanbul ve İzmir şehirleri de ciddi kuraklık riski altındadır ve bu illerdeki sektörel su kullanımları rezervuarlardaki tatlı su depolamaya bağımlıdır. Kuraklığın önlenmesi öncelikle etkin bir su yönetiminin uygulanması ile mümkündür. Türkiye'de su kullanımının en büyük payına sahip olan tarımsal sulama uygulamalarıdır ve aynı zamanda yaşanan kuraklık olaylarından da en çok etkilenen sektör tarım sektörüdür. Bu nedenle ülkemizde sürdürülebilir su ve gıda tedariki karşısında ciddi bir tehdit oluşturan kuraklıklarla, tarımda akılcı ve etkin bir su yönetimi ile mücadele edilebilir. Bunun yanında Türkiye ekonomisi, zengin doğal kaynaklarını kullanmak ve kuraklığın etkilerini hafifletmek için sürdürülebilir girişimler yapmak için iyi bir konuma sahiptir. Türkiye kuraklık riskine karşı çoğunlukla acil durumlarda çözüm geliştirmektedir, son yıllarda bunun yerine daha gerçekçi bir yönetim geliştirmenin yollarını aramaktadır. Türkiye'de kuraklık ile ilgili stratejik planların oluşturulması ve takibi son derece önemlidir. Bunun en iyi örneği, yerel ve il düzeyindeki kuraklık yönetimi bileşenlerini esas alan ve temel planlama araçlarını kullanarak hazırlanan kuraklık riskine karşı hazırlıklı olma ve kuraklık

azaltma önlemlerini ele almak için öncelik alanlarının ana hatlarını çizen Türkiye Ulusal Kuraklık Yönetimi Strateji Belgesi ve Eylem Planı ve Türkiye Tarımsal Kuraklıkla Mücadele ve Eylem Planlarının geliştirilmesi ve ulusal düzeyde etkin bir şekilde uygulanmasıdır.

KAYNAKLAR

1. Abebe A. ve Foerch G. 2008. Stochastic simulation of the severity of hydrological drought. *Water and Environment Journal*, 22, 2–10.
2. Agboola A., Gabriel A., Aliyu E. ve Alese B. 2013. Development of a fuzzy logic based rainfall prediction model. *International Journal of Engineering and Technology*, 3, 427–435.
3. Alam, A. J., Rahman, M. S., ve Sadaat, A. H. M. 2014. Markov chain analysis of weekly rainfall data for predicting agricultural drought. In *Computational Intelligence Techniques in Earth and Environmental Sciences*, 109–128.
4. Ali Z., Hussain I., Faisal M., Nazir H. M., Hussain T., Shad M. Y., Mohamd Shoukry A. ve Hussain Gani S. 2017. Forecasting drought using multilayer perceptron artificial neural network model. *Advances in Meteorology*, 1–9.
5. AMS. 2013. Drought: an information statement from the American Meteorological Society. Adopted by the American Meteorological Society Council.
6. Balti, H., Abbas, A. B., Mellouli, N., Farah, I. R., Sang, Y. ve Lamolle, M. 2020. A review of drought monitoring with big data: Issues, methods, challenges and research directions. *Ecological Informatics*, 60, 101136.
7. Banik, P., Mandal, A., ve Rahman, M. S. 2002. Markov chain analysis of weekly rainfall data in determining drought-proneness. *Discrete Dynamics in Nature and Society*, 7(4), 231–239.
8. Chen J. ve Yang Y. 2012. SPI-based regional drought prediction using weighted Markov Chain model. *Research Journal of Applied Sciences, Engineering and Technology*, 421, 4293–4298.
9. Crausbay, S., A. Ramirez, S. Carter, M. Cross, K. Hall, D. Bathke, J. Betancourt, S. Colt, A. Cravens, M. Dalton, J. Dunham, L. Hay, M. Hayes, J. McEvoy, C. McNutt, M. Moritz, K. Nislow, N. Raheem, ve T. Sanford. 2017. Defining ecological drought for the 21st century. American Meteorological Society.
10. Cutore P., Mauro G. ve Cancelliere A. 2009. Forecasting Palmer index using neural networks. *Journal of Hydrologic Engineering* 14, 588–595.
11. Dai, A. 2011. Drought under global warming: a review. *Wiley Interdisciplinary Reviews: Climate Change*, 2(1), 45–65.
12. Deng J., Chen X., Du Z. ve Zhang Y. 2011. Soil water simulation and prediction using stochastic models based on LS-SVM for Red Soil Region of China. *Water Resources Management*, 25, 2823–2836.
13. Durdu Ö. F. 2010 Application of linear stochastic models for drought forecasting in the Büyük Menderes river basin, western Turkey. *Stochastic Environmental Research and Risk Assessment*, 24(8), 1145–1162.
14. Eriyagama, N., Smakhtin, V. Y. ve Gamage, N. 2009. Mapping drought patterns and impacts: a global perspective. Vol. 133, Iwmi.

15. Eroğlu, T. ve Apaydın, H. 2020. Estimation of Drought by Streamflow Drought Index (SDI) and Artificial Neural Networks (ANNs) in Ankara-Nallihan Region. *Turkish Journal of Agriculture - Food Science and Technology (TURJAF)*, 8(2):348-357.
16. FAO, 2017. Water Report 44. Drought characteristics and management in Central Asia and Turkey.
17. FAO. 2012. Coping with water scarcity: An action framework for agriculture and food security. Food and Agriculture Organization of the United Nations, 78(100). Rome, Italy.
18. Hao, Z., AghaKouchak, A., Nakhjiri, N. ve Farahmand, A. 2014. Global integrated drought monitoring and prediction system. *Scientific Data*, 1(1), 1-10.
19. Hayes, M.J. 2011. Comparison of Major Drought Indices: Introduction. National Drought Mitigation Center.
20. IPCC Özel Raporu, 2019. Hurlbert, M., J. Krishnaswamy, E. Davin, F.X. Johnson, C.F. Mena, J. Morton, S. Myeong, D. Viner, K. Warner, A. Wreford, S. Zakieldeen, Z. Zommers : Risk Management and Decision making in Relation to Sustainable Development. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. In press.
21. Keskin M. E., Terzi Ö., Taylan E. D. ve Küçükyaman D. 2009. Meteorological drought analysis using data-driven models for the Lakes District, Turkey. *Hydrological Sciences Journal*, 54, 1114–1124.
22. Li J., Zhou S. ve Hu R. 2016. Hydrological drought class transition using SPI and SRI time series by loglinear regression. *Water Resources and Management*. 30, 669–684.
23. Meng, L., Ford, T. ve Guo, Y. 2017. Logistic regression analysis of drought persistence in East China. *International Journal of Climatology*. 37(3), 1444-1455.
24. Mishra A., Desai V. ve Singh V. 2007. Drought forecasting using a hybrid stochastic and neural network model. *Journal of Hydrologic Engineering*, 12, 626–638.
25. Mishra, A. K. ve V. P. Singh, 2010. A review of drought concepts. *Journal of hydrology*, 391(1-2), 202-216.
26. Morid, S., Smakhtin, V. ve Bagherzadeh, K. 2007. Drought forecasting using artificial neural networks and time series of drought indices. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, 27(15), 2103-2111.
27. Nnaji G. A., Clark C. J., Chan-Hilton A. B. ve Huang W. 2016. Drought prediction in Apalachicola–Chattahoochee–Flint River Basin using a semi-Markov model. *Natural Hazards*, 82(1), 267-297.
28. Ochoa-Rivera J. C. 2008. Prospecting droughts with stochastic artificial neural networks. *Journal of Hydrology*, 352, 174–180.
29. Ozger M., Mishra A. K. ve Singh V. P. 2011. Estimating Palmer drought severity index using a wavelet fuzzy logic model based on meteorological variables. *International Journal of Climatology*, 31, 2021–2032.
30. Palmer, W.C. 1965. Meteorologic Drought. US Department of Commerce, Weather Bureau, Research Paper No. 45, p. 58.

31. Park S., Im J., Jang E. ve Rhee J. 2016. Drought assessment and monitoring through blending of multi-sensor indices using machine learning approaches for different climate regions. *Agricultural and Forest Meteorology*, 216, 157–169.
32. Paulo A. A. ve Pereira L. S. 2007. Prediction of SPI drought class transitions using Markov chains. *Water Resources Management* 21, 1813–1827.
33. Sattari, M.T., Anli, A. S., Apaydin, H. ve Kodal, S. 2012. Decision trees to determine the possible drought periods in Ankara. *Atmosfera*, 25(1), 65-83.
34. Sattari, M.T., Yürekli, K. ve Ünlükara, A. 2011. Karaman ilinde yapay sinir ağları yaklaşımı kullanılarak kuraklığın tahmini. *Tarım Bilimleri Araştırma Dergisi*, 4 (1):7-13.
35. Shah, R. D. ve Mishra, V. 2015. Development of an experimental near-real-time drought monitor for India. *Journal of Hydrometeorology*, 16(1), 327-345.
36. Stagge, J. H., Kohn, I., Tallaksen, L. M. ve Stahl, K. 2015. Modeling drought impact occurrence based on meteorological drought indices in Europe. *Journal of Hydrology*, 530, 37-50.
37. Sureh, F. S., Sattari, M. T. ve İrvem, A. 2019. Estimation of monthly precipitation based on machine learning methods by using meteorological variables. *Mustafa Kemal Üniversitesi Tarım Bilimleri Dergisi*, 24, 149-154.
38. Şen, Z. 1998. Probabilistic formulation of spatio-temporal drought pattern. *Theoretical and applied climatology*, 61(3), 197-206.
39. Tatlı, H. 2015. Downscaling standardized precipitation index via model output statistics. *Atmosfera*, 28(2), 83-98.
40. UNCCD. 1994. Elaboration of an international convention to combat desertification in United Nations Environment Programme (UNEP), 2006. *Geo Year Book 2006: An Overview of Our Changing Environment*, Nairobi.
41. Vicente-Serrano, S. M., Beguería, S. ve López-Moreno, J. I. 2010. A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. *Journal of climate*, 23(7), 1696-1718.
42. W., Sheffield, J., Stefanski, R., Cripe, D., Pulwarty, R., Vogt, J. V. ve Lawford, R. 2013. Toward global drought early warning capability: Expanding international cooperation for the development of a framework for monitoring and forecasting. *Bulletin of the American Meteorological Society*, 94(6), 776-785.
43. White, D. H. ve Walcott, J. J. (2009). The role of seasonal indices in monitoring and assessing agricultural and other droughts: a review. *Crop and Pasture Science*, 60(7), 599-616.
44. Wilhite, D. A. 2000. Drought as a natural hazard: concepts and definitions.
45. Wilhite, D. A. ve M.H. Glantz. 1985. Understanding: The Drought Phenomenon: The Role of Definitions. *Water International* 10(3), 111-120.
46. Wilhite, D. A., Sivakumar M. V. K. ve R.S. Pulwarty. 2014. Managing drought risk in a changing climate: The role of national drought policy. *Weather and Climate Extremes* 3: 4-13.
47. WMO, 1997. *Climate, Drought and Desertification*. Rapor No: 869. Geneva.
48. WMO, 2012. *Standardized Precipitation Index User Guide*, No.1090, Geneva.

49. World Meteorological Organization (WMO) and Global Water Partnership (GWP), 2016: Handbook of Drought Indicators and Indices (M. Svoboda and B.A. Fuchs). Integrated Drought Management Programme (IDMP), Integrated Drought Management Tools and Guidelines Series 2. Geneva.
50. WWF, 2010. Global Water Scarcity: Risk and challenges for business.
51. Yong, B., Liu, D., Gourley, J. J., Tian, Y., Huffman, G. J., Ren, L., ve Hong, Y. 2015. Global view of real-time TRMM multisatellite precipitation analysis: Implications for its successor global precipitation measurement mission. *Bulletin of the American Meteorological Society*, 96(2), 283-296.
52. Yürekli, K., Taghi Sattari, M., Anlı A. S. ve Hınıs, M. A. 2012. Seasonal and annual regional drought prediction by using data-mining approach. *Atmósfera*, 25(1), 85-105.
53. Zhang, T., Li, J., Hu, R., Wang, Y., ve Feng, P. 2017. Drought class transition analysis through different models: a case study in North China. *Water Science and Technology: Water Supply*, 17(1), 138-150.

**YAŞAYIŞ EVLƏRİ VƏ LƏMLƏR (YAŞAYIŞ EVLƏRİ VƏ LƏMLƏRİN
FUNKSIONAL FƏRQLƏNDİRİLMƏSİ)**

HOUSES AND LAMS (FUNCTIONAL DIFFERENCE BETWEEN HOUSES AND LAMS)

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Açar sözlər: Ləm, yaşayış evləri , nadir tikili**Keywords:** Lam, living houses, rare building**Ключевые слова:** Лам, жилые дома, редкое здание**ABSTRACT**

The folk residential architecture in the southern part of our country is distinguished by its originality. This includes summer houses called Lam. These buildings from the XVIII-XIX centuries are mostly found in Lankaran, Astara and Masalli districts. In the past, there were about 50 Lams in the Archivan village of Astara alone. Later, due to natural disasters or neglect, the buildings were destroyed. During the summer, the Lams played an important role in the family's comfort, hospitality and overnight stay. At present, this unique architectural example is kept in the yard of Asadulla Musayev, a resident of Archivan village. Lam was reconstructed two years ago by specialists from the Ministry of Culture's Restoration Department.

GİRİŞ

Bol atmosfer yağıntıları ilə xüsusi olaraq seçilən, Lənkəran subtropik bölgəsi binaların mühüm hissələrində istifadə olunan zəngin ağac növləri ilə məşhur idi. Eyni ilə, Quba-Xaçmaz bölgəsində olduğu kimi, məhz burada da sifarişçinin maddi vəziyyətindən asılı olaraq bişmiş kərpic və çiy kərpic əsas tikinti materialı olaraq, istifadə edilirdi. Ölkəmizin cənub bölgəsində olan xalq yaşayış üslubu və bədii xüsusiyyətləri, özünəməxsusluğu ilə seçilir. Bu memarlıq və tarixi-mədəni abidələr, eyvan görünüşü yaratmaqla yanaşı, həm də çox peşəkar sənətkarlıqla tikilib. Ləmlər əsasən Astara, Lənkəran, Masallı, Lerik və Yardımlı ərazisində aşkarlanmışdır. Ləmlər də, həmçinin Talış bölgəsinin xalq yaşayış arxitekturasını əks etdirir və özünə xas üslubu ilə seçilir. Bu kimi tikililər dağətəyi və düzən ərazilərdə üstünlük təşkil edirdi. Bu tikililər xüsusi ilə, orta və son əsrlərdə istifadə olunsalar da, günümüzdə də bunlardan bir neçəsinin mövcudluğuna şahidlik edirik. Bunlardan Astara rayonunda 19 ləm, Lənkəran rayonunda 2 ləm, Masallı rayonunda isə 1 ləm olduğunu qeyd etmək lazımdır. Hal-hazırda, onlar xüsusi və yerli əhəmiyyətli abidə olaraq dövlət tərəfindən mühafizə olunmaqdadır. Sovet dönəmində, həmçinin ləmdən kino çəkilişlərində də istifadə olunmuşdur. Belə ki, 1964-cü ildə, rejissor Ağarza Quliyev tərəfindən ekranlaşdırılmış, “Ulduz” kinofilminin bir çox kadrları Astara rayonunun Ərçivan kəndində, Əsədulla Musayevin həyətindəki ləmdə çəkilib. Qeyd edək ki, həmin ləm günümüzdə də mövcudluğunu saxlamaqdadır.

Əsas hissə

Lənkəran Azərbaycan Respublikasının ən qədim şəhərlərindən biri olmaqla yanaşı, həm də cənub bölgəsinin ən böyük şəhəridir. Həmçinin “Cənub mirvarisi” də adlanır. Ötən əsrin əvvəllərində və keçmiş zamanlarda, hər bir şəhərimizin yenidən qurma və bərpa işləri reallaşdırılarkən, müəyyən ictimai tələblər də nəzərə alınmışdır. Milli şəhərsalma prinsiplərinin çox ciddi və məsuliyyətli qorunduğu yaşayış məntəqələrindən biri də, məhz

Lənkəran qala-şəhəri olmuşdur. Burada inkişaf və bərpa işləri zamanı, nəinki binaların tikintisi, yolların çəkilişi, döşənməsi, hətta şəhərdə hansı şəxslərin yaşaya bilməsi amili də mühüm olaraq qeydə alınmışdır.

Xalq memarlığı inciləri sayılan malikanə tipli kütləvi yaşayış evləri ilə yanaşı, həmçinin şəhərin mərkəzi rayonunda XX əsrin əvvəllərində yerli əhalinin zəngin təbəqəsinin, eləcə də talış xanları varislərinin modern, eklektika üslubunda inşa edilən tikililəri meydana gəlmişdir. Lənkəran əhalisinin yüksəliş prosesi çox ləng gedirdi, bu səbəblə də şəhər ərazisinin genişliyi ilə bağlı olaraq, tikililərin böyük sıxlıqla inşa edilməsinə heç bir ehtiyac yox idi. [3]

Ləmlər “yay evləri” olaraq da adlanırdı. XVIII-XIX əsrlərdən qalan bu tikililərə daha çox Lənkəran, Astara, Masallı rayonları, ərazisində rast gəlinir.

Vaxtilə yalnız Astaranın Ərçivan kəndində 50-yə yaxın Ləm mövcud olmuşdur. Sonrakı zamanlarda isə, bu tikililər təbii fəlakətlərin təsirindən və ya diqqət edilməməsi səbəbi ilə dağıntıya məruz qalmışdır. [1] Yay fəsli zamanı, günəşli günlərdə ailənin rahat həyat şəraiti olmasında, Ləmlərin rolu böyük olub. Astara rayonunun Ərçivan kəndində yerləşən, Əsədulla Musayevin həyətində yerləşən Ləm iki il bundan əvvəl Mədəniyyət Nazirliyinin Bərpa İdarəsinin mütəxəssisləri tərəfindən yenidən rekonstruksiya edilib. [2]

Lənkəran rayonunun Boladi kəndində yerləşən, XIX əsrdə yay fəslində istidən qorunmaq, həmçinin istirahət üçün inşa edilmiş, dörd tərəfi açıq sütunlar üstündə olan ikimərtəbəli guşə də belə abidələr sırasında yer almaqdadır. Ləm Boladi adlanan bu yer “yay evi” də adlanır. Ləmlər əsasən Cənub bölgəsində XVIII-XIX əsrlərdə daha geniş yayılmışdır. Artıq istilər yaxınlaşdığı zaman isə, insanlar daimi yaşayış evlərini bir müddətlik olaraq tərk edib, bu yay evlərinə köçərmişlər. Ləmin aşağı hissəsi (sütunları) qırmızı kərpicdən, yuxarısı isə meşə ağacından düzəldilir və müxtəlif əl işləri ilə dekorasiya edilir, bu da öz növbəsində ləmə xüsusi və özünəməxsus gözəllik bəxş edir. Ümumiyyətlə, ləmlər Cənub zonasının spesifik tikililəridir ki, bu tikililərə başqa zonalarda rast gəlinməməkdədir. [4]

Bu tikililər istirahət məkanıdır. Yayda burada istirahət edirlər. Qədim dövrlərdə arabalar olub, maşın olmayıb. Buradan keçən insanlar isə, burada gecələyib istirahət edərmişlər. Sanki o vaxtlar ustalar biliblər ki, bu səmtdə hzəin külək əsir. İkinci mərtəbəyə çıxanda da külək əsir. O küləyin yeridir. Yayda yaxşı istirahət etmək olur. Astaranın Ərçivan kəndindəki ləmin maraqlı bir tarixçəsi də ondan ibarətdir ki, burada 1963-cü ildə ən məşhur kino filmlərimizdən biri olan Ulduz bədii filmi çəkilib. Filmdəki dillər əzbəri olan Məhəmməd və Züleyxanın səhnəsi məhz bu ləmdə çəkilmişdir. Bir zamanlar yerli əhalinin yay yaşayış evi olan bu tikililər, indi tarixi əhəmiyyətli abidə kimi dövlət tərəfindən mühafizə olunur. Ləmlərin inşa edildiyi əsas ərazilər isə, əsasən yaşayış evlərinə yaxın məkanlar, bağlar olmuşdur. Kvadrat formasında olan bu tikililər əsasən 2 və 3 mərtəbəlidir. Bünövrəsi qırmızı kərpicdən, digər hissələri isə yerli meşə materiallarından çəkilən şalban və taxtalardan, damı isə suğal adlanan kirəmitdən düzəldilmişdir. Maraqlısı isə odur ki, inşasında istifadə olunan ağac materialları bir birinə keçirmə yolu ilə işlənib və heç bir mismardan istifadə edilməyib. Hava şəraitinin daima normal qaydada olmasına görə, Ləmin ətrafına sədd çəkilməyib. [5]

Hal-hazırda isə, Masallıda 1 ləm və Lənkəranda da müəyyən ərazilərdə bir-neçə ləmə rast gəlmək mümkündür. Həmçinin Astara rayonu ərazisində də, bu tipli müəyyən qədər ləmlər qalıb ki, sonradan bu tikililər gözəl arxitektura nümunəsi olduğuna və özünəməxsus fərqli xüsusiyyətlər daşdığına görə əhəmiyyətli abidələr kimi dövlət uçotuna verilmişdir. Astarada yerli iqlim şəraitinə əsaslanan ləmin fərqli bir üslubda, tikinti növü də mövcuddur. Bu isə, ləm tipində inşa edilən iki mərtəbəli yay evləridir. Bu kimi tikililərə isə, ərazidə əsasən nadir hallarda rast gəlmək mümkündür. [4]

NƏTİCƏ

Bir sözlə, ləmlər Azərbaycanın ən nadir arxitektura və bədii xüsusiyyətlər nümunələrindəndir. Məhz bu tikililər dövrünün çox gözəl sənətkarlığı ilə tikilmişdirlər. Ləmlər özünəməxsus görkəmə və orijinallığa, üsluba malik olduğundan, eyni zamanda, Azərbaycanın yalnız Talış yaşayış məskənlərində mövcud olduğuna görə, tarixi abidə kimi də diqqəti çəkən tikililərdəndir. Ləmlər, həmçinin isti yay günlərində, istirahət üçün inşa olunmuş, “Yay evləri”dir.

ƏDƏBİYYAT SİYAHISI

1. Hüseynbala oğlu B. Talışlı M., “Lənkəran” 1990
2. Şəfiyev Ə. “Azərbaycanın cənub bölgəsinin tarix və mədəniyyət abidələri”. Bakı-2007.
3. Əliyarlı S. “Azərbaycan tarixi üzrə qaynaqlar”. Bakı, “Çıraq”, 2007.
4. Lənkəran ləmləri. Kəpəz TV, 29.03.2013
5. “Söz” jurnalı, oktyabr 2016

LƏNKƏRANIN MEMARLIĞININ İNKİŞAF YOLLARI WAYS OF DEVELOPMENT OF LANKARAN ARCHITECTURE

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Açar sözlər: Memarlıq, tədqiqat, antik

Keywords: Architecture, research, antique

Ключевые слова: Архитектура, исследовать, античный

ABSTRACT

The history of Lankaran region, one of the most beautiful and charming corners of Azerbaijan, is very old. Archaeological excavations in the region confirm that people lived in these areas as early as the Bronze Age, in the III-II millennia BC. Lankaran is also one of our regions rich in historical, religious and architectural monuments. The topic we will discuss in this article is about the history and development of Lankaran architecture

GİRİŞ

Görkəmli Azərbaycan alimi, tarixçi və mütəfəkkiri Abbasqulu ağa Bakıxanov "Gülüstani İrəm" (1841), Mirzə Əhməd Mirzə Xudaverdi oğlu 1882-ci il tarixində qələmə aldığı "Əxbərnəmə" kitablarında "Ləngərkünən" adlandırılmış Lənkəran antik tarixə malikdir. XVII əsr alman alimi Adam Oleari isə bu şəhəri, məhz Lənkərkünən olaraq, adlandırmışdır. Lakin burada, arxeoloqlar tərəfindən aparılan, arxeoloji tədqiqatlar geniş əraziləri əhatə etmədiyinə görə şəhərin inşası tarixi, hələki fakt və sübutlarla, dəqiq müəyyənləşdirilməmişdir. Buna baxmayaraq bölgə ərazisində aparılmış araşdırmalar bu yerlərdə, hələ lap qədim dövürlərdən insanların yaşadığının təsdiqini tapmışdır. Xüsusilə də əlverişli iqtisadi-coğrafi mövqeyi, füsunkar təbiətə məxsusluğu, geniş ticarət əlaqələri, qərblə-şərqi birləşdirən vacib karvan yollarının üstündə və Xəzər dənizi sahillərində yerləşməsi, şəhərin inkişafını bir qədər də sürətləndirmişdir.

ƏSAS HİSSƏ

Bu ərazidə reallaşdırılmış arxeoloji qazıntılar Lənkəran ərazisində hələ tunc dövründən, yəni eramızdan əvvəl III-II minilliklərdə qədim insanların yaşaması üçün əlverişli şərait olduğunu, insanların yaşadığını təsdiq etmişdir. Məhsuldar torpaqları, isti su bulaqları və mülayim iqlimə məxsus, Lənkərandə əhalinin ən qədim məşğuliyyəti əkinçilik, maldarlıq, bostancılıq, bağçılıq, balıqçılıq, ipəkçilik və arıçılıq olmuşdur. Qədim Lənkərandə dəmirçilik, dulusçuluq, və digər bir-cox sənət sahələri geniş yayılmış, xanlığın sosial-iqtisadi inkişafında ticarət mühüm rol oynamış, İran, Türkiyə, Rusiya, Orta Asiya dövlətləri ilə və həmçinin Çin, Pakistan, Hindistan kimi ölkələrlə çox əhatəli və sürətli inkişafda olan ticarət əlaqələri yaradılmışdır. Qədim şəhər özünəməxsus memarlığı, 8-19-cu əsrlərə aid tarixi binaları, zəngin mədəni irsi və adət-ənənləri ilə misilsiz görünüşə məxsusudur. Memarlıq abidələri üçün yenidənqurma və bərpa işlərinə xüsusi diqqət yetirilmişdir. İlk əvvəl Məscidlərin, qalaların içərisində bərpa işləri aparılmış, dizayn tərtibini yeni tərz və üslubda etmək səyləri göstərilmişdir. Lənkərandə tarixi görməli yerlər çoxluq təşkil edir və onların sırasında

Lənkəran qalası, daha dəqiq desək, onun günümüzədək gəlib çatmış fraqmentləri xüsusi diqqət cəlb edir. Belə ki, qala XVIII əsrdə inşa edilmiş, məhz Talış xanlığında vacib müdafiə istehkamlarından biri olaraq tanınmışdır. Qala, orta əsrlər üçün ənənəvi olan, vacib hadisələr zamanı isə su ilə doldurulan xəndəklərlə əhatə olunmuşdur. Bu tikilinin əsas obyektləri isə hücum edənlərin nişan alınaraq atəşə məruz qaldığı şimal və cənub qüllələridir. [3]

Burada, diqqət cəlb edən əsas xüsusi cəhət ondan ibarətdir ki, yalnız Lənkəranda yox, bütün Azərbaycan ərazisində müxtəlif dövrlərə və həmin dövrlərə uyğun olan dini inancların tələblərinə əsaslanan memarlıq abidələrinin quruluşunda, bir-çox fərqliliklər müşahidə olunmuşdur. İlk olaraq büt-pərəstliyin, daha sonra da İslam dininin hökmranlıq etdiyi Lənkəran memarlığı bu dinlərin və yaxud dinlərin məxsusi cərəyanlarının təsiri ilə formalaşmışdır, desək, heç də yanlışdır. İranla sərhəd ərazisində yerləşmək, xristian rusların hakimiyyətində olmaq və bu kimi, bir sıra digər səbəblər XIX-XX əsrlərdə memarlığın inkişafına istiqamət vermişdir. [2]

Lənkəranın başqa ərazilərlə quru və su yolu ilə əlaqə saxlamağının mümkünlüyü, şəhərin 1654-cü ildə Səfəvi hökmdarı II Şah Abbas tərəfindən Lənkəran və Muğanın hakimi təyin edilən Seyyid Abbasın iqamətgahına çevrilməsinə əsas səbəb olub. Səfəvi hökmdarı Sultan Hüseyn tərəfindən işlənmiş bir fərmandan bəlli olur ki, 1703-cü ildə Lənkəran şəhəri də daxil olmaqla Muğanı Abbasqulu xan (Mir Abbas) hakimiyyəti idarə edirdi. Rus arxiv sənədlərinə görə, 1726-cı ildə Mir Abbasın Osmanlılar tərəfindən öldürülməsi hadisəsindən sonra Mir Əzizin idarəsinə keçmişdir, bu dövrdə isə Qızılağacı Musa xan idarə edib.

XVIII əsrin ortalarında tədricən Böyük bazar, Kiçik bazar, Qala və b. məhəllələrdən təşkil olunmuş Lənkəran şəhəri formalaşmışdır. Mir Mustafa xan və Mir Həsən xanın hakimiyyəti dövründə isə şəhər böyüyüb və sürətli şəkildə inkişaf edib. Lənkəran şəhəri qala divarları ilə əhatə edilmiş və bir-çox xan sarayı, məscid, qala, hamam, bazar və karvansaralar tikilmişdir. [1]

Memarlıq abidələrindən Lənkəranda qala, Hacı Mirzə hamamı, məscid (XVIII-XIX əsrlər), Aşağı Nüvədi, Seyidəkəran, Sütəmurdov kəndlərindən məscid (XIX əsr) qorunub saxlanılır. Yuxarı Nüvədi kəndində qədim Əbirlər qülləsi, Şıxəkəran kəndində Şeyx Zahid türbəsi, Lənkəran şəhərində Kiçik Qala məscidi, Güldəstə minarəsi, Hacı Mirzə hamamı, binanın fasadını bəzəyən dəqiq və bir o qədər də füsunkar naxışları ilə seçilən gözəl Xan Evi kimi tarixi abidələr qorunub saxlanmışdır. [4] Şəhərin qərbində Bəlləbur qalasının xarabalıqları da mövcuddur. Bu qalanın inşasında çay daşlarından və bişmiş qırmızı kərpicdən istifadə edilmişdir. Lənkəranda yerli əhəmiyyətli memarlıq abidəsi sayılan Kiçik Bazar məscidi isə 1906-cı il tarixində inşa edilib. Məscidin inşasına Tağı bəy, Ağa bəy, molla Nəsir və dövrün bütün şəhər camaatı müyyən miqdarda vəsait verib. Məscidin nəccarı usta Rəhim və onun atası olub. Lənkəranın gözəl memarlıq abidələrindən, daha biri də Mir Əhməd xanın yaşayış evidir. Bu binanın tikintisi 1913-cü ildə tamamlanıb. Bütün tikililərdə Milli memarlıq elementlərindən xüsusi bacarıqla istifadə olunub. [4]

Lənkəran, həmçinin antik dini-memarlıq abidələri ilə zəngin rayonlarımızdan biridir. Burada yerləşən Bəlləbur qalası, orta əsr memarlığının nümunəsidir. Bu abidənin tarixi VIII-IX əsrlərə söykənir.

Azərbaycanda İslam dini öz təzahürünü tapdıqdan dərhal sonra bu ərazidə bir neçə ziyarətgahlar: türbələr, pirlər, ocaqlar, xanagahlar yaranmışdır. Bu müqəddəs məkanlardan birinə misal olaraq Lənkəran rayonunun Şıxəkəran (Şıxəkəran) kəndində yerləşən Şeyx Zahid türbəsinə göstərmək olar. Lənkəranda ərazisindəki Seyid Xəlifə türbəsi XIX əsrin yadigarıdır. Gil kəndində yerləşir. El arasında bu türbə həmçinin də “Sexəlifə” adlanır. Günümüzdə Şeyx Zahid türbəsi yalnız Lənkəran rayonu deyil, həmçinin respublika ərazisində tanınan məşhur ziyarətgahlardan biridir. Xalq arasında bu müqəddəs ziyarətgaha böyük inam mövcuddur.

Onu da qeyd etmək lazımdır ki, Seyid Xəlifə türbəsi mədəni tarixi abidə kimi dövlət tərəfindən mühafizə olunmaqdadır. Lənkəran ərazisində yerləşən məşhur Mayakın 1747-1786-cı illərdə inşa edildiyi ehtimal olunur. Həmin vaxtlarda Mayak və həbsxana adlandırılan binalar kompleks şəklində fəaliyyət göstərirdi.

Dairəvi qala isə Lənkəran qalası ilə eyni vaxtda Lənkəran ərazisində 1747-1786-cı illərdə inşa edilmişdir.

Lənkəran teatrının tarixi isə uzaq keçmişə dayanır. 1850-ci il tarixində dahi rus dramaturqu A.S.Qriboyedovun “ağıldan bəla” komediyasının tamaşaya qoyulması əhəmiyyətli hadisə olub.

N.B.Vəzirov adına Lənkəran Dövlət Dram teatri 1973-cü ildə öz qapılarını teatrsevərlərin üçünə açıb. Mirzə İbrahimovun “Yaxşı adam” komediyası isə oynanılan ilk tamaşa olub. Bu tamaşanın əsər rejissoru isə Əşrəf Quliyev olmuşdur. Lənkəran ərazisində yerləşən digər bir tarixi abidə isə iki dəfə Sovet İttifaqı Qəhrəmanı adına layiq görülmüş tank qoşunları General-mayoru Həzi Aslanovun ev muzeyi olmuşdur. Ev muzeyi 1969-cu il 9 may tarixli qələbə günündə açılmışdır.

NƏTİCƏ

Belə nəticəyə gəlmək olar ki, qədim tarixə malik şəhərlərdən biri olan Lənkəranda hökm sürən gözəl iqlim şəraiti, şəhərin ətraf mühitinin gözəlliyini, füsunkarlığını təzahür etdirir. Şəhər özünəməxsus memarlığı, 8-19-cu əsrlərə aid tarixi binaları və zəngin mədəni irsi, adət-ənənələri ilə misilsiz görünüşə məxsusdur. Memarlıq abidələri üçün yenidənqurma və bərpa işlərinə Lənkəran rayonunda xüsusi diqqət yetirilmişdir. İlk əvvəl məscidlərin, qalaların içərisində bərpa işləri aparılmış, dizayn tərtibini yeni tərzdə və üslubda etmək səyləri göstərilmişdir. Lənkəranın möhtəşəm memarlıq incisi olan “Lənkəran qalası” əsas abidələrdən biri olaraq özünü təcəssüm etdirir.

ƏDƏBİYYAT SİYAHISI

1. Şəfiyev Ə. “Azərbaycanın cənub bölgəsinin tarix və mədəniyyət abidələri”. Bakı-2007.
2. Hüseyinov M., Bretanski L., Salamzadə S., “Azərbaycanın memarlıq tarixi”. 1963
3. Hüseynbalaoglu B. Talışlı M., “Lənkəran” 1990
4. Əliyərli S. “Azərbaycan tarixi üzrə qaynaqlar”. Bakı, “Çıraq”, 2007.

**FARKLI BİYOAKTİF BOR BİLEŞİKLERİNİN BİYOLOJİK VE SPEKTROSKOPİK
ÖZELLİKLERİNİN İNCELENMESİ**

THE EVALUATION OF THE BIOLOGICAL AND SPECTROSCOPIC PROPERTIES OF
THE DIFFERENT BIOACTIVE BORON COMPOUNDS

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ÖZET

Bor bazlı organik sentezlerde, yeni bileşiklerin hazırlanmasına bağlı olarak borun eşsiz koordinasyon kimyası nedeniyle bor popüler araştırma alanlarından biri haline gelmiştir. Elektronik, spektroskopik ve foto-fiziksel özellikleri nedeniyle, ilaç endüstrisi, Akademi, yeni terapötikler, antioksidan ve antimikrobiyal aktiviteleri geliştirmek için bor bileşiklerine ve moleküllere giderek daha fazla önem verilmektedir. Bu bor bileşikleri güçlü Lewis asitleridir, çünkü bor, nükleofillerle bağ (koordinat kovalent bağları) oluşturmalarına izin veren boş bir p-orbitale sahiptir. Bor merkez atomu, fizyolojik koşullar altında nötral trigonal düzlemsel sp^2 'den tetrahedral sp^3 hibridizasyonuna kolayca dönüştürülebilir ve bor içeren moleküllerin spektroskopik ve biyolojik özelliklerini oluşturur. Tri-koordinat trigonal düzlemsel bor molekülleri üzerinde boş p-orbitalinin avantajından yararlanarak, anyonların ve nötral Lewis bazlarının tespitinde Lewis asit bazlı belirleyiciler, katalizör, antimikrobiyal ajanlar ve koruma grupları olarak yaygın olarak kullanılmıştır. Dört koordinatlı tetrahedral bor bileşiklerinin bu sınıfını oluşturmak için kullanılan ligandların kimyasal ve termal stabilizeye sahip oldukları kanıtlanmıştır. Yeni Tri ve tetra koordineli bor bileşikleri, spektroskopik çalışmanın yanı sıra antimikrobiyal aktiviteler ve antioksidan çalışmalar için tasarlanmıştır. Farklı nötral gruplarla oluşan dört koordinasyon bağlarının yanı sıra kovalent B-O ve B-C bağları yapıyı havada kararlı hale getirdiğinden, bu çalışmada yeni, ucuz, kolay sentezlenebilir ve değiştirilebilir bor bileşikleri sınıfı daha sonra bunlara karşılık gelen farklı türevleri sentezlenmiştir. Bu yeni sentezlenen bileşikler 1H ve ^{13}C NMR, FTIR, UV-Vis ve LC-MS/MS spektroskopisi, erime noktası, element analizi ve voltametri teknikleri ile karakterize edildi. Daha sonra sentezlenen bileşiklerin antimikrobiyal ve antioksidan etkileri araştırıldı. Sentezlenen farklı bor komplekslerinin in vitro antibakteriyel ve antioksidan aktivitesi, resazurin bazlı et suyu mikrodilüsyon yöntemi kullanılarak patojenik bakteri suşuna karşı test edildi ve her bor kompleksinin MIC değerleri belirlendi.

Anahtar Kelimeler: Bor Bileşikleri, Sentez, Spektroskopi, Biyolojik Çalışmalar.

ABSTRACT

Boron-based organic synthesis has become one of the most popular research areas due to the unique coordination chemistry of boron which allows the preparation of functionalized novel compounds. Due to their unique electronic, spectroscopy, and photo physical properties, the pharmaceutical industry, and academia are paying increasing attention to boron compounds and related molecules to develop novel therapeutics and remarkable antioxidant, and

antimicrobial activity. These boron compounds are strong Lewis acids because boron has an empty p-orbital which allows them to form dative bonds (coordinate covalent bonds) with nucleophiles. The boron center can be readily converted from neutral trigonal planar sp^2 to tetrahedral sp^3 hybridization under physiological conditions, rendering the unique spectroscopic and biological properties of boron-containing molecules. Taking advantage of the low-lying empty p-orbital on tri-coordinate trigonal planar boron molecules have also been widely employed as Lewis acid-based sensors in the detection of anions and neutral Lewis bases, as a catalyst, antimicrobial agents, as protecting groups. Whereas main chelate ligands used to form this class of four-coordinate tetrahedral boron compounds is proved to be with good chemical and thermal stability. The novel tri- and tetra coordinated boron compounds have been designed for spectroscopic study, as well as antimicrobial activities and antioxidant studies. Because the formed four-coordination bonds with different neutral groups as well as covalent B-O and B-C bonds make the structure stable in air, a new class of cheap, easily-synthesizable and modifiable boron compounds and their corresponding different derivatives were synthesized in this study. These newly synthesized compounds were fully characterized by ^1H and ^{13}C NMR, FT-IR, UV-Vis, and LC-MS/MS spectroscopy, melting point, elemental analysis, and cyclic voltammetry techniques. Then, the antimicrobial and antioxidant effects of the synthesized compounds were investigated. The *in vitro* antibacterial and antioxidant activity of the synthesized different boron complexes was tested against four pathogenic bacteria strains using the resazurin-based broth microdilution method, and the MIC values of each boron complexes were determined.

Keywords: Boron compounds, Synthesis, Spectroscopy, Biological studies.

1. INTRODUCTION

In the search for new drug candidate, the properties of a diverse array of boron-containing systems have been investigated, from novel therapeutics to the antioxidant or antimicrobial activity in pharmaceutical industry and academia (Yang, 2018; Pasa, 2019). These boron compounds with drug candidate potential are strong Lewis acids because boron has an empty p-orbital which allows them to form dative bonds (coordinate covalent bonds) with nucleophiles. Also, with its vacant pz orbital, three-coordinate boron is inherently electron deficient and is a strong-electron acceptor (Entwistle and Marder, 2002). The boron center can be readily converted from neutral trigonal planar sp^2 to tetrahedral sp^3 hybridization under physiological conditions, rendering the unique spectroscopic and biological properties of boron-containing molecules. Taking advantage of the low-lying empty p-orbital on tri-coordinate trigonal planar boron molecules have also been widely employed as Lewis acid-based sensors in the detection of anions and neutral Lewis bases (Cassidy 2018), as a catalyst, antimicrobial agents (Reedy 2016), as protecting groups (Shimada 2018). Due to its vacant p-orbital, boron is a strong Lewis acid and could drive the formation of a dative bond (coordinate covalent bond) with a pair of electrons on the hydroxyl and amine groups of amino acid residues, carbohydrates and nucleic acids (Sumiyoshi, 2019; Yülüce, 2019).

One of the most important uses of boron compounds is that they are preferred as antimicrobial and antioxidant agents in pharmaceutical chemistry. Due to their antimicrobial and antioxidant properties, the synthetic efforts to provide new molecules are still ongoing (Kilic, 2020a and 2020b). However, the therapeutic drug potential of boron complexes has shown remarkable antibacterial, antifungal, antimalarial, antimycobacterial, anticancer, anti-HIV properties (Trippier, 2010; Hughson, 2002). Boron-containing compounds have been explored as inhibitors for different biological targets and some of them were approved by Food and Drug

Administration (FDA) as the drugs to treat a variety of diseases such as multiple myeloma, cancer, etc (Yudin, 2017; Kirihata, 2020).

In the light of this information given, we reported the synthesis, characterization and *in vitro* antimicrobial activities of two different boron compounds. The structures of all newly synthesized complexes were assigned by the ^1H and ^{13}C NMR, FT-IR, UV-Vis spectroscopy, LC-MS/MS spectrometry and cyclic voltammetry technique as well as elemental analysis. Then, the antimicrobial activity of two different boron compounds against the bacteria and fungi has been evaluated. Also, in this study, the antioxidant capacity of the two different boron compounds was compared with BHA and BHT standards by using four different methods.

2. MATERIALS AND METHODS

2.1. General considerations

All organic solvents and starting materials used in the study were obtained from commercial suppliers and used as received. Since a dry atmosphere is required, synthesis of two different boron compounds was performed under the Ar atmosphere and a Dean-Stark apparatus was used to remove the water formed during the reaction. The formation of two different boron compounds were studied using different spectroscopic methods.

2.2. Synthesis and spectroscopic results of boron compound (1 and 2)

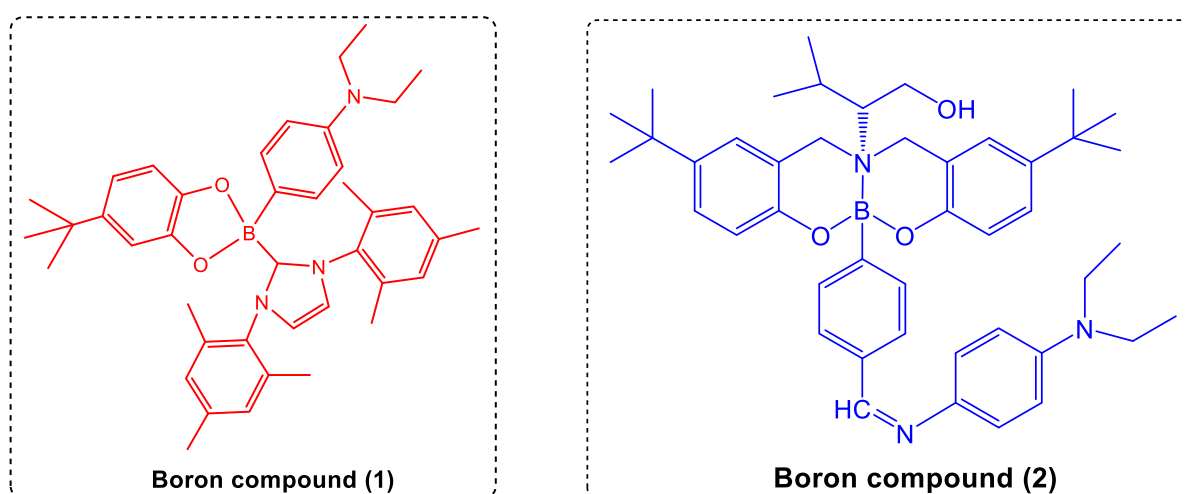
The boron compounds (**B₁**) were prepared from the reaction of (4-(Diethylamino) phenyl) boronic acid and corresponding 4-*tert*-butyl catechol for boronate ester have been carried out in 1:1 molar ratio in refluxing in toluene for 30 h using a Dean-Stark extraction apparatus to remove the water by-product. Then, a suitable amount of this solution was slowly added to a mixture of 1,3-bis(2,6-diisopropylphenyl) imidazol-2-ylidene carbene (IPr) in toluene at room temperature and the reaction mixture was stirred at room temperature for 36 h with a yield of up to 54%, as shown in Scheme 1.

The boron compounds (**B₂**) were prepared from the reaction of 4-*tert*-butylphenol, (R)-(-)-2-Amino-3-methyl-1-butanol, and 36% aqueous formaldehyde in ethanol/water (30+10 mL, respectively) was slowly added to a 100 mL two-necked round-bottom flask at 25 °C and the solutions or mixture were refluxed for 24 h. Then, 4-formylphenyl boronic acid were added to this mixture in a 100 mL round-bottom flask with an argon (Ar) connection and refluxed with continuous stirring for 24 h using a Dean-Stark apparatus to remove the water from-product. Followed by *N,N*-Diethyl-*p*-phenylenediamine was added in to the solution. A few drops of HCOOH was added into the reaction mixture as a catalyst. The reaction mixture was refluxed for 8 h with continuous stirring and then the mixture was cooled down slowly to room temperature. Excess solvent was removed under the rotary evaporator. The obtained products were crystallized in $\text{CHCl}_3/\text{C}_2\text{H}_5\text{OH}$ (1:3) by slow evaporation (Scheme 1).

Boron compound (1): Yield (%): 54, M.p. = 128 °C, Elemental Analysis (calculated for $\text{C}_{47}\text{H}_{63}\text{BN}_3\text{O}_2$) (F.W: 712.9 g/mol) (%): C, 79.19; H, 8.91; N, 5.89. Found: C, 79.22; H, 8.87; N, 5.85. LC-MS/MS (Scan ES^+): $m/z = 713.8$ $[\text{M}+\text{H}]^+$. FT-IR (ATR, $\nu_{\text{max}}\text{-cm}^{-1}$): 3113 and 3069 $\nu(\text{Ar-CH})$, 2961-2867 $\nu(\text{Aliph-CH})$, 1539 $\nu(\text{HC=CH})$, 1489-1429 $\nu(\text{C=C})$, 1236 $\nu(\text{B-O})$, 1058 $\nu(\text{C-O})$ and 904 and 803 $\nu(\text{B-C})$. $^1\text{H-NMR}$ (400 MHz; CDCl_3): δ (ppm) = 7.54 (t, 2H, $J = 8.0$ Hz, Ar-CH), 7.30 (d, 4H, $J = 7.6$ Hz, Ar-CH), 7.25 (s, 2H, Ar-CH), 7.10 (s, 1H, Ar-CH), 6.48 (d, 1H, $J = 1.6$ Hz, Ar-CH), 6.40 (d, 1H, $J = 2.0$ Hz, Ar-CH), 6.38 (s, 2H, N- $\text{HC}=\text{CH-N}$), 6.15 (d, 2H, $J = 8.0$ Hz, Ar-CH), 3.36-3.30 (q, 4H, N- CH_2), 2.37-2.30 (m, 4H, $\text{CH}-(\text{CH}_3)_2$), 1.20 (d, 12H, $J = 6.8$ Hz, $\text{CH}-(\text{CH}_3)_2$), 1.13 (d, 12H, $J = 6.8$ Hz, $\text{CH}-(\text{CH}_3)_2$), 1.11 (s, 9H, C-

CH_3), and 0.99 (s, 6H, N- CH_2 - CH_3). ^{13}C -NMR (100 MHz; CDCl_3): δ (ppm) = 163.04 ($\text{N}=\text{C}$), 151.42, 149.40, 144.97, 140.43, 132.11, 130.81, 129.82, 129.20, 128.58, 124.66, 124.00, 123.78, 122.33, 115.32, 113.31, 111.87, 106.91, and 106.37 (Ar- CH and N- $\text{CH}=\text{CH}$ -N), 44.27 (N- CH_2), 34.08 ($\text{C}-\text{CH}_3$), 31.75 ($\text{C}-\text{CH}_3$), 29.86 and 29.37 ($\text{CH}-(\text{CH}_3)_2$), 29.28 and 28.99 ($\text{CH}-(\text{CH}_3)_2$), 24.42 and 23.78 ($-\text{CH}_2-\text{CH}_3$). ^{11}B NMR ($\text{DMSO}-d_6$, 192.5 MHz, 25 °C, δ ppm): 1.82. UV-Vis (λ_{max} /(nm), * = shoulder peak): 221, 262, 284 and 346* ($\text{C}_2\text{H}_5\text{OH}$); 245, 265, 288, and 351 (CHCl_3).

Boron compound (2): Yield (%): 83, M.p. = 104 °C, Elemental Analysis (calculated for $\text{C}_{44}\text{H}_{58}\text{BN}_3\text{O}_3$) (F.W: 687.8 g/mol) (%): C, 76.84; H, 8.50; N, 6.11. Found: C, 76.80; H, 8.46; N, 6.16. LC-MS/MS (Scan ES^+): m/z = 687.8 $[\text{M}]^+$ and 688.8 $[\text{M}+1]^+$. FT-IR (ATR, $\nu_{\text{max}}-\text{cm}^{-1}$): 3055 $\nu(\text{Ar}-\text{CH})$, 2969-2869 $\nu(\text{Aliph}-\text{CH})$, 1610 $\nu(\text{C}=\text{N})$, 1508-1448 $\nu(\text{C}=\text{C})$, 1283 $\nu(\text{B}-\text{O})$, 1149 $\nu(\text{C}-\text{O})$ and 953 $\nu(\text{B}-\text{N})$. ^1H -NMR (400 MHz; CDCl_3): δ (ppm) = 9.95 (s, 1H, $\text{HC}=\text{N}$), 7.78-6.61 (m, 14H, Ar- CH), 4.00 (s, 4H, Ar- CH_2), 3.81 (d, 1H, J = 6.4 Hz, $\text{CH}-\text{CH}_2-\text{OH}$), 3.46-3.26 (m, 5H, $(\text{CH}_3)_2-\text{CH}$ and N- CH_2), 3.18 (d, 1H, J = 6.8 Hz, N- $\text{CH}-\text{CH}$), 2.82 (s, 2H, CH_2-OH), 1.29 and 1.24 (s, 18H, Ar- $\text{C}-(\text{CH}_3)_3$), 1.13 (t, 6H, J = 6.4 Hz, N- $\text{CH}_2-(\text{CH}_3)_2$). 0.96 and 0.84 (d, 6H, J = 6.4 Hz, $\text{CH}-(\text{CH}_3)_2$). ^{13}C -NMR (100 MHz; CDCl_3): δ (ppm) = 168.54 ($\text{HC}=\text{N}$), 156.20, 155.74, 142.04, 132.30, 129.93, 128.22, 127.78, 127.49, 126.58, 125.60, 124.55, 124.13, 123.06, 122.21, 118.63, 116.65, 116.00, 114.90, 112.26 and 111.13 (Ar- CH), 64.98 and 64.22 (N- CH), 62.47 (CH_2-OH), 45.68 (Ar- CH_2), 44.50 (N- CH_2), 34.03 ($\text{C}-(\text{CH}_3)_3$), 31.58 ($\text{C}-(\text{CH}_3)_3$), 29.41 ($\text{CH}-(\text{CH}_3)_2$), 19.28 and 17.60 ($\text{CH}-(\text{CH}_3)_2$), 12.67 and 12.42 (N- $(\text{CH}_2-\text{CH}_3)_2$). UV-Vis (λ_{max} /(nm), * = shoulder peak): 272, 322, 401, 467 and 592 ($\text{C}_2\text{H}_5\text{OH}$); 274, 329, 399, 481 and 596* (CHCl_3).



Scheme 1. Synthesis of proposed boron compounds (1 and 2)

2.3. In vitro antibacterial activity screening of boron compounds

The in vitro antibacterial activity of boron compounds was tested against the following organisms: *Escherichia coli* (ATCC 25922), *Bacillus cereus* (ATCC 11778), *Staphylococcus aureus* (ATCC 25923), and *Listeria monocytogenes* (ATCC 7644). The minimum inhibitory concentration (MIC) defines the lowest concentration of an antimicrobial compound that inhibits the visible growth of a microorganism. The MIC values of the two boron compounds were determined using the broth microdilution method based on the Clinical Laboratory Standard Institute (CLSI) guidelines M07-A9 with slight modifications. Briefly, three to four discrete bacterial colonies with similar morphology selected from a 24-hour agar plate were

inoculated into 4 mL sterile Luria-Bertani (LB) broth and incubated at 35 °C for a few hours. The turbidity of bacterial suspension was adjusted to 0.5 McFarland Standard (approximately 1.0 to 2.0×10^8 colony forming units per mL) with sterile saline. An additional 1:150 dilutions were created in Luria-Bertani (LB) broth to achieve the turbidity that each well contains approximately 5.0×10^5 CFU/mL after inoculation. The compounds were dissolved in Dimethyl sulfoxide (DMSO) at a concentration of at least 15 fold higher than the highest concentration to be tested and diluted the final stock concentration with LB broth so that the final concentration of DMSO during the experiment was in a safe range for strains that we used.

3. RESULTS

The synthetic routes for the synthesis of two boron compounds are shown in Scheme 1. The formation of two boron compounds was fully characterized through a combination of NMR, FT-IR, UV-Vis, LC-MS/MS spectrometry, melting point, and elemental analysis. Finally, a comprehensive experimental investigation of the antioxidant, and antibacterial activity of the two boron compounds were tested. In vitro antibacterial activity of the boron compounds was determined against one Gram-negative and three Grampositive bacteria strain by resazurin-aided broth microdilution method. The antibacterial effectiveness of a compound is measured by the minimum inhibitory concentration (MIC). Although the single crystal X-ray structures of the resulting molecules are not obtained in various solvents and suitable conditions, other spectroscopic data show that the proposed structures were successfully synthesized and were consistent with the proposed structures.

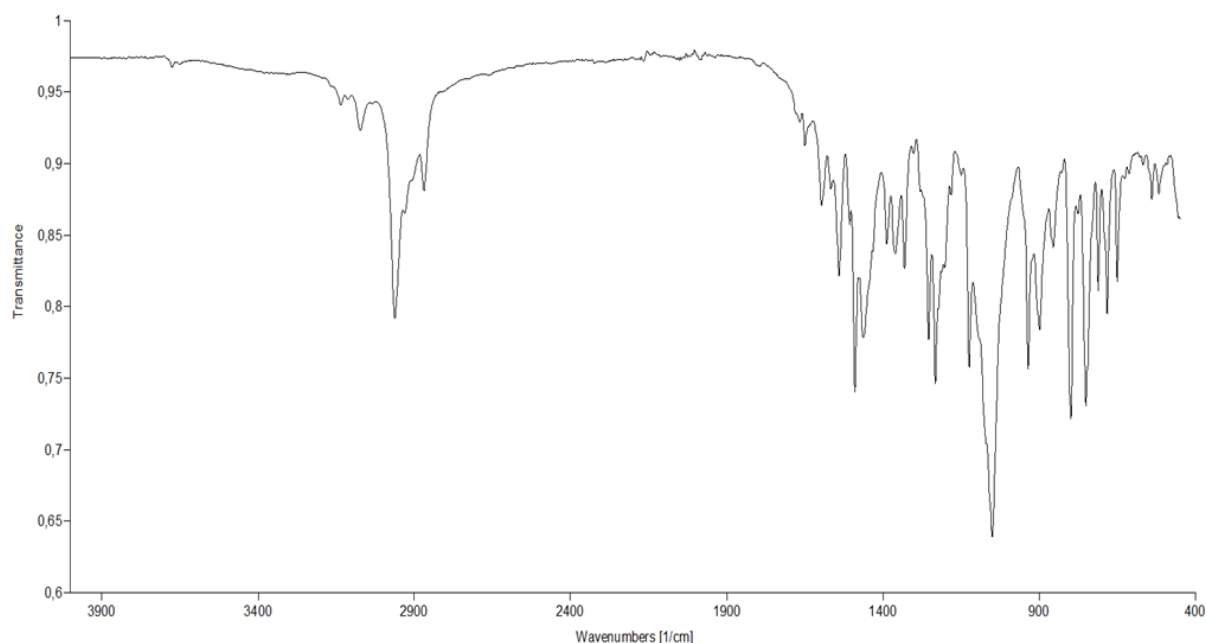


Figure 1. FT-IR spectra of boron compound (1)

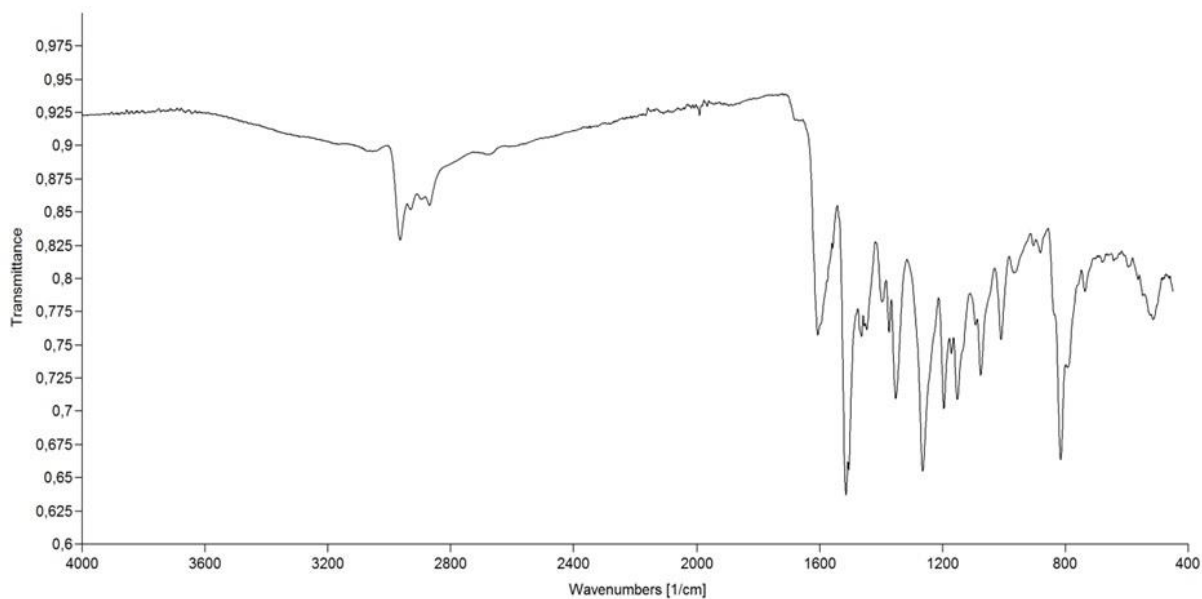


Figure 2. FT-IR spectra of boron compound (2)

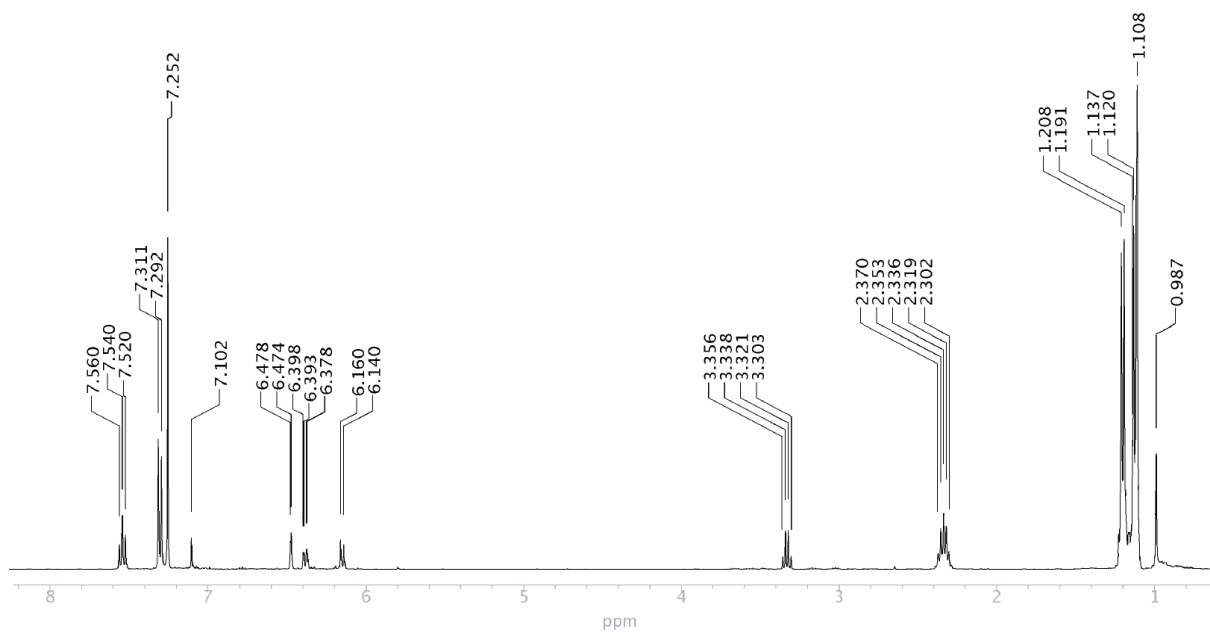


Figure 3. ¹H NMR spectra of boron compound (1)

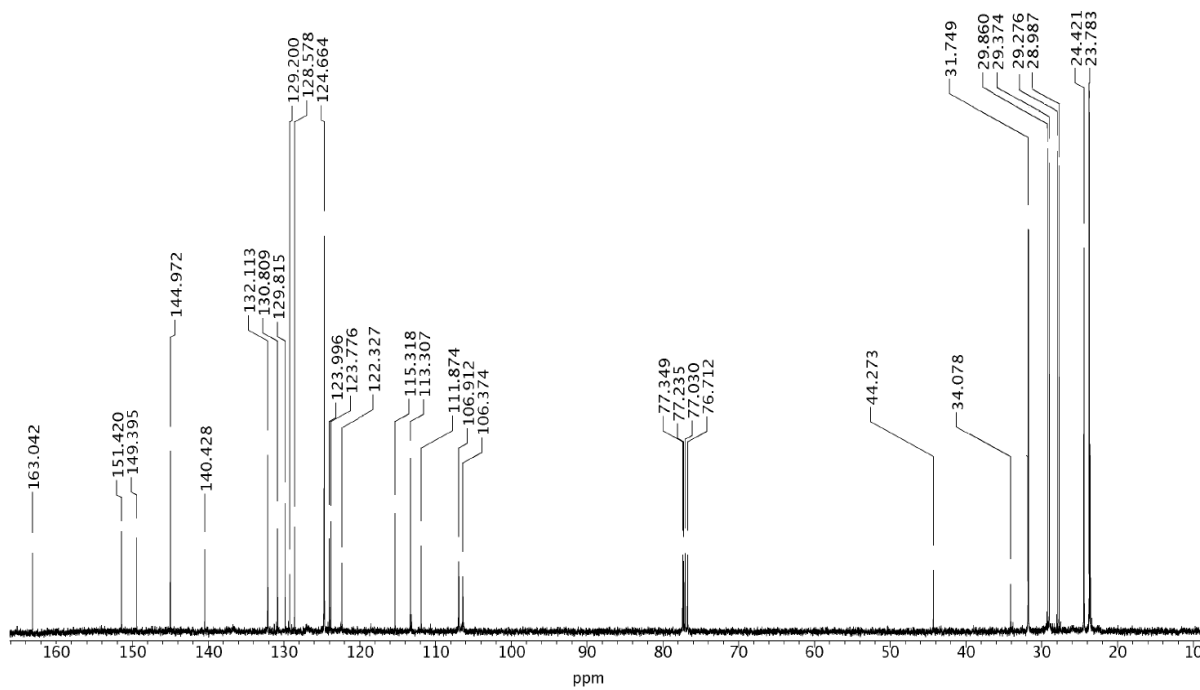


Figure 4. ¹³C NMR spectra of boron compound (1)

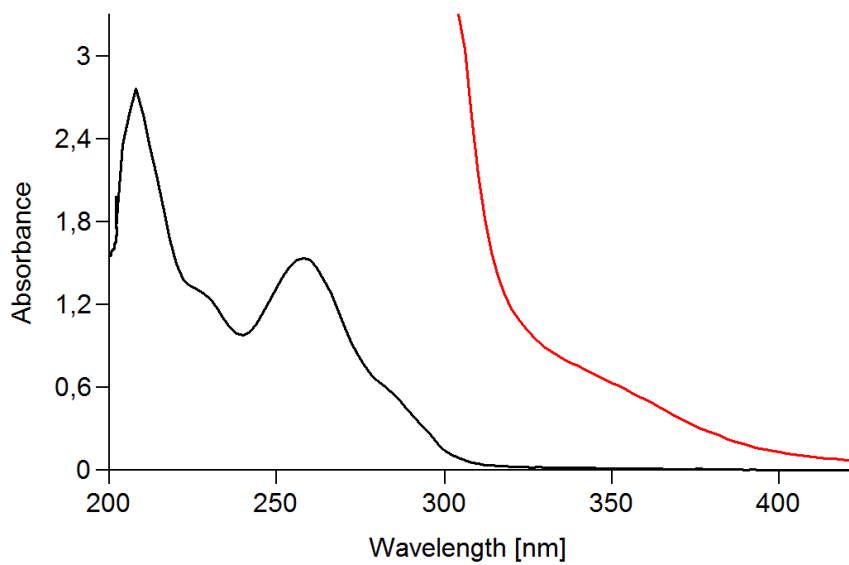


Figure 5. UV-Vis spectra of boron compound (2) in C₂H₅OH solvent

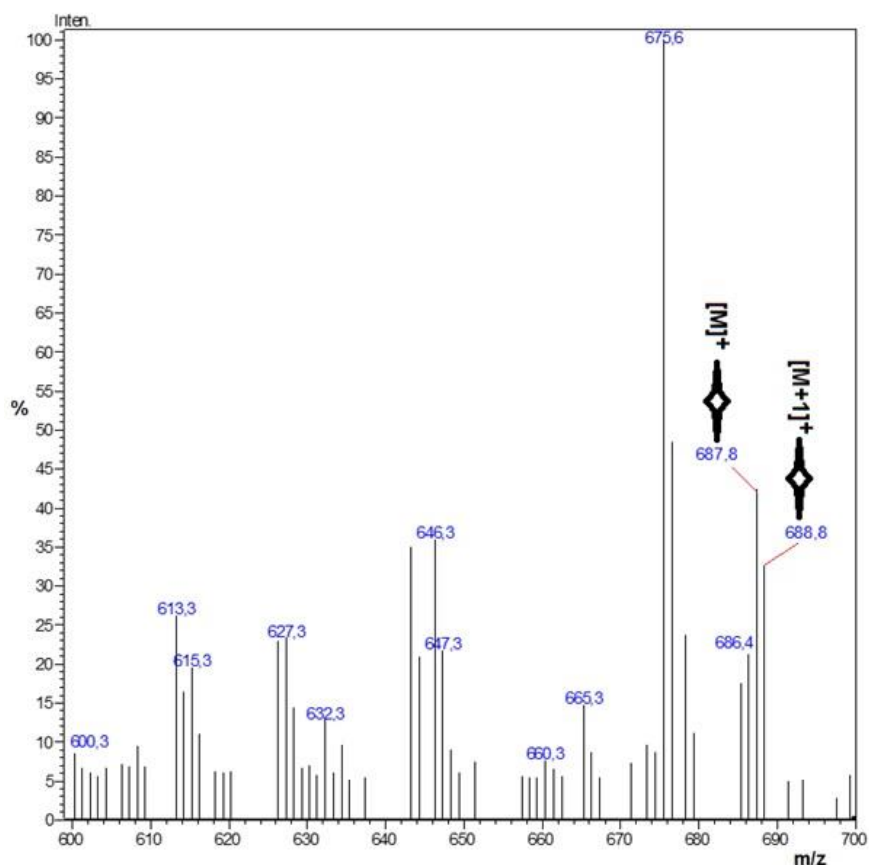


Figure 6. LC-MS/MS spectra of boron compound (2)

Table 1. Results of the MIC values for the tested boron complexes (1 and 2) against bacterial strains.

	MIC Value ($\mu\text{g/mL}$)			
	G-negative		Gram-positive	
	<i>Escherichia coli</i>	<i>Bacillus cereus</i>	<i>Staphylococcus aureus</i>	<i>Listeria monocytogenes</i>
Boron(1)	4	4	4	512
Boron(2)	16	17	34	16

4. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In this study, we describe the successful synthesis of two boron compounds (1 and 2). These two boron compounds were characterized by NMR, FT-IR, UV-Vis, LC-MS/MS spectroscopy, melting point, as well as elemental analysis. The target two boron compounds (1 and 2) are soluble in several organic solvents and stable in the solid state. The NMR, FT-IR, UV-Vis, LC-MS/MS spectroscopy, melting point, and elemental analysis results were used to characterize the proposed structures of two boron compounds (1 and 2), respectively. The spectroscopic and analytical results of two boron compounds indicate the formation of boron compounds and the results are in good agreement with the proposed structures. In the

FT-IR spectra of the two boron compounds (**1** and **2**), the bands due to vibrations of $\nu(\text{B-O})$ bonds of boron compounds are located at range 1236-1283 cm^{-1} indicates the formation of boron complexes. The characteristic stretching vibrations of the aromatic and aliphatic $\nu(\text{C-H})$ groups were observed in the range 3047-3113 and 2961-2795 cm^{-1} , respectively (Kilic, 2020a and 2020b). The UV-Vis transition of the boron compounds (**1** and **2**) have been recorded at the scanning range of 200 nm 1200 nm in $\text{C}_2\text{H}_5\text{OH}$ and CHCl_3 at room temperature. The characteristic UV-Vis transition might be ascribed to the $\pi \rightarrow \pi^*$ transitions in the conjugated ring system of boron complexes with $n \rightarrow \pi^*$ transition of non-bonded electrons or π -to-vacant B p-orbital transition, respectively (Nocentini, 2018). The formation of proposed boron compounds (**1** and **2**) can be easily spotted in the NMR spectrum due to the presence of protons and carbons chemical shifts of the aromatic and aliphatic group in NMR scale. For compounds characterization, the LC-MS/MS spectral results were confirmed the proposed structures for the boron compounds (**1** and **2**) recorded in methanol. The boron compounds (**1** and **2**) exhibits the ion peak that is found at $m/z = 713.8$ amu $[\text{M}+\text{H}]^+$ for (**1**) and at $m/z = 686.4$ amu $[\text{M}+\text{H}]^+$ for (**2**), respectively. In vitro antibacterial activity of the two boron complexes (**1** and **2**) was determined against one Gram-negative and three Gram positive bacteria strain by resazurin-aided broth microdilution method. The antioxidant effect of synthesized two boron compounds in-vitro antibacterial activities were investigated. MIC values were looked at to measure the antibacterial effectiveness of the compounds. It was determined that two boron compounds (**1** and **2**) showed higher activity than the antibiotics we used against bacteria. It has been observed that the boron compound (**1**) stabilizes plasmid DNA at the lowest concentration of $\text{H}_2\text{O}_2 + \text{DMSO}$ by eliminating the scavenging effect at the highest rate. The results show that 100 μL of the two boron compounds (**1** and **2**) had low activity according to standards when DPPH radical removal activities were compared to standards. The boron compound (**2**) has a MIC value of 512 $\mu\text{g}/\text{mL}$. Also, the two boron compounds (**1** and **2**) have been tested for the antioxidants properties. two boron compounds showed high activities in antioxidants studies. Again in this study, two boron complexes introduced their antibacterial activities in-vitro, so we can say that it has more promising effects for developing new drugs.

REFERENCES

1. Yang F, Zhu M, Zhang J, Zhou H. 2018. Synthesis of biologically active boron containing compounds. *Med. Chem. Commun.*, 9: 201-211.
2. Pasa S, Erdogan O, Yenisey C. 2019. Synthesis and structural identification of boron based Schiff compounds with Ishikawa endometrial cancer and antioxidant activity. *J. Mol. Struct.* 1186:458-467.
3. Entwistle C. D. and Marder T. B. 2002. Boron Chemistry Lights the Way: Optical Properties of Molecular and Polymeric Systems. *Angew. Chem. Int. Ed.* 41(16):2927-2931.
4. Cassidy S.J, Brettell-Adams I, McNamara L.E, Smith M.F, Bautista M, Cao H, Vasiliu M, Gerlach D. L, Qu F, Hammer N. I, Dixon D. A, Rugar P. A. 2018. Boranes with Ultra-High Stokes Shift Fluorescence. *Organometallics.* 37, 3732-3741.
5. Reddy E. R, Trivedi R, Kumar B. S, Sirisha K, Sarma A. V. S, Sridhar B, Prakasham R. S., 2016. Synthesis, characterization and antimicrobial activity of novel Schiff base tethered boronate esters of 1,2-O-isopropylidene- α -D-xylofuranose. *Bioorg. Med. Chem. Lett* 26, 3447-3452.
6. Shimada N, Urata S, Fukuhara K, Tsuneda T, Makino K., 2018. 2,6-

- Bis(trifluoromethyl)phenylboronic Esters as Protective Groups for Diols: A Protection/Deprotection Protocol for Use under Mild Conditions. *Org. Lett.* 20, (19): 6064-6068.
7. Natsutani I, Iwata R, Yamai Y. S., Ishida K, Nagaoka Y, Sumiyoshi T. 2019. Design, synthesis and evaluations of spiro-fused benzoxaborin derivatives as novel boron-containing compounds, *Chem. Biol. Drug Des.* 93: 657-665.
 9. Tülüce Y, Masseh H. D. I, Koyuncu İ, Kilic A, Durgun M, Özkol H. 2019. Novel Fluorine Boron Hybrid Complex as Potential Antiproliferative Drugs on Colorectal Cancer Cell Line, *Anticancer. Agents Med. Chem.* 19: 627-637.
 9. Kilic A, Beyazsakal L, Findik B. T, Incebay H. 2020. Synthesis and electrochemical investigation of chiral amine bis (phenolate)-boron complexes: In vitro antibacterial activity screening of boron compounds. *Inorg. Chim. Acta* 510:119777.
 10. Kilic A, Savci A, Alan Y, Beyazsakal L. 2020. The synthesis of novel boronate esters and N-Heterocyclic carbene (NHC)-stabilized boronate esters: Spectroscopy, antimicrobial and antioxidant studies. *J. Organomet. Chem.* 917:121268.
 11. Trippier P. C, McGuigan C. 2010. Boronic acids in medicinal chemistry: Anticancer, antibacterial and antiviral applications. *MedChemComm.* 1:183-198.
 12. Chen X, Schauder S, Potier V, Van Dorsselaer A, Pelczer I, Bassler B. L, Hughson F. M. (2002) Structural identification of a bacterial quorum-sensing signal containing boron. *Nature* 415:545-549.
 13. Tan J, Cognetta A. B, Diaz D. B, Lum K. M, Adachi S, Kundu S, Cravatt B. F, Yudin A. K. 2017. Multicomponent mapping of boron chemotypes furnishes selective enzyme inhibitors, *Nat. Commun.* 8:1760.
 14. Meiyanto E, Susidarti R. A, Jenie R. I, Utomo R. Y, Novitasari D, Wulandari F, Kirihata M. 2020. Synthesis of new boron containing compound (CCB-2) based on curcumin structure and its cytotoxic effect against cancer cells, *J. Appl. Pharm. Sci.* 10:60-066.
 15. Nocentini A, Supuran C. T, Winum J. Y. 2018. Benzoxaborole compounds for therapeutic uses: a patent review (2010-2018), *Expert Opin. Ther. Pat.* 28:493-504.

PERENNIAL WEEDS OF MOULOUYA POTATO: DIVERSITY-DISTRIBUTION AND THREAT IN THE CULTURE

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ABSTRACT

The description of botanical, ethological, agronomical and biogeographic attributes of the floristic heritage of the weeds of the potato of Moulouya in North-East Morocco is based on 31 surveys, 172 weedy species were encountered including 94 perennial species belonging to 22 botanical families. Six families alone provide 63 % of the species: *Poaceae* (15), *Asteraceae* (10), *Liliaceae* (11), *Lamiaceae* (17) *Solanaceae* (4) and *Apiaceae* (3). These families alone account 60 species. The study of ethological spectrum show that the geophytes come in first place with 54 species followed by hemicryptophytes with 33 species and contribute respectively with 57,45 and 35,10. The Mediterranean floristic element (50%) is dominant and characterizes this flora. The abundance and frequency of perennial species has resulted in the identification of 14 noxious species.

Keywords: Potato, Moulouya, perennial Weeds.

INTRODUCTION

Potato (*Solanum tuberosum*. L.), is a annual, tuberous solanaceous plant native to South America. It's the fourth largest food crop in the world, it's the most widely consumed in the world due to its high nutritional value and is gradually becoming a staple food in many countries, with more than one billion consumers worldwide (Fao, 2010).The potato was introduced in Morocco in the 19th century and has become increasingly important in the diet (Anonym 1999) .The area occupied by market gardening in Morocco varies each year between 180 and 200,000 ha, of which 50 to 60,000 ha are sown with potatoes (Mapm, 2014). In 2016, the area was 59,400 ha of potatoes (Mapm, 2017). In Moulouya, the crop is the main market garden species cultivated in the region with an average area of around 5000 ha, of which 4000 to 4500 ha are for seasonal potatoes (Anonyme, 2011). However, the crop in the region is subject to various attacks from bio-aggressors, whether pests, diseases or weeds. With about 4200 species and subspecies of vascular plants, Morocco has one of the richest and most diversified spontaneous flora of the Mediterranean basin (Jahandiez et Maire, 1934, pp.222). Some of these floristic elements are more or less directly or indirectly related to the many environments modified by man, and constitute for the latter a vegetation which, for many reasons and to varying degrees, the concept "undesirable"(Boulet et *al.*, 1989).

The aim of this work is to study systematical, biological and agronomical aspects of the perennial weeds flora of potato cultivated in easterne of Morocco.

MATERIALS AND METHODS

1-Characteristics of the environment

The region concerned by the present study is the Triffa plain located in eastern Morocco, at the northeastern extremity of the country, bordering the Mediterranean Sea and the Morocco-Algerian border. It has a Mediterranean-type climate. The rainfall is low in the order of 150 to 300mm/year (Negre, 1959, pp. 386 ; Ionesco, 1965, pp.69) .

2-Performing floristic surveys

31 floristic surveys were carried out in the potato plots in the Triffa plain-Oriental region of Morocco. The sampling method used is "tours of station", we start with the center of the sampled station and then we make tours in the rest of the station. The «tours of station» (Maillet, 1981, pp.200).within the limits of the station makes it possible not to omit the rare species and to better appreciate the abundance of the species in the parcel. The surveys were conducted in the winter and spring, from February to April.

RESULTS AND DISCUSSION

1-Systematic aspect

Based on 31 floristico - ecological surveys, 172 weeds species had been inventoried including 94 perennial species belonging to 22 botanical families and 63 genus. This number of families represents 17, 74 % of families of Moroccan flora. Regarding the specific contribution and number of species encountered, they are summarized in Table 1. Of the 22 families of perennial species encountered, 6 clearly dominate the potato flora, especially: *Lamiaceae* (17), *Poaceae* (15), *Asteraceae* (10), *Liliaceae* (11), *Solanaceae* (4) and *Apiaceae* (3). These families alone account 60 species, or 63, 82 % of the total population.

Table 1: Contribution of families and perennial species encountered

N°	Families	Number		Contribution in %
		species	Genus	
1	<i>Lamiaceae</i>	17	12	18.08
2	<i>Poaceae</i>	15	9	15.96
3	<i>Asteraceae</i>	10	7	10.64
4	<i>Liliaceae</i>	11	8	11.70
5	<i>Solanaceae</i>	4	3	4.26
6	<i>Apiaceae</i>	3	2	3.19
7	<i>Brassicaceae</i>	3	2	3.19
8	<i>Fabaceae</i>	3	2	3.19
9	<i>Euphorbiaceae</i>	3	2	3.19
10	<i>Plantaginaceae</i>	3	1	3.19
11	<i>Scrophulariaceae</i>	3	2	3.19
12	<i>Polygonaceae</i>	3	1	3.19
13	<i>Convolvulaceae</i>	2	2	2.13
14	<i>Urticaceae</i>	2	1	2.13
15	<i>Araceae</i>	2	1	2.13
16	<i>Caryophyllaceae</i>	2	1	2.13
17	<i>Rubiaceae</i>	2	1	2.13

18	<i>Amaranthaceae</i>	2	1	2.13
19	<i>Cucurbitaceae</i>	1	1	1.06
20	<i>Malvaceae</i>	1	1	1.06
21	<i>Cyperaceae</i>	1	1	1.06
22	<i>oxalidaceae</i>	1	1	1.06
	22 Families	94	63	100

2- Geographic origine

The analysis of Table 2 show a net dominance of perennial weeds of Mediterranean biogeographic distribution with 47 species, or 50% of the total population. This result is in agreement with those reported by the various studies carried out in Morocco, (Braun-blancquet et Maire, 1924, pp.1-124), reported that on all the Moroccan flora of which 2/3 are Mediterranean. Souss (Wahbi et Taleb, 1995, pp.30-41p), with more than 50%, followed by perennials of Cosmopolitan origin with 12 species (12, 76%) and European origin with 9 species (9, 57%). These results were in agreement with those found by (Chafik and *al.*, 2012), cosmopolitan and sub-cosmopolitan (12.31%) and European (7.18%).

Table 2: Biogeographic distribution of perennial species

Species origine	Perennial Weeds	
	Number of species	Contribution in %
Mediterranean	47	50
Cosmopolitan	12	12,76
European	9	9,57
Paleotemperate	7	7,45
Tropical	5	5,32
Eurasian	3	3,19
Iberian Mauritanian	3	3,19
American	2	2,13
African	1	1,06
Algerian-Moroccan endemics	1	1,06
Moroccan Endemics	1	1,06
Various	3	1,06

3- Ethological aspect

The biological classification adopted for the 94 perennial species encountered is that of (Raunkiaer, 1905, pp. 437), which is based on the position of the permanent buds in relation to the soil surface during the period of vegetative rest. Overall, the perennial weeds species encountered were related to 4 biological types. The ethological spectrum is mentioned in the table 3, The potato weeds flora is home to a large proportion of geophytes with 54 species (57,45%), hemicryptophytes come in second place with 33 species (35,10%), 5 nanophanerophyte species (5,32%) and 2 parasitic species (2,13%). These results were in agreement with those found by (Chafik and *al.*, 2012) 5 nanophanerophyte species (2, 56%) and 2 parasite species (1, 02%).

Table 3: Ethological types of perennial weeds of potato

Ethological types	Number of species	Contribution in %
Geophytes	54	57,45
Hemicryptophytes	33	35,10
Nanophanerophytes	5	5,32
parasites	2	2,13
Total	94	100

4-Agronomic aspect

Five perennial species were judged to be harmful due to their high Partial Harmfulness Index and their biological type: *Cynodon dactylon*. (L.) Pers., *Convolvulus arvensis*. L., *Cyperus rotundus*. L. *Amaranthus deflexus* and *Convolvulus althaeoides*. L. table 4 Despite negligible abundance and relative frequency, *Solanum elaeagnifolium* has been found in some potato plots and in other crops, the species has been considered by the FAO as an invasive plant in the Mediterranean area (Taleb, 2009 , pp.57).

Table 4 : Classification of the most harmful species on potato.

Species	P.H.I	Biological type
Group 1 : species of P.H.I > 1000		
<i>Cynodon dactylon</i>	1203,5 IV	Ge
<i>Cyperus rotundus</i>	1180,0 IV	Ge
<i>Convolvulus arvensis</i>	1160,5 IV	Ge
<i>Convolvulus althaeoides</i> . L	1082,5 III	Ge
<i>Amaranthus deflexus</i>	1010,2 III	Ge
Group 2 : species of 500 < P.H.I <1000		
<i>Bryonia dioica</i>	872,0 III	Ge
<i>Cardaria draba</i>	513,8 III	Ge
Group 3 : species of P.H.I <500		
<i>Beta vulgaris</i> subsp. <i>maritima</i> (L.) Arcang	485,0 III	Hc
<i>Sonchus oleraceus</i>	477,6 II	Hc
<i>Silene vulgaris</i> . (Moench) Garcké.	412,2 II	Ge
<i>Cardaria draba</i> . (L.) Desv.	303,0 II	Ge
<i>Launaea nudicaulis</i> . (L.) Hoker Fil.	356,5 II	Hc
<i>Sonchus asper</i> . (L.) Hill.	184,5 II	Hc
<i>Oxalis pes-caprae</i>	112,3 II	Ge

CONCLUSION

The present work has enabled us to characterise the systematic, biological and agronomic aspects of perennial weeds related to potato cultivation in the Moroccan Oriental region. The plots selected for the study present a fairly varied weed flora, 172 species, including 94 perennial species, belonging to 22 botanical families, some of which make a strong contribution to the total specific population (*Lamiaceae*, *Poaceae**Asteracea* *Liliaceae* *Solanaceae*)

REFERENCES

- [1] Fao.2010. faostat. Fao. Org. Production, 2008, consulted on 12/03/2018
- [2] Anonyme.1999. Technology Transfer Bull. Agronomic and Veterinary Institute Hassan II, National Programme for Technology Transfer in Agriculture CNTTA
- [3] Mapm. 2014 website of the Ministry of Agriculture and Maritime Fisheries, accessed on 11/12/2019
- [4] Mapm. 2017. website of the Ministry of Agriculture and Maritime Fisheries, accessed on 17/01/2021
- [5] Anonyme. 2011. Status report. DRA
- [6] Jahandiez , C et Maire, R. 1931-1934. Catalogue des plantes du Maroc, 3 tomes, édition le chevalier, Paris,222
- [7] Boulet, C. Tanji , A, et Taleb, A. 1989. Index synonymique des taxas présentes dans les milieux cultivés ou artificialisés du Maroc Occidental et Central. Actes Inst. Agron.
- [8] Negre, R. 1959. Recherches phytogéographiques sur l'étage de végétation méditerranéenne aride (sous étage chaud) au Maroc Occidental. Travaux de l'Institut Scientifique Chérifien, série botanique, 13-386
- [9] Ionesco, T. 1965. Considérations bioclimatiques et phytoécologiques sur les zones arides du Maroc. Les Cahiers de la Recherche Agronomique, 191-69
- [10] Maillot, J .1981. Evolution des peuplements dans le Montpelliéraie sous la pression des Techniques culturales. Thèse DDI, USTL, Montpellier, 200p.
- [11] Raunkiaer, C. 1905. Types biologiques pour la géographie botanique. Bull. Acad, R. Danemark, 5, 347-437
- [12] Chafik, Z. A.berrichi, A.Tale, B. 2012. Flore adventice de la pomme de terre dans l'Oriental marocain: aspects systématique, biologique et agronomique.
- [13] Braun-blanquet et Maire R. 1924. Etude de la végétation et de la flore Marocaine. Mémoire de la société des Sciences Naturelles du Maroc, vol. 8, 1-124
- [14] Wahbi, M et Taleb, A. 1995. Mauvaises herbes des vergers d'agrumes dans la région du Souss : Aspects botaniques et agronomiques. AMPP : Protection des agrumes, 30-41
- [21] Taleb, A. 2009. Journées de sensibilisation sur la gestion intégrée des plantes envahissantes, en particulier la morelle jaune, 57p.

THEORETICAL CALCULATION OF SPECIFIC HEAT CAPACITY OF TUNGSTEN-TECHNETIUM ALLOY

TUNGSTEN-TEKNESYUM ALAŞIMININ KAPASİTESİNİN TEORİK OLARAK HESAPLANMASI

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ÖZET

Bu çalışmada, katıların ve sıvıların bazı termodinamik özelliklerini belirlemek için Debye fonksiyonu için yeni bir analitik ifade sunulmuştur. Metodumuz gama fonksiyonuna ve binom genişleme fonksiyonuna dayanmaktadır. Debye fonksiyonları diğer analitik ifadeler ile karşılaştırılmış ve geniş bir parametre aralığı için uygun serilerin yakınsaklığı gösterilmiştir. Bilindiği gibi saf tungsten (W) ve alaşımları plazma teknolojisinde önemli bir rol oynamaktadır. Bu nedenle, tungsten, tungsten-teknesyum alaşımının özgül ısı kapasitesini hesaplamak için önerilen analitik formül kullanılmıştır. Hesaplama sonuçları, bu analitik formülün, tungstenin özgül ısı kapasitesi için doğru ve hassas sonuçlar verdiğini göstermiştir. Bu çalışmada, bildiğimiz kadarıyla, tungsten-teknesyum alaşımının özgül ısı kapasitesinin Debye fonksiyonlarına göre hesaplanması ilk olarak önerilmiştir. Hesaplamalar, artan sıcaklıkla tungsten ve tungsten-teknesyum alaşımının özgül ısı kapasitesinin arttığını göstermektedir. Tungstenin özgül ısı kapasitesi hesaplama sonuçları deneysel verilerle karşılaştırılmış ve yöntemin diğer malzemeler için de kullanılabileceği gösterilmiştir.

Anahtar Kelimeler: Termodinamik özellikler, Debye fonksiyonu, Özgül ısı kapasitesi, Tungsten-teknesyum alaşımı

ABSTRACT

A new analytical expression for the Debye function has presented to determine some thermodynamic properties of solids and liquids, in this study. Our method is based on a gamma function and binomial expansion function. Other analytic expressions of Debye functions have been given and the convergence of the suitable series has been shown for a wide range of the parameters. As well known, pure tungsten (W) and its alloys are playing a role important in plasma technology. Therefore, the proposed analytical formula has been applied to calculate the specific heat capacity of tungsten, tungsten-technetium alloy. The results of the calculation have shown that this analytical formula gives accurate and sensitive results specific heat capacity for tungsten. In this work, to our knowledge, the specific heat capacity of the tungsten-technetium alloy is first proposed for the calculation of the Debye functions. The calculations shows that the specific heat capacity of tungsten and tungsten-technetium alloy increase with the increasing temperature. The results of the calculation for

the specific heat capacity of tungsten have been compared with experimental data and demonstrated that the method can be satisfactorily used for other materials.

Keywords: Thermodynamic properties, Debye functions, Specific heat capacity, Tungsten-technetium alloy

1. INTRODUCTION

In controlled thermonuclear fusion studies, high-temperature hydrogen plasma is trapped in closed, interlocking strong toroidal magnetic fields called tokamaks or stellarators. It is known that the wall materials in the immediate around of the plasma greatly influence the performance of the plasma. In this case, Tungsten and its alloys are among the most promising plasma coating materials in terms of high melting temperature ($\sim 3410^\circ\text{C}$), low sputtering efficiency, high thermal conductivity, and low coefficient of thermal expansion [1-2]. In addition, pure tungsten is also used as a shielding material in systems related to nuclear fusion reactors. Therefore, studies on the thermodynamic properties of pure tungsten and its alloys [3-8] are important in terms of improving the engineering properties of materials used in nuclear fusion reactors. Technetium is a silvery-gray transition metal belonging to group VIIB (Mn and Re). Technetium, which has no stable isotope in nature, is produced artificially. The isotope produced from the Mo/Tc generator is the most widely used radionuclide for diagnosing diseases. The electrochemical properties of technetium are taken part between rhenium and manganese [9]. Although studies on tungsten-technetium (W-Tc) alloys are scarce [10-11], the structural stability, electronic structures, mechanical properties, and Debye temperature of the W-Tc alloy are investigated according to the density functional theory principles method by Xue et al., [12] and the elastic modulus of the crystal system are discussed with the Voigt-Reuss-Hill [13 15] approaches developed to calculate the elastic coefficients. In this study, it was reported that tungsten-technetium alloys have cubic lattice.

The cubic structure has three independent elastic constants, C_{11} , C_{12} ve C_{44} , which are generally used to characterize the deformation capacity against externally applied pressure and with the corresponding stability condition is expressed as $C_{11} - C_{12} > 0$, $C_{11} + 2C_{12} > 0$ and $C_{44} > 0$ [16].

Debye temperature, derived from atomic thermal vibration theories of solids, is an important physical parameter for solids. The Debye temperature characterizes the degree of dynamical degradation of the lattice, as well as the bonding strength between atoms. The thermodynamic behavior of alloys is better understood by the analysis of the calculated Debye temperatures.

Debye temperature θ calculated using the elastic constants of the structure; v_m is expressed as follows [17] using one of the standard calculation methods based on the average sound velocity.

$$\theta = \frac{h}{k_B} \left[\frac{3n N_A \rho}{4\pi M} \right]^{1/3} v_m$$

Here, n is the total number of atoms in each molecule, M is Molecular mass, h is Planck constant, N_A is Avogadro number, k_B is Boltzmann constant and ρ is density of mass.

In this work, a new analytical formula for Debye function is presented. Heat capacities of W and $W_{15}Tc_1$, $W_{14}Tc_2$ alloys have calculated. The obtained result is compared with theoretical and experimental data.

2. MATERIAL AND METHOD

2.1. Debye Function

The Debye function n for integer and non integer is following as [18-19].

$$D_n(\beta, x) = \frac{n}{x_D^n} \int_0^{x_D} \frac{t^n}{(e^t - 1)^\beta} dt, \quad (1)$$

where $x_D = \theta/T$, θ is Debye temperature and T is temperature. The binomial expansion theorem is used to calculate n -dimensional Debye function. The binomial expansion theorem is expressed following form [20]:

$$(x \pm y)^n = \sum_{j=0}^{\infty} (\pm 1)^j F_j(n) x^{n-j} y^j \quad (2)$$

Here $F_j(n)$ is binomial coefficient [20]. The considering Eq. (2) in Eq. (1), we obtain the following analytical expression for the integer Debye function.

$$D_n(\beta, x) = \frac{n}{x_D^n} \lim_{N \rightarrow \infty} \sum_{m=0}^N (-1)^{m-2n-1} F_m(-\beta) (\beta+m)^{-n-1} (-n(n-1)! + \Gamma(n+1, x_D(\beta+m))), \quad (3)$$

where $\Gamma(\alpha, x)$ is incomplete Gama function [20] and N is upper limit of series.

2.2. Defining heat capacity with Debye Function

The Debye function can be used to evaluate heat capacity of solids. The heat capacity can be expressed with Debye function following form.

$$C_v = 3N_A k_B L_v(x_D) \quad (4)$$

Here $L_v(x_D)$ is auxiliary function [21]. $L_v(x_D)$ is written following as:

$$L_v(x_D) = (n+1) D_n(1, x_D) - \left(\frac{n x_D}{e^{x_D} - 1} \right) \quad (5)$$

The heat capacity can be calculated by considering Eq.(3) in Eq. (5).

3. RESULTS

Table 1. Heat capacity C_v ($J mol^{-1} K^{-1}$) of W

$\theta = 363.9K$ [12]			
$T(K)$	Eq.(4)		Experimental [22]
	$n = 3$	$n = 2$	
60	6.4838	8.59537	8.39
70	8.62271	10.6641	10.73
80	10.6128	12.5193	12.80
90	12.3874	14.1332	14.56
100	13.9324	15.5139	16.02
140	18.1956	19.2358	19.82

180	20.5062	21.2112	21.78
200	21.2573	21.8482	22.41
500	24.2952	24.4021	25.16
700	24.6097	24.6643	25.86
1000	24.7791	24.8047	26.70
1500	24.8702	24.8785	28.12
2000	24.9021	24.9021	29.60
2400	24.9145	24.9095	31.79

Table 2. The results of calculation of heat capacity of W-Tc

$T(K)$	$W_{15}T_{c1} \quad \theta = 350.1K$ [12]		$W_{14}T_{c2} \quad \theta = 365.0K$ [12]	
	Eq.(4)		Eq. (4)	
	$n = 3$	$n = 2$	$n = 3$	$n = 2$
60	6.99672	9.1003	6.44454	8.55644
70	9.19081	11.1994	8.57876	10.6224
80	11.1971	13.0544	10.5672	12.4774
90	12.9615	14.6486	12.3423	14.0925
100	14.4807	15.9993	13.8891	15.4755
140	18.6013	19.5845	18.1632	19.2079
180	20.7957	21.457	20.4829	21.1914
200	21.5037	22.0567	21.2374	21.8313
500	24.3426	24.4417	24.2913	24.3989
700	24.6343	24.6847	24.6077	24.6626
1000	24.7913	24.8147	24.7781	24.8039
1500	24.8756	24.8827	24.8697	24.8781

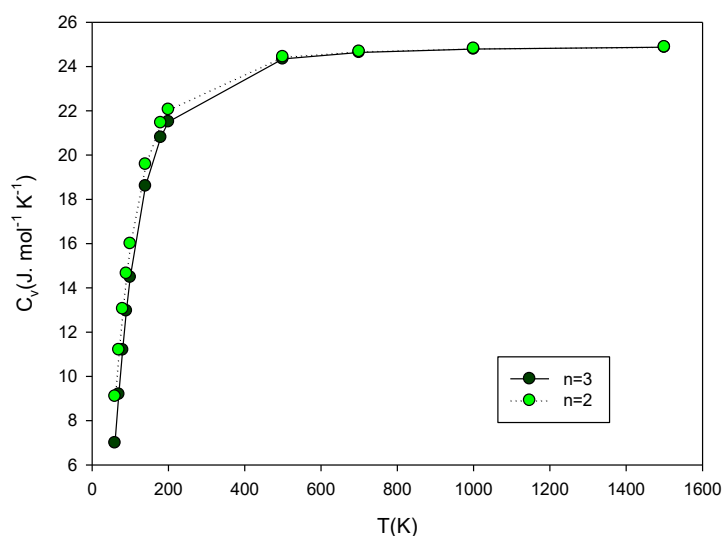


Figure 1. The change of heat capacity to temperature of $W_{15}T_{c1}$

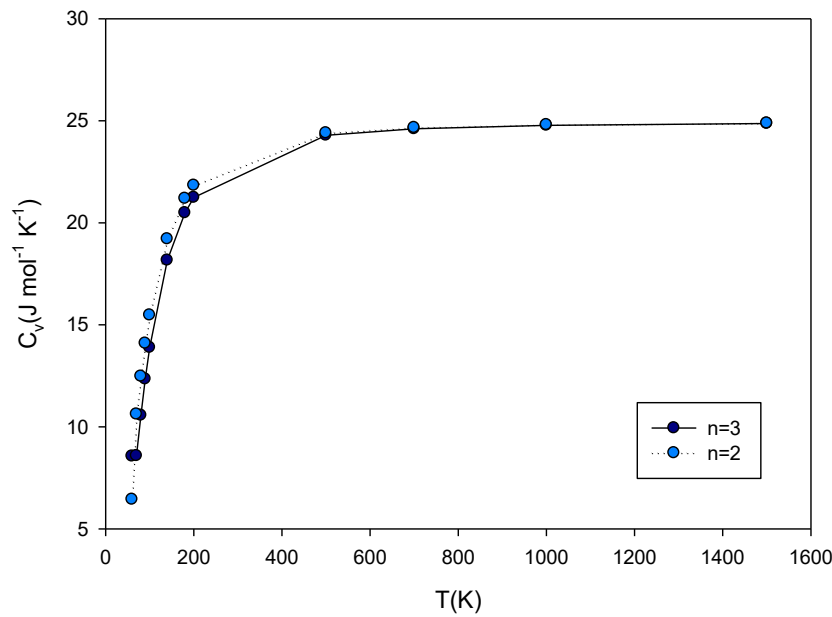


Figure 2. The change of heat capacity to temperature of $W_{14}Tc_2$

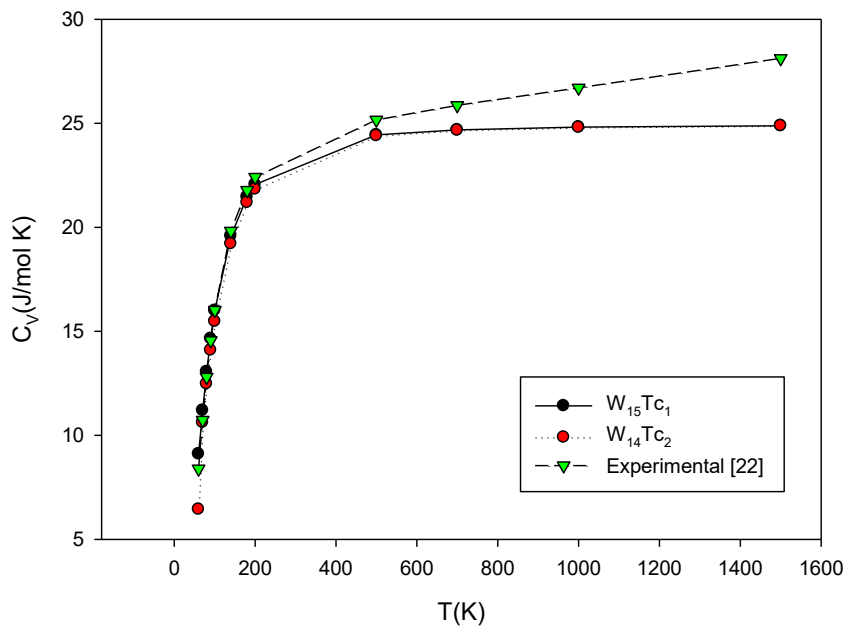


Figure 3. The change of heat capacity to temperature of W-Tc alloy and experimental data

4. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In this study, a new and efficient analytical formula is derived for the integer Debye function. The obtained formula was calculated at different values of n , β and x and it was seen from the calculation results that the formula gave satisfactory results. The calculations are made Mathematica 7.0 Software Program. As it is known, some thermodynamic properties of materials can be calculated using the Debye function. To demonstrate the accuracy and precision of this formula, it has been applied to W and W-Tc alloys for heat capacity

calculations. As seen from Table 1, the calculation results for $n = 3$ give approximate values to the experimental data. For $n=2$, it gives results closer to the experimental data. According to the data obtained from Table 1, the value of $n=2$ is a suitable value for calculating the heat capacity of W. In this paper, we calculated the heat capacity of the W-Tc alloy with the Debye function due to the convenience of this calculation. As far as our knowledge, the heat capacity of the W-Tc alloy has first calculated according to the Debye function in this study. We have seen that the accuracy of the data we received by drawing graphs at different temperature ranges. As can be seen from Figs. (1)-(2), the desired curves for the heat capacity of W-Tc alloy have been obtained. As can be seen from Fig.3, the contribution of Technetium to the purity of Tungsten is negligible.

REFERENCES

1. Suri A, Krishnamurthy K.N, Batra, I. S., 2010. Materials issues in fusion reactors. *Journal of Physics: Conference Series* 208 (012001), 1-18.
2. Kitsunai Y, Kurishita H, Kayano H, Hiraoka Y, Igarashi T, Takida T., 1999. Microstructure and impact properties of ultra-fine grained tungsten alloys dispersed with TiC. *Journal of Nuclear Materials* 271-272 , 423-428.
3. Ekman M, Persson K, Grimvall G., 2000. Phase diagram and lattice instability in tungsten-rhenium alloys. *Journal of Nuclear Materials* 278, 273-276.
4. Kim Y. D, Oh N. L, Oh S.T, Moon I.H., 2001. Thermal conductivity of W–Cu composites at various temperatures. *Materials Letters* 51, 420–424.
5. Dosovitskiy G. A, Samoilenkov S. V, Kaul A. R, Rodionov D. P., 2009. Thermal Expansion of Ni–W, Ni–Cr, and Ni–Cr–W Alloys Between Room Temperature and 800 °C. *Int J Thermophys* 30, 1931–1937.
6. Jiang D. Y, Ouyang C. Y, Liu S. Q., 2016. Mechanical properties of W–Ti alloys from first-principles calculations. *Fusion Engineering and Design* 106, 34–39.
7. Jiang D, Zhou Q, Liu W, Wang T, Hu J., 2019. First-principles study the structures and mechanical properties of binary W-V alloys. *Physica B: Condensed Matter* 552, 165–169.
8. Jiang D, Wu M, Liu D, Li F, Chai M, Liu S., 2019. Structural Stability, Electronic Structures, Mechanical Properties and Debye Temperature of Transition Metal Impurities in Tungsten:A First-Principles Study. *Metals* 9 (967), 1-16.
9. Loveland W. D, Morissey D. J, Seaborg G. T., 2006. *Modern Nuclear Chemistry*. New Jersey: Published by John Wiley and Sons, Inc., Hoboken-New Jersey Published in Canada, 119-120.
10. Autler S. H, Hulm J. K, Kemper R. S., 1965. Superconducting Technetium-Tungsten Alloys. *Physical Review* , 140 (4A), 1177-1180.
11. Nelson R. G, Oxeeffe D. P., 1968. Concluding Progress Report a Study of Tungsten Technetium Alloys , Washington: Battelle Memorial Institute Pacific Northwest Laboratory Richland, 1-68.
12. Xue L, Wang X, Xue F, Zhou X, Guo F, Jiang D., 2021. Structural, mechanical, electronic properties and Debye temperature of tungsten-technetium alloy: A first-principles study. *Fusion Engineering and Design* 168 (112433), 1-7.
13. Voigt W., 1928. Über die Beziehung zwischen den beiden Elasticitäts constanten

- isotroper Körper. Ann. Physik 38 (1889), 573–587.
14. Reuss A., 1929. Berechnung der Fliegrenze von Mischkristallen auf Grund der Plastizitäts bedingung für Einkristalle. Zamm Z. Angew. Math. Mech., 9, 49–58.
 15. Hill R., 1952. The Elastic Behaviour of a Crystalline Aggregate. Proc. Phys. Soc. Sect. A 65 (1952), 349-354.
 16. Mouhat F, Coudert, F. X., 2014. Necessary and sufficient elastic stability conditions in various crystal systems. Physical Review B 90 (224104), 1-4.
 17. Anderson O. L., 1963. A Simplified Method for Calculating the Debye Temperature from elastic Constants. J. Phys. Chem. Solids 24, 909-917.
 18. Kittel Ch. Introduction to Solid State Physics (Wiley, New York, 1976)
 19. Mason, W. Physical Acoustics. Principles and Methods (Academic, New York, 1965)
 20. Gradshteyn, I.S., Ryzhik, I.M. Tables of Integrals, Sums, Series and Product, 4th edn. (Academic Press, New York, 1980)
 21. Kubo, R. Statistical mechanics: an advanced course with problems and solutions. (North-Holland, Amsterdam, Mir; 1965. Moscow 1967).
 22. White, G. K., Collocott, S. J., J. Phys. Chem. Ref. Data, 13 (4) 1984, 1251-1257.

MODAL ANALYSIS FOR SOLID AND HOLLOW POWER ULTRASONIC HORN USING FEM

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ABSTRACT

Nowadays, ultrasonic horn considered to be one of the most acoustical tools which is performed for machining processes, through vibrating and transferring sufficient energy from transducer to the working area. A horn with proper design will help to solve issues and to minimize damage to the vibration system and generator. This work presents a modal analysis of two different horn profiles with different materials (steel, aluminium and titanium), using finite element based ANSYS software code. The result reveal higher natural frequencies for all vibrational modes of titanium horn for both exponential solid and circular hollow profiles. While circular hollow profile with all materials shows lower at first and second modes and after that increase at third and fourth mode shapes while it back to decrease at fifth and sixth mode shape. The titanium material shown better acoustic properties compared with aluminium and steel.

Keywords: Ultrasonic horn ; USM; Finite Element Simulation; modal analysis; steel; aluminum; natural frequency; mode shape

INTRODUCTION

Modern industries are mostly depending on machining of hard and brittle materials with high accuracy in order to match the requirement of applications. Ultra Sonic Machining (USM) considers one of these modernized processes which are recommended in industries due to their non-thermal and stress free machining. USM is a mechanical type of advanced machining process which is typically advantageous for machining of material having hardness more than 45 Rc. The high velocity longitudinal waves are normally used in USM because it propagates easily in solids, liquid and gases. The high frequency vibration produced by transducer do not possesses adequate amplitude needed to remove the material from the work piece. The amplitude of 5-10 μm needs to be amplified to approximately 100 μm for effective machining. Therefore horn is used not only to amplify the vibration but also to transmit the vibration from the transducer to the work piece. Effective machining using USM requires the horn to be in resonance with the transducer. The material removal takes place in USM by combination of three different modes. Mechanical abrasion due to localized hammering of the abrasive grain between the tool and work piece is the prime reason. Micro chipping by free impact of abrasive particle and erosion of work surface by cavitations is also responsible for material removal during USM. The vibrating tool transfer the energy to the abrasive grains and thus removes the material in a precise reverse form of the tool shape. The shape or profile of horn decides the extent of vibrational energy magnification. Since the vibration of energy remains same throughout the length of the horn therefore the decrease of cross section area increases the energy density. In actual practice horns of different profiles like conical, stepped or exponential are used in USM. The stepped profile produce high amplitude but it is prone to breakage due to large vibration stress. The conical profile is the most widely used horn design due to its ease of manufacturing and good amplitude magnification. Horn of exponential

profile is most difficult to manufacture but it has good amplification ability. The calculation of resonant length is a critical aspect of horn design and it must be equal to multiple of half wavelength of the system so that maximum vibration can be obtained at the tool end of the horn. A CAD based design procedure was proposed by Amin et al. [1]. The authors found that horn profile with conical shape at the upper end and cylindrical shape at the lower end provide maximum magnification factor. Nad [2] investigated the dynamic properties of different horn profiles. It was observed that the resonance frequency and the amplification factor are the two most critical parameters for the selection of horn. The amplification factor decreases with the increase of cross-section area and slenderness ratio. Seah et al. [3] investigated the effect of the change in design variables on the frequencies and stress concentration in the conical and stepped horns using ANSYS. Nad and Cismancova [4] analyzed the influence of geometrical parameters on dynamic properties of different horn profiles like exponential, stepped, and conical. They found that the resonance frequency must be more than 20 kHz and amplification factor must be greater than unity for effective machining. Yadava and Deoghare [5] developed FEM based design procedure for sonotrode of rotary ultrasonic machining (RUM). The authors obtained the various stress components in the horn and found that the stress components varies linearly along the radial length and the stress obtained at the resonant frequency is considerably smaller than the stress obtained at other frequencies. Youssef and El-Hofy [6] developed a design methodology to determine the horn contour using the general empirical formula. Analysis and design of acoustics horn were performed by Shu et al. [7] using ANSYS software. Modal analysis and harmonic analysis were performed to find the natural frequencies and amplitude amplification of different horn profiles. FEM was used by Nanu and Marinescu [8] to investigate the effect of step length, diameter and corners radius size on stepped horn profile during ultrasonic assisted EDM machining. Roy and Jagdish [9] designed a circular hollow horn for USM using ANSYS. Modal analysis and harmonic analysis was performed and it was observed that circular hollow horn provides better magnification factor compared to conical and exponential horns and the developed stress is comparatively less than the stepped, conical, and exponential horns. The above literature review reveals that even though modal analysis using FEM has been performed for various horn profiles but a comparative analysis for solid and hollow exponential profiles has not been reported. Moreover, the analysis of these two horns for two different horn materials is very sparse. Therefore in this study modal analysis for solid and hollow exponential horn profiles for two different materials have been performed using FEM based ANSYS software.

FINITE ELEMENT MODELING

Numeric analysis based on finite element method is preferred for analysis of horn design compared to analytical and experimental methods because the solution of wave equation through analytical method is very difficult and experimental approach is not reproducible and time consuming. Axial vibration of an elastic member with varying cross section is the basis of horn design for USM. Since the frequency of fixed-fixed case is similar to free-free case therefore in this modal analysis the FEM analysis has been performed for fixed-fixed condition because the free-free condition is semi-indefinite in nature [13]. USM is based on propagation of longitudinal wave through ultrasonic horn therefore generalized wave equation can be applied for modal analysis [12]. The resonant frequency and resonant length are the two most critical parameters affect the magnification factor of USM. Since the tool is very light in weight and do not affect the resonance condition of horn therefore in this analysis the tool has not been taken into consideration. In this study the dimension of the solid exponential

and circular hollow exponential horn with circular cross section in the transverse direction has been taken from the reference [15] respectively with the exception that in case of exponential horn solid profile has been taken unlike the hollow profile considered in reference [15]. The length of the exponential solid and circular hollow exponential horn considered for the analysis is 121.0 mm both. Material properties of steel, aluminium and titanium are shown in

Table 1.

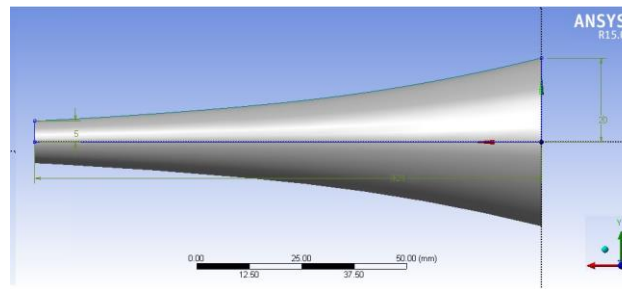
Table 1: Material properties of steel and Alum.

Mate rials	Yo ung Modulus (G N/m ²)	Pois son's ratio (-)	De nsity (K g/m ³)
Steel	200	0.3	7800
Alum inum	71. 0	0.33	2700
Titan ium	113 .8	0.34	4430

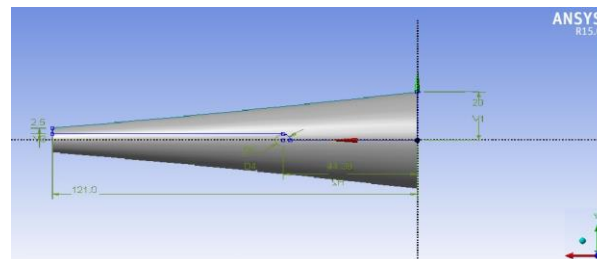
Since a 3D model has been developed for both the geometry (Figure 1), analysis has been performed for six nodes. Modal analysis reveals the resonant frequency of the geometry [13]. Mode shapes indicate that structure will oscillates within a particular frequency [14]. There may be multiple modes for a structure and each mode shape occurs at a particular frequency known as natural frequency of the mode at which all the available energy supplied by excitation is absorbed by the horn. Discrimination of geometry has been done using 3D tetrahedron element and number of nodes obtained after convergence test for each horn profile is shown in Table 2

Table 2: Horn profiles with number of elements and nodes

Types of Horn exponential dimension	N odes	Ele ments
Solid	20 33	106 6
Hollo w	36 282	252 56



(a) Exponential solid horn



(b) Hollow exponential horn

Figure 1: Sketch of parts dimension for solid exponential horn and hollow exponential horn

Each node of the element has three translational degrees of freedom so that the element can deform in all three directions in space. After post processing, the natural frequency have been obtained for different modes. Mesh generation analysis were carried out for the both horn types as shown in Figure 2.

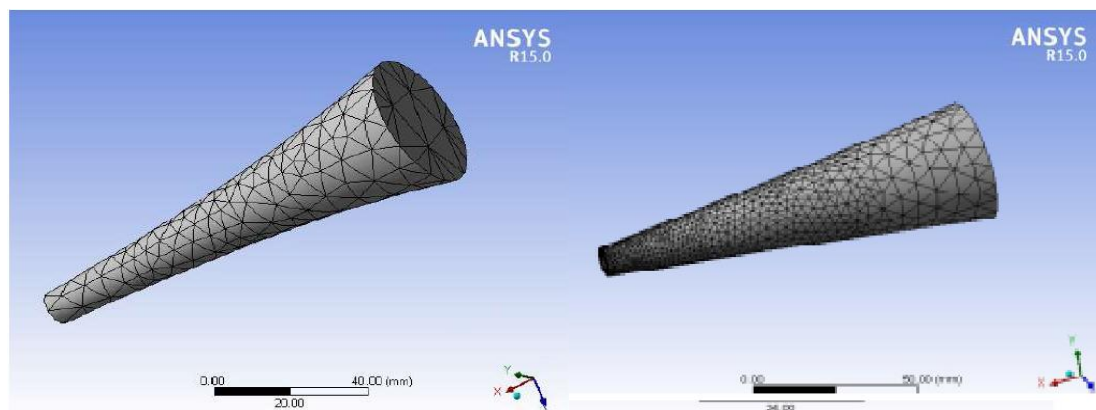


Figure 2: Mesh generation of solid and hollow exponential horns

RESULTS AND DISCUSSION

1.1 3.1 Modal analysis of solid exponential ultrasonic horn

The ultrasonic machining; take place at frequency greater than 20 kHz. In this analysis six modes has been generated and the frequency obtained for steel and aluminium is shown in Figure 3. It can be observed from Figure 4, that natural frequency of titanium solid

exponential horn is higher compared with aluminium and steel for the solid exponential horn for all the six different modes.

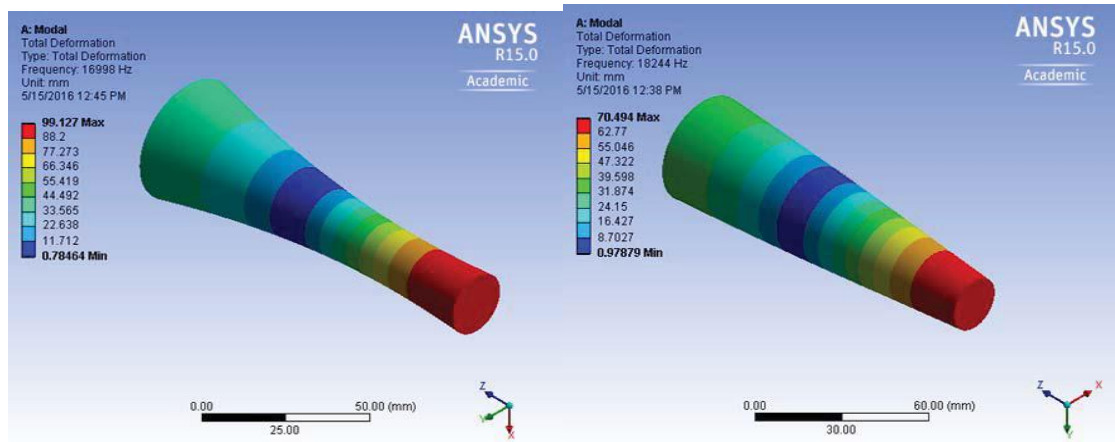


Figure 3: Modal analysis of solid exponential horns with different profiles

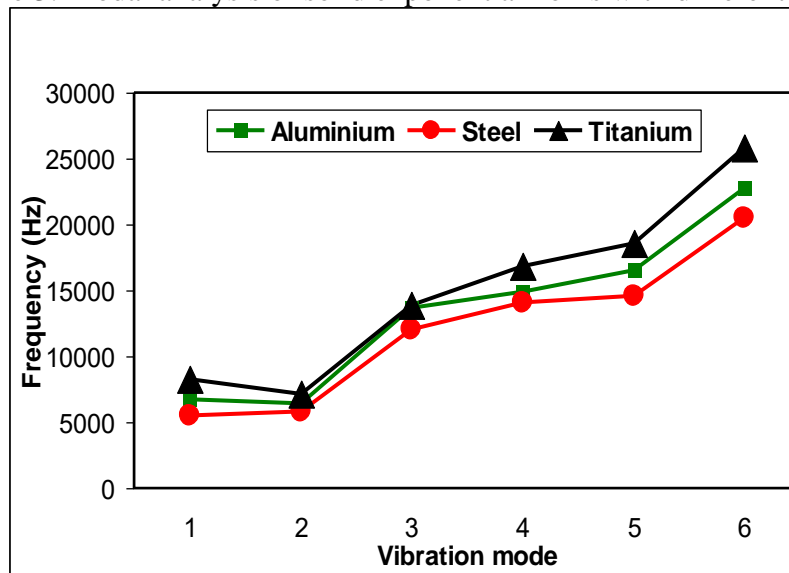


Figure 4: Natural frequency produced in solid exponential horn of titanium, aluminum and steel

1. 3.2 Modal analysis of hollow exponential ultrasonic horn

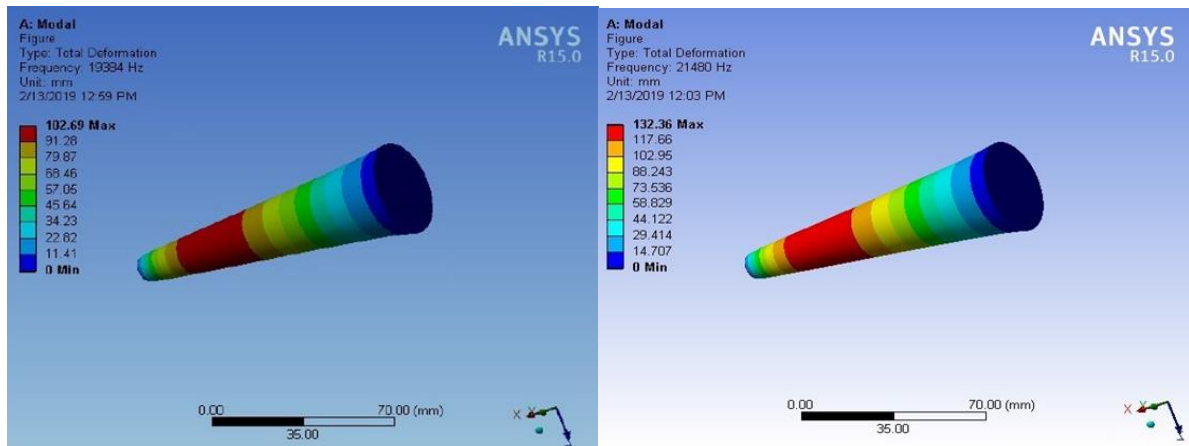


Figure 5: Modal analysis of hollow exponential horn with different profiles

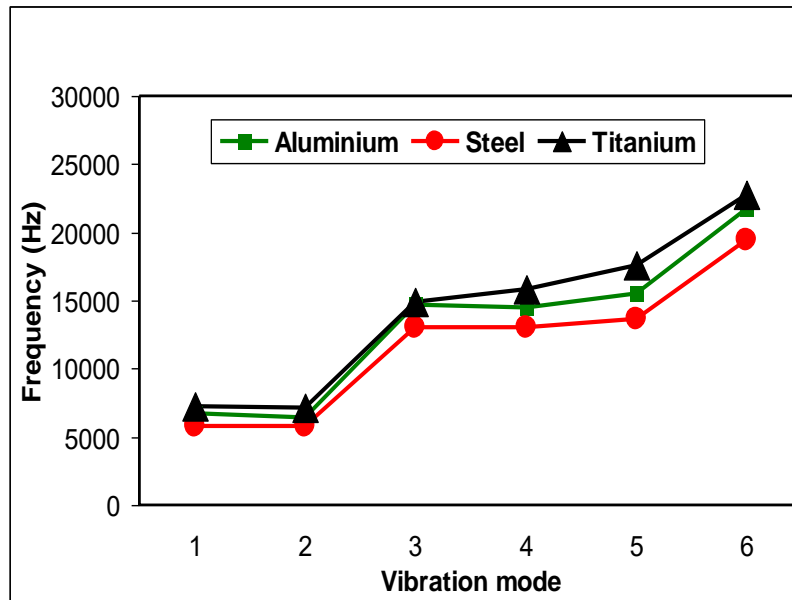


Figure 6: Natural frequency produced in hollow exponential horn of titanium, aluminum and steel

CONCLUSIONS

Modal analysis of two different horn profiles which are usually difficult to manufacture has been performed for solid exponential and circular hollow exponential profile using FEM based ANSYS software. The following salient conclusions have been drawn from the analysis. The study reveals that different frequencies are generated at different modes and the desired mode at which longitudinal mode of vibration is created is the 6th mode for both solid exponential and circular hollow exponential horn profile. Natural frequency of titanium horn is always higher for all the six modes for both solid exponential and circular hollow exponential horn profile, compared with aluminium and steel that reveals lower in vibration modes. Initially, the natural frequency is higher in 1st and 2nd mode shape for solid

exponential, then reduce in 3rd and 4th mode shape and again increase in the 5th and 6th mode shapes. For the two types of horn, titanium materials exhibit better acoustic properties in providing high natural frequencies along several modes, compared with horns that made from aluminium and steel, that shown lower values of natural frequencies and mode shapes.

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CONFLICT OF INTEREST

No conflict of interest for this article.

REFERENCES

- [1] Amin SG, Ahmed MHM, Youssef HA (1995) Computer aided design of acoustic horns for ultrasonic machining using finite element analysis. *J Mater Process Technol* 55:254–260.
- [2] Nad M (2010) Ultrasonic horn design for ultrasonic machining technologies. *Appl Comput Mech* 4:79–88.
- [3] Seah KHW, Wong YS, Lee LC (1993) Design of tool holders for ultrasonic machining using FEM. *J Mater Process Technol* 37:801–816
- [4] Nad M, Cicmancova L (2012) The effect of the shape parameters on modal properties of ultrasonic horn design for ultrasonic assisted machining. 8th Int.DAAAM Baltic Conf.Indus trialEngg.,Tallinn, pp, 57–62.
- [5] Yadava V, Deoghare A (2008) Design of horn for rotary ultrasonic machining using finite element method. *Int J Adv Manuf Tech* 39: 9–20.
- [6] Youssef HA, & El-Hofy H (2008) *Machining technology—machine tools and operations*. CRC Press Taylor and Francis Group.13: 978-1-4200-4339-6.
- [7] Kuen-Ming Shu, Wen-Hsiang Hsieh and Hoa-Shen Yen (2013). On the design and analysis of acoustic horn for ultrasonic welding. *Trans. of Canadian Society for Mechanical Engineering*. 37:3-905-916.
- [8] Alexandru Sergiu nanu and Niculae Ion Marinescu (2011). Study on ultrasonic stepped horn geometry design and FEM simulation. *Nonconventional Technologies Review*. 4-2011:25-30.
- [9] Subhankar Roy and Jagdish (2017). Design of a circular hollow ultrasonic horn for USM using finite element analysis. *Int J Adv Manuf Technol* (2017) 93:319–328.
- [10] Subhankar Roy, Jagadish (2016) Design of a circular hollow ultrasonic horn for USM using finite element analysis. Springer Verlag London.
- [11] Kremer D, Ghabrial SM, Moisan A (1981) The state of the art of ultrasonic machining. *Ann. CIRP*. pp.30. No.1. pp. 107–110.
- [12] Rawson FF (1987) High power ultrasonic resonant horns. Part 1—basic design concepts: effects of material and horn dimensions.

- [13] Gorman RW (1985) ANSYS-PC manual. Swanson Analysis Systems Inc, Pennsylvania.
- [14] Tuncer HK, Norrie DH (1987) Finite element hand-book. McGraw-Hill, New York.
- [15] Suresh Kumar V P, Manikandan N. (2017) Design and Analysis of Ultrasonic Welding Horn using Finite Element Analysis, International Journal of Engineering Science Technology and Research (IJESTR).

MENTAL HEALTH AND COGNITIVE BEHAVIORAL THERAPY**RUH SAĞLIĞI VE BİLİŞSEL DAVRANIŞÇI TERAPİ****Assoc. Prof. Dr. Nilgun ULUTASDEMİR**Gümüşhane University, Faculty of Health Science Gümüşhane, TURKEY,
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ORCID: 0000-0002-5427-1063**ABSTRACT**

Cognitive behavioral therapy emerges as a structured therapy. In the cognitive behavioral therapy process, the therapy is carried out in accordance with the cognitive therapy protocol specific to the disease under consideration. However, while applying this protocol, each session that constitutes the treatment process also has a similar plan in itself. There is no random or natural flow in cognitive therapy sessions. A uniform standard format is applied in cognitive behavioral therapy and sessions are structured. The session starts with asking how the individual generally feels. Then comes the phase of connecting with the previous session, where the aim is to ensure the integrity of the therapy, to remember what was spoken in the previous session. The control of inter-session applications given as homework in the previous session is one of the components that can be included at the beginning of the session. The difference of cognitive therapy from other therapies is that the agenda items are primarily addressed at the beginning of the session. Generally, in cognitive therapy, agenda items are determined in the first minutes of the session. When there are more than one agenda items, whichever is important in terms of the goals of therapy is addressed first. When a certain agenda item is completed in important areas within the session, summaries are made occasionally to clarify the issue. At the end of the session, a general summary containing the important issues of the session is made. Summarizing provides both clarification of information and understanding of the topics. The last element of the cognitive therapy session is asking the client to make an assessment of the session. The purpose of asking the individual to evaluate the session is to learn how the client feels during the session and to understand their feelings. Sometimes there may be problems with therapy. One of the main problems caused by the patient is the patient's inability to bring or clarify a specific subject. Resistance in some personality disorders can make it difficult to determine the agenda. When we understand the patient well while applying the main structure in cognitive behavioral therapy, if the patient understands us well, if we stay away from approaches such as lecturing and lecturing, if we put the patient at the center of the therapy, we will have an effective therapy.

Keywords: Mental Health, Cognitive behavioral therapy, Sessions**ÖZET**

Bilişsel davranışçı terapi yapılandırılmış bir terapi olarak karşımıza çıkmaktadır. Bilişsel davranışçı terapi sürecinde terapi ele alınan rahatsızlığa özgü bilişsel terapi protokolüne uygun bir biçimde yürütülür. Ancak bu protokol uygulanırken tedavi sürecini oluşturan her seansın da yine kendi içinde birbirine benzer bir planı vardır. Bilişsel terapi seanslarında rastgele ya da doğal gidişata bırakılmış bir akış söz konusu değildir. Bilişsel davranışçı terapide tek biçimli bir standart format uygulanır ve seanslar yapılandırılmıştır. Seans bireyin genel olarak kendisini nasıl hissettiğinin sorulmasıyla başlamaktadır. Daha sonra önceki seansla bağlantı kurma aşaması gelmektedir. Burada amaç terapideki bütünlüğü sağlamak bir önceki seansta konuşulanları hatırlamaktır. Bir önceki seansta ödev olarak verilen seanslar arası uygulamaların kontrolü seansın başında yer alabilen bileşenlerden biridir. Bilişsel terapinin diğer terapilerden farkı gündem maddelerinin öncelikle seansın başında ele alınmasıdır. Çoğunlukla bilişsel terapi de seansın ilk dakikalarında gündem maddeleri belirlenir. Gündem maddeleri birden fazla olduğunda terapinin hedefleri açısından hangisi önemliyse o öncelikle ele alınır. Seansın içinde önemli alanlarda belli bir gündem maddesi tamamlandığında ara ara konuyu netleştirmek için özetlemeler yapılır. Seansın sonlarında ise seansın önemli konularını içeren genel bir özetleme yapılır. Özetleme yapmak, hem bilgilerin netleşmesini hem de konuların anlaşılmasını sağlar. Bilişsel terapi seansının son

ögesi danışandan seansla ilgili bir değerlendirme yapmasının istenmesidir. Bireyin seansla ilgili değerlendirme yapmasını istemedeki amaç danışanın seans sırasında kendisini nasıl hissettiğinin öğrenilmesi ve duygularının anlaşılmasıdır. Bazen terapide sorunlar yaşanabilir. Hastadan kaynaklı sorunların başında hastanın belirdin bir konu getirememesi, veya netleştirememesi gelir. Bazı kişilik bozukluklarında direnç gösterme gündem belirlemeyi zorlaştırabilir Bilişsel davranışçı terapide ana yapıyı uygularken biz hastayı iyi anlarsak hasta bizi iyi anlarsa, nutuk çekme, ders verme gibi yaklaşımlardan uzak durursak hastayı terapinin merkezine koyarsak etkili bir terapi yapmış oluruz.

Anahtar Kelimeler: Ruh sağlığı, Bilişsel davranışçı terapi, seanslar

GİRİŞ

Bilişsel davranışçı terapi diğer psikoterapilerden farklı olarak yapılandırılmış bir tedavi olarak karşımıza çıkmaktadır. Burada belirtilmek istenen iki durum vardır. İlki bilişsel davranışçı terapi sürecinde seanslar arası yapılandırılmıştır. Terapideki sürecin genel yapısı değerlendirme ilk psikoterapi görüşmesi terapi süreci ve yinelemeyi önleme ve güçlendirme görüşmeleri sırasını izler. İkinci ise her seansın kendi içinde de benzer bir yapısının olmasıdır. Seanslar da aynen terapi süreci gibi kısa bir değerlendirme, gündem belirleme ile başlamakta ve bilişsel davranışçı müdahalelerle sürmekte özet ve geribildirimle bitmektedir (Türkçapar, 2018).

BİLİŞSEL TERAPİ SEANSININ BİLEŞENLERİ

1. Duygu durum Kontrolünün Yapılması ve Hafta İçinde Yaşanan Önemli Olaylar
2. Önceki Seansla Bağlantı Kurma
3. Seansta Verilen Uygulamaların Kontrolü
4. Gündem Belirleme
5. Gündem Maddelerinin Ele Alınması
6. Yeni Seansta Verilen Uygulamaları Planlama
7. Seansın Özetlenmesi
8. Danışandan Geribildirim

Bilişsel davranışçı terapi sürecinde terapi ele alınan rahatsızlığa özgü bilişsel terapi protokolüne uygun bir biçimde yürütülür. Ancak bu protokol uygulanırken tedavi sürecini oluşturan her seansın da yine kendi içinde birbirine benzer bir planı vardır. Bilişsel terapi seanslarında rastgele ya da doğal gidişata bırakılmış bir akış söz konusu değildir. Bilişsel davranışçı terapide tek biçimli bir standart format uygulanır ve seanslar yapılandırılmıştır (Türkçapar, 2018).

DUYGUDURUM KONTROLÜ

Seans hastanın genel olarak kendisini nasıl hissettiğinin sorulmasıyla başlar. Buradaki amaç bireyin kendisini terapistin karşısında nasıl hissettiğinin belirlenmesidir. Eğer hastanın duygu durumunda bir sorun varsa kısaca buna neden olan bir şey olup olmadığı sorulur; bu aynı zamanda hafta içinde yaşanan önemli olaylara da geçiş olur (Türkçapar, 2018; Yoveland Safren, 2015).

Buradaki amaç hastayı etkileyen bir olay olup olmadığını öğrenmektir.

Terapist: Bu hafta içinde benim bilmem gereken bir olay yaşadınız mı? Yaşantınızda bir değişiklik oldu mu?

ya da az konuşan bir hastaya;

Terapist: Bu haftanız nasıl geçti? gibi açık uçlu sorular sorulabilir.

Burada ortaya konan sorunlar gündem maddesi olarak ele alınır ve diğer seanslarda görüşülmek üzere kaydedilir (Türkçapar, 2018; Akkoyulu ve Türkçapar, 2013).

Örneğin hafta içinde eşiyile bir tartışması olduğunu ve hala bunun etkisinde olduğunu söylüyorsa bizim açımızdan da merkezi bir soruna dönük bir konu ise;

Terapist: İsterseniz eşinizle olan bu tartışmayı bugünkü gündemimize alalım ne dersiniz?

Danışan: Evet olabilir.

ÖNCEKİ SEANSLA BAĞLANTI KURMA

Burada amaç terapideki bütünlüğü sağlamak bir önceki seansta konuşulanları hatırlamak ayrıca seansla ilgili daha sonradan ortaya çıkan soruları cevaplamak ve seansla ilgili geribildirim almaktır. Terapistin

burada ana hedefi hastanın önceki seanstan ne öğrendiğini onda ne kaldığını anlamak ve önceki seansla ilgili bitmemiş onu rahatsız eden bir durum olup olmadığını bulmaktır (Türkçapar, 2018).

SEANSTA VERİLEN UYGULAMALARIN (EV ÖDEVLERİNİN KONTROLÜ)

Bir önceki seansta ödev olarak verilen seanslar arası uygulamaların kontrolü seansın başında yer alabilen bileşenlerden biridir. Ödev konusu gündem maddeleriyle ilgili ise ödevin ele alınması gündem maddeleriyle birlikte olabilir (Glazer ve ark., 2006; Türkçapar, 2018).

Ödevin ele alınması terapinin çok önemli gördüğü bir durumda vurgulanmasını sağlamakla birlikte ve danışana değer verildiğini gösterir (Soylu ve Topalaoğlu, 2015; Türkçapar, 2018).

HANGİ TÜR EV ÖDEVLERİ VERİLEBİLİR?

1. Amaç listesi oluşturmak
2. Bilgi vermeye yönelik BDT ile ilgili kitap okumak (Bibliyoterapi)
3. Psiko-eğitim materyalleri
4. Kendini gözlemlemek (Self monitoring)
5. Etkinlik kaydı yapmak (Soylu ve Topalaoğlu, 2015).

Danışana hafta arası yapacağı şeyi söylerken veya diğer hafta kontrol ederken çoğu hastada taşıyabileceği olumsuz çağrışımlar nedeniyle ödev yerine uygulama, pratik, deneme, alıştırma gibi terimler kullanmak daha uygun olur (Türkçapar, 2018; Gonzalez ve ark., 2012).

GÜNDEM BELİRLEME

Bilişsel terapinin diğer terapilerden farkı gündeme alınacak maddelerin seansın başında konuşulup belirlenmesidir (Türkçapar, 2018).

Gündem belirleme adını verdiğimiz etkinlik aslında her seansın başında o seansta hedeflenen amaçların belirlenmesidir. Her seansın kendi içinde bir başı sonu ve hedefi olacak şekilde yürütülmesi terapi sürecini açık ve anlaşılır kılar.

Gündem belirlemenin özünde bireyin var olan karmaşık sorununu parçalara bölerek çözümlenmeye çalışmaktır. Hastanın sorununu ağır yaşamalarından birisi de sorununu karmaşık ele alınmaz görmesidir (Friedbeg, 2015; Türkçapar, 2018).

Gündem belirlemenin yapılacağı en uygun zaman uygulama kontrolünden sonraki zamandır. Gündem konularını genellikle 1 ila 3 konu oluşturur. Daha fazla madde konulduğunda verim almakta sorun olabilir (Türkçapar, 2018).

Duygu durum kontrolü, hafta içi yaşanan önemli olaylar, önceki seansla bağlantı kurma ve ödev kontrolünden kişinin sorunuyla bağlantılı, kişinin duygusunu, davranışını, düşüncesini etkileyen önemli konular ortaya çıktığında bunlar gündeme alınır (Boettcher ve Piacentini, 2006; Türkçapar, 2018).

GÜNDEM BELİRLEMENİN SUNULUŞU

TERAPİST: Her hafta 45 dakikamız var, sizin bu 45 dakika içinde olabildiğince fazla şey almanızı istiyorum. Bu nedenle görüşmelerden önce birkaç dakikanızı o gün hangi konuların sizin için önemli olduğunu ve hangi konuların ele alınmasını istediğinizi düşünmeye ayırmanızı istiyorum.

İLERLEYEN SEANSLARDA GÜNDEM BELİRLENMESİ

Terapist: Son görüşmemizden bu yana nasılsınız?

Danışan: İyiyim.

Terapist: O güne kıyasla bir fark var mı?

Danışan: Bir değişiklik yok (**duygu durum kontrolü**)

Terapist: Görüşmediğimiz süreçte hayatınızda bir değişiklik var mı bilmem gereken bir şey var mı?

Danışan: Hayır her şey aynı (**yaşam olayları**)

Terapist: İlk görüşmemizde bilişsel modeli konuşmuştuk daha sonra bu görüşmeyle ilgili bir şeyler düşündünüz mü? Ya da aklınızda bununla ilgili ne kaldı? (**önceki seansla bağlantı kurma ve geribildirim**)

Danışan: Neden oluyor nasıl oluyor bilemiyordum sizin yardımınızla birtakım şeylerin farkına vardım.

Terapist: Geçen hafta size verdiğim bir yemek çizelgesi vardı. Onu gayet güzel doldurmuşsunuz. Bunun için size teşekkür ederim. İsterseniz bu kayıtları bugün detaylı konuşalım. Bugün peki görüşmek istediğiniz başka hangi konular var?

Danışan Özerkliği

Danışan bireylerin yaşamlarında kendileri için en doğru olacak seçimi yapmalarına yani hür iradesine saygı duymak danışmanlıkta ana ilkedir. Danışmanlar danışanlarının kişisel sorumluluklar üstlenmesinde ve hayatlarıyla ilgili kontrolü ele almasında onlara destek olmaya çalışmalıdırlar. Danışmanlar kendi değerleri üzerinde diretmemeli, gerektiğinde danışanlarını başka bir danışmana yönlendirmelidirler (Nelson-Jones, 2014).

Gizlilik

Danışmanlıkta danışanların güvenlerini kazanmak ve sürdürmek oldukça önemli bir konudur. Üçüncü şahıslarla iletişime geçme durumunda mutlaka danışanların izinleri almaları gerekmektedir (Nelson-Jones, 2014). Danışanların kayıtlarının güvenli bir şekilde tutulması gerekmektedir.

Danışmanlar sosyal ortamlarında, akrabalarla ve arkadaşlarıyla görüşmelerinde danışanlarının sorunları ve yaşamları hakkında detaylı bilgi vermekten kaçınmalıdırlar (Nelson-Jones, 2014).

Danışan Korunması

Danışan korunması danışanlarla birey olarak ilgilenmeyi kapsamaktadır. Danışmanlar danışan bireylerin yararına en iyi şekilde hizmet edebilmek için yeterli mesleki yeterliliğe sahip olmalıdır. Danışmanlar danışanlarının fiziksel güvenliklerini sağlamak için gerekli önlemlerin alınması gerekmektedir. Ayrıca danışmanlıkta cinsel yönden kötüye kullanım, duygusal ve mali sömürüler de etik dışı konular arasında yer almaktadır. Mali sömürü olarak da hakedilenden fazla ücret talebi, danışmanlığı gereksiz yere uzatma gibi etik dışı konular yer almaktadır (Nelson-Jones, 2014).

Mesleki Gözlem ve Gelişim

Danışmanların mevcut danışanlarının ve gelecekteki danışanlarının performanslarını gözleme ve geliştirme sorumlulukları vardır. Danışmanlar mutlaka danışmanlık süreci ve sonuçları ile ilgili değerlendirmeler yapmalıdır. Ayrıca danışmanların faydalı olabilecek sonuçları takip etme ve uygulamaya katma sorumlulukları vardır (Nelson-Jones, 2014).

Danışmanlıkta Etik Neden Önemlidir?

Danışmanlık etik temellere dayanmadığı sürece, yararlı herhangi bir amaca hizmet edemez. Danışanlar genellikle sorunlu ya da hassas olduklarında yardım ararlar. Onların dileği; danışmanların öncelikle gerçek anlamda özerkliğe ve iyilik haline ulaşmalarına yardımcı olmalarını sağlamalarıdır. Bu durum danışmanlığın doğası gereği, danışan ile etik bir ilişki içinde olmayı gerektirir. Danışmanlık süreci başladığında danışanın ilk endişelerinden biri “Danışanım olan bu kişiye ne ölçüde güvenebilirim” dir. Danışman, kişisel bütünlüğe sahip görünüyorsa, onun tüm danışmalarında uyguladığı etik standartların benzer bir düzeyde olacağı tahmin edilir. Tanım olarak güven, kişiye ya da sisteme inanç sağlamak amacıyla gerekli olan bilgileri tamamlamayı içerir. Bu noktada bazı danışanlar, gerçek konuları açıklamadan önce daha az ciddi konularda danışmanı test ederek olası riskleri denetler. Bu noktada bazı danışanlar, gerçek konuları açıklamadan önce daha az ciddi konularda danışmanı test ederek olası riskleri denetler (Yeşilyaprak, 2013).

Her iki durumda da güven; danışanın hassas ve incinmeye oldukça açık olduğu bir zamanda danışmanın gücünü onun yararına veya zararına kullanması ile eyleme dönüşür. Danışmanlıkta etik ilkelere bağlı kalmak bu nedenle önemlidir. Bir kişinin yararlanmaya açık oluşu diğerine, mesleki uzmanlık ve gücün kullanılması konusunda karşılıklı bir zorunluluk yaratır. Güvenli bir ortam yaratılmadan danışmanlık yapmak imkansızdır. Danışana açık yüreklilikle ve aktif olarak sürece katılımı için yeteri kadar güven verilmelidir (Yeşilyaprak, 2013).

SONUÇ

Danışmanlıkta etik ilkelere bağlı kalmak oldukça önemlidir. Bir kişinin yararlanmaya açık oluşu diğerine, mesleki uzmanlık ve gücün kullanılması konusunda karşılıklı bir zorunluluk yaratır. Güvenli bir ortam yaratılmadan danışmanlık yapmak imkansızdır. Danışana açık yüreklilikle ve aktif olarak sürece katılımı için yeteri kadar güven verilmelidir. Terapi sürecinde ve sonrasında korunması gereken bu sınırlar, etik yönetmelik, ilke ve kurullarla belirlenmeye ve korunmaya çalışılmalıdır.

KAYNAKLAR

1. Koocher, G.P, Keith-Spiegel, P. (1998). Ethics in psychology: Professional standards and cases. New York: Oxford.
2. Zeren, Ş, Bulut, E. (2018). Çevrimiçi Psikolojik Danışmada Etik ve Standartlar: Bir Model Önerisi. Türk Psikolojik Danışma ve Rehberlik Dergisi. 8(49):63-80.
3. www.psikolog.org.tr. Türk Psikologlar Derneği. Etik Yönetmeliği. Erişim tarihi 6 Haziran 2021.
4. Yeşilyaprak, B. (2013). Psikolojik Danışmanlık Uygulamalarında Etik Standartlar. 3. baskı. Nobel Yayıncılık, s.138-148.
5. Çobanoğlu, N. (2007). Tıp Etiği. 1. basım, İlke Yayınevi, s.9-17.
6. Türk Psikologlar Derneği (TPD). (2004). Türk Psikologlar Derneği Etik Yönetmeliği. <http://www.psikolog.org.tr/turkey-code-tr.pdf>. Erişim tarihi 6 Haziran 2021.
7. Terakye, G, Ocakçı, A.F. (2013). Etik konulardan seçmeler. İstanbul: İstanbul Tıp Kitabevi.

PHYSICOCHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF SOURDOUGH

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ABSTRACT

Sourdough is the oldest biotechnological process and mixture of flour and water. Sourdough microbiota relies on environmental factors. Lactic acid bacteria (LAB) is the most dominant in sourdough. Although species belonging to the genera *Leuconostoc*, *Weissella*, *Pediococcus*, *Lactococcus*, *Enterococcus* and *Streptococcus* have been isolated, the most frequently observed bacteria in sourdough is *Lactobacillus*. Yeasts isolated from sourdough *Saccharomyces*, *Candida*, *Cryptococcus*, *Pichia*, *Rhodotorula* and *Torulospora*. Sourdough is classified under 3 groups as Type I, Type II and Type III according to the method used in bread production. Type I sourdoughs are produced by pre-fermenting the dough and are known as traditional sourdough bread production. Type II sourdoughs are suitable for industrial applications. They have semi-fluid characters and can be easily processed. Type III sourdoughs are prepared by drying the sourdough. In this study, the type I method for sourdough was used and liquid sourdoughs were prepared to investigate pH, total titrable acidity (TTA), volume, ethanol, count of LAB, yeast and mesophilic aerobic bacteria (MAB). According to the results, the samples that gave the best results for the combination of bacteria were *L. mesenteroides* subsp. *mesenteroides*, *L. pentosus*, *L. paralimentarius*, *L. plantarum* and *P. acidilactici*. *C. keyfr*, *K. exigua*, *W. anomalus* and *S. cerevisiae* were found to be the best yeast samples in combinations in terms of sourdough rising and rapid swelling development.

Keywords: Liquid sourdough, LAB, Yeasts, Fermentation

1. INTRODUCTION

Physicochemical and microbiological is one of the most significant characteristics to prepare sourdough. Type I, type II and type III are sourdough protocols. Type I is based on daily refreshment. The aim of daily refreshment keeps the sourdough flora in an active state. Type II refers to liquid sourdoughs and type III is the dried form of the liquid sourdoughs. Both are industrially manufactured and are commonly used by the bakeries. Type II and Type III sourdough require the addition of bakers' yeast, *Saccharomyces cerevisiae*, for leavening. (Yağmur et al., 2016).

Sourdough is an intermediate product for dough and bread preparation and consists of metabolically active microorganisms (De Vuyst & Neysens, 2005). These microorganisms are generally LAB and yeasts, especially *Saccharomyces*, *Candida* etc. LAB are divided into two groups as homofermentative and heterofermentative. While homofermentative bacteria ferment sugar to form lactic acid and trace amounts of other products; heterofermentative

ones produce significant amounts of CO₂, alcohol, acetic acid and other volatile compounds besides lactic acid. As a result of a symbiotic life maintained by yeasts and LAB in sourdough fermentation, yeasts and heterofermentative LAB are responsible for the dough rising, while LAB affect the elasticity, acidity and flavor of the bread (Akgün, 2007).

2. MATERIAL AND METHODS

2.1. Sourdough Preparation

In the study, each LAB and yeast strains were multiplied separately and centrifuged. After the cultures centrifuged under aseptic conditions were washed twice with saline, they were diluted with saline to form LAB species 10⁹ colony forming units (cfu)/ml and yeast species 10⁷ cfu/ml. Microorganism counts were determined by counting MRS agar (Difco, Detroit) and Potato dextrose agar (PDA; Difco, Detroit), respectively (Erkmen, 2015). The culture mixture was obtained by mixing equal amounts (1 ml) of each species. Sourdough culture production was prepared with whole wheat (Golia type wheat) flour. Orbital mixer (HY-10M, Mateka, Tekirdağ) was used in sourdough production.

160 g of whole wheat flour, 240 g of tap water and 2.4 g of edible salt were added and mixed for a while. Then, the microorganism culture was kneaded in a kneading machine for a while with a dough yield of 300 using LAB and yeast strains, and the microorganism culture mixture was added at a level of 10⁹ cfu/ml LAB and 10⁷ cfu/ml yeast per gram of dough, and kneading was continued. After the kneading was completed, the main sourdough bread culture was prepared by fermentation at 28°C for 24 h. Refreshments were made every 24 h during the 3-day fermentation period. This sourdough bread culture was used in the production of sourdough bread.

Eighteen different starter combinations were used as inoculums during sourdough production. Starter combinations were prepared as Table 1.

Table 1. Combination LAB and yeasts to prepare sourdough

1	<i>L. brevis</i> + <i>L. paraplantarum</i> + <i>S. cerevisiae</i>
2	<i>L. pentosus</i> + <i>L. paraplantarum</i> + <i>P. kudriavzevii</i> + <i>S. cerevisiae</i>
3	<i>L. brevis</i> + <i>L. plantarum</i> + <i>E. hirae</i> + <i>P. kudriavzevii</i> + <i>W. anomalus</i>
4	<i>L. pentosus</i> + <i>P. acidilactici</i> + <i>S. cerevisiae</i> + <i>P. kudriavzevii</i>
5	<i>L. plantarum</i> + <i>P. acidilactici</i> + <i>E. faecalis</i> + <i>K. unispora</i> + <i>C. tropicalis</i> + <i>C. glabrata</i>
6	<i>L. plantarum</i> + <i>P. acidilactici</i> + <i>L. paraplantarum</i> + <i>E. faecalis</i> + <i>S. cerevisiae</i> + <i>P. kudriavzevii</i> + <i>C. tropicalis</i> + <i>W. anomalus</i>
7	<i>L. brevis</i> + <i>L. pentosus</i> + <i>P. kudriavzevii</i>
8	<i>L. plantarum</i> + <i>L. pentosus</i> + <i>P. kudriavzevii</i> + <i>G. candidum</i>

- 9 *L. plantarum* + *L. pentosus* + *K. unispora*
- 10 *P. acidilactici* + *L. brevis* + *K. marxianus*
- 11 *L. brevis* + *P. acidilactici* + *E. hira* + *K. unispora* + *P. kudriavzevii* + *C. Kefyr*
- 12 *L. brevis* + *L. pentosus* + *L. plantarum* + *E. hira* + *P. kudriavzevii* + *K. unispora* + *K. marxianus*
- 13 *Lb. brevis* + *L. mesenteroides* subsp. *cremoris* + *S. cerevisiae*
- 14 *L. plantarum* + *L. brevis* + *K. marxianus*
- 15 *L. brevis* + *L. mesenteroides* subsp. *cremoris* + *S. cerevisiae* + *K. marxianus*
- 16 *P. acidilactici* + *L. mesenteroides* subsp. *mesenteroides* + *K. marxianus*
- 17 *L. brevis* + *P. acidilactici* + *L. mesenteroides* subsp. *mesenteroides* + *S. cerevisiae*
- 18 *L. brevis* + *L. mesenteroides* subsp. *mesenteroides* + *P. acidilactici* + *S. cerevisiae* + *K. marxianus*

2.2. Physicochemical and Microbiological Analysis

pH: In the analysis, 90 mL distilled water was added to 10 g sample and homogenized for 1 min, and the pH value was measured with a pH-meter (Erkmen, 2015).

Total titrable acidity (TTA): On the homogenized 10 mL sample, 3-4 drops of 3% phenolphthalein indicator were dropped and titrated with 0.1 N NaOH until the light red (pink) color remained constant for 1 min. The amount of 0.1 N NaOH consumed was calculated as the amount of acid to be consumed for 100 g sample.

Volume: In order to determine the rising power values of the dough prepared with sourdough cultures, 1.5 g of table salt (w/w), 20% liquid sourdough culture and the amount of water to come from the liquid sourdough are taken into account in the beaker. A soft dough was prepared by mixing with the help of a glass baguette. The dough samples in the cylinder were incubated for 4 hours in an incubator set at 30°C. The volume values at the beginning (V_i) of the dough samples and the volume values at the end of each hour (V_s) were recorded. The change in the volume of the dough samples was calculated in mL and volume % (İpek, 2017; Bircan et al., 2017).

$$V \text{ (mL)} = V_s - V_i; \quad \% \text{ volume} = (V_s - V_i) / V_i \times 100$$

V_i = first volume (mL); V_s = final volume (mL)

Ethanol: Ethanol in the sourdough was determined using HPLC (Shimadzu, Kyoto, Japan) according to Paramithiotis et al. (2006).

Count of LAB, yeast and mesophilic aerobic bacteria (MAB): 25 g of the samples were weighed and 225 mL of peptone water was added. A homogeneous mixture was obtained by mixing for 1 min with a Warring Blender (steel, 1 liter). Brain Heart Infusion Agar for MAB count, MRS agar for LAB counts and M17 agar were inoculated using the pouring method.

The planted petri dishes were incubated for 1-3 days at 30°C. Bacteria counts were calculated by counting after incubation (Erkmen, 2015).

For yeast counting from the homogenized mixture, seeding was done on PDA using the smear method and incubated at 30°C for 3-5 days. Then, the total number of yeasts was calculated by counting the yeast-specific colonies (Erkmen, 2015).

3. RESULTS

pH, TTA, volume and ethanol: The pH, titration acidity, volume and ethanol values of sourdoughs during fermentation are given in Table 2. The pH value varied between 4.05 and 4.81 with lactic acid fermentations during the fermentation period in sourdough. In the sourdough created by making different combinations, a decrease in titration acidity was observed as the pH value increased. The variation of pH in sourdough samples mostly depended on whether the species number of homofermentative bacteria was high or low. Lower pH was determined especially in sourdoughs 6, 12 and 18 where heterofermentatives were high.

Titrate acidity in sourdoughs varied between 2.95 and 3.69. In the sourdough created by making different combinations, a decrease in titration acidity was observed as the pH value increased. Homofermentative ones produce only lactic acid by glucose fermentation. Heterofermentative ones, on the other hand, metabolize glucose and produce products such as ethanol, acetic acid, and CO₂ as well as lactic acid. LABs affected pH by producing significant amounts of lactic acid. Variations in the acidification properties of LABs in doughs were determined and it was seen that the main reason for this was mostly due to homofermentative LABs. In the research, heterofermentative LABs produce CO₂ outside of yeast, causing noticeable swelling and aroma formation in doughs. In the study, pH and titration acidity were found to be higher in control sourdoughs than in sourdoughs. Control doughs swelled less than sourdoughs. The reasons for these are that they create gas in heterofermentative LABs in sourdoughs as well as yeasts and convert usable sugars into organic substances other than ethanol because they use them in their LABs alongside yeasts. On the other hand, more ethanol was produced in the control doughs. This may be due to the high number of LABs in sourdoughs, where they compete with yeasts for substrate and limit the substrates that yeasts can use.

Table 2. Results of chemical and physical analyzes of sourdoughs

Sourdough	pH	TA (%)*	Volume (%)	Ethanol (mg/kg dough)
Control	5.12±0.01	3.30±0.08	155.87±12.4	170.42±10.5
1	4.76±0.09	3.14±0.03	168.04±8.3	111.34±10.5
2	4.32±0.05	3.18±0.07	170.32±7.3	151.34±9.2
3	4.28±0.12	3.15±0.16	169.98±9.8	130.62±9.2
4	4.26±0.04	3.54±0.14	167.16±6.5	111.04±4.5
5	4.22±0.06	3.30±0.02	154.20±10.1	132.60±7.2
6	4.05±0.07	3.45±0.19	169.56±9.8	148.71±3.6

7	4.79±0.10	3.01±0.02	167.54±11.5	125.67±4.2
8	4.64±0.07	3.16±0.03	170.82±13.3	148.54±9.6
9	4.73±0.09	3.12±0.19	170.54±13.3	152.34±9.6
10	4.43±0.11	3.25±0.07	167.90±14.5	120.98±4.4
11	4.35±0.14	3.67±0.01	167.78±14.5	128.54±5.2
12	4.10±0.12	3.69±0.07	169.12±9.8	150.67±7.2
13	4.89±0.14	2.95±0.01	168.23±10.3	130.14±7.6
14	4.65±0.12	3.10±0.19	168.98±10.3	150.12±9.5
15	4.48±0.06	3.28±0.08	168.32±10.3	128.56±6.3
16	4.54±0.12	3.37±0.16	169.34±9.8	151.36±10.2
17	4.39±0.05	3.41±0.04	167.98±8.5	115.36±6.8
18	4.27±0.12	3.52±0.07	168.57±7.3	148.45±9.6

*Lactic acid

Count of LAB, yeast and MAB: The results of microbiological analysis of sourdoughs are given in Table 3. As a result of the 3-day fermentation of the sourdoughs, the number of LABs varied between 6.28 and 7.98 log cfu/g. In the study, adding a large number of LAB to sourdough production caused a higher number of sourdoughs. This situation was determined especially in the 6th, 12th and 18th sourdoughs. As the variety of LAB added to sourdough increased, it caused an increase in the number of LAB detected after fermentation. This showed that LABs do not have an inhibitory effect on each other and can multiply together in sourdough production. A similar situation was also found in yeasts. As the number of added yeast species increased, the fermentation resulted in an increase in the number of yeasts in sourdoughs. Yeast count in sourdoughs varied between 5.24 and 6.91 log cfu/g. Another important result of the study showed that when the isolated LABs and yeasts are used together in sourdough production, they do not have negative effects on each other and can be used in bread production. As a result of sourdough fermentation, the number of MAB varied between 3.08 and 5.45 log cfu/g. The MAB number was found to be lower in sourdoughs with high LAB counts. Especially with the use of a small number of LABs (one or two species), the number of MABs was higher. Depending on the increase in the number of LABs in sourdough, variability was observed in the number of MAB and yeast. Lactic acid produced by LAB affected the counting result in sourdough samples. MAB count was higher in control sourdough. This is due to insufficient acid formation. Because the number of LAB and yeast remained lower than the numbers formed in sourdough.

Table 3. Microbiological analysis results in sourdoughs

Sourdough	LAB log (cfu)/g	MAB log (cfu)/g	Yeasts log (cfu)/g
Control	2.34±0.03	6.56±0.03	3.56±0.04
1	6.62±0.05	5.45±0.01	5.24±0.01
2	6.48±0.03	4.92±0.09	5.27±0.01
3	6.92±0.08	4.78±0.05	5.38±0.01
4	7.17±0.08	4.38±0.02	5.78±0.05
5	7.28±0.08	4.27±0.02	5.92±0.05
6	7.51±0.10	4.24±0.02	6.45±0.03
7	6.54±0.03	4.98±0.09	5.50±0.05
8	6.76±0.02	4.63±0.07	5.62±0.05
9	6.98±0.08	4.36±0.02	5.96±0.02
10	7.04±0.08	4.18±0.06	6.18±0.02
11	7.26±0.08	4.12±0.06	6.53±0.03
12	7.42±0.10	4.16±0.06	6.75±0.07
13	6.28±0.03	4.78±0.05	5.48±0.06
14	6.50±0.05	4.54±0.07	5.54±0.05
15	6.82±0.02	4.22±0.02	6.22±0.02
16	6.88±0.02	4.25±0.02	6.25±0.02
17	7.27±0.08	4.01±0.04	6.78±0.07
18	7.98±0.07	3.87±0.04	6.91±0.07

4. DISCUSSION AND SUGGESTION

The change in pH in sourdough samples is due to bacteria that are homofermentative and heterofermentative. Homofermentative ones produce only lactic acid by glucose fermentation. Heterofermentative ones, on the other hand, metabolize glucose and produce ethanol, acetic acid and CO₂ besides lactic acid. LAB produced significant amounts of lactic acid, which affected the pH. The acidification properties of LAB have varied, but in general, heterofermentative bacteria produce more acid than homofermentative bacteria. pH, which directly affects the fermentation rate of the dough, is an important technological criterion. One of the important issues limiting the use of sourdough in bread production is the slow acid

production or metabolic activity of lactic strains. Considering this negative situation, selection was made according to parameters such as rapid decrease in pH and rapid increase in acidity value of the lactic strains used in the study. According to the results, the samples that gave the best results for the combination of bacteria were *P. pentosaceus*, *L. mesenteroides* subsp. *mesenteroides*, *L. pentosus*, *L. paralimentarius*, *L. plantarum* and *P. acidilactici*. *C. keyfr*, *K. exigua*, *W. anomalus* and *S. cerevisiae* were found to be the best yeast samples in combinations in terms of sourdough rising and rapid swelling development.

REFERENCES

1. Akgün FB., 2007. Production of sourdough powder and its potential use in bread production. Pamukkale University, M. Sc. Thesis in Food Engineering (in Turkish).
2. Bircan D, Güray CT, Bostan K., 2017. Studies on Sour Dough Bread Making by Different Methods, *Aydın Gastronomy*, 1(1), 1-8 (in Turkish).
3. De Vuyst L, Neysens P., 2005. The sourdough microflora: Biodiversity and metabolic interactions. *Trends in Food Science and Technology*, 16(1–3), 43–56.
4. Erkmen O., 2015. Basic Methods for the Microbiological Analysis of Foods. 3th Press, Nobel Akademik Yayıncılık, Ankara.
5. İpek Ö., 2017. Technological properties of some baker's yeast isolated from turkish sourdough. Ankara University, Graduate School of Natural and Applied Sciences, M. Sc. Thesis (in Turkish).
6. Yağmur G, Tanguler H, Leventdurur S, Elmaci SB, Turhan EÜ, Francesca N, Settanni L, Moschetti G, Erten H., 2016. Identification of Predominant Lactic Acid Bacteria and Yeasts of Turkish Sourdoughs and Selection of Starter Cultures for Liquid Sourdough Production Using Different Flours and Dough Yields. *Polish Journal of Food and Nutrition Sciences*, 66(2), 99–107.
7. Paramithiotis S, Gioulatos S, Tsakalidou E, Kalantzopoulos G., 2006. Interactions between *Saccharomyces cerevisiae* and lactic acid bacteria in sourdough. *Process Biochemistry*, 41: 2429–2433.

EFFECT OF DIFFERENT COMBINATION LACTIC ACID BACTERIA AND YEASTS ON PHYSICOCHEMICAL, TEXTURE AND CALORIMETRIC PROPERTIES OF SOURDOUGH BREAD

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ABSTRACT

The effect of sourdough lactic acid bacteria (LAB) and yeasts was investigated for improving the texture of the bread. Eight LAB and nine yeasts were used to determine the combination of sourdough bread microbial. Sourdough bread was investigated using pH, total titrable acidity, moisture, height, dry matter, crust and inner color, volume, specific volume, texture properties, calorimetric properties and sensory analysis. In the study, it was determined that when heterofermentative and homofermentative bacteria are used together and when three or more types are used in bread production, sourdough bread retains more moisture after 7 days of storage. Besides, more voluminous breads were obtained by using homofermentative, heterofermentative and yeast together. However, these volumes were not at a level that would affect the appearance and texture of the bread. Texture analysis of bread doughs are the hardness, stickiness, flexibility and chewiness obtained at the 4th and 24th hours. Thermal analysis result was calculated on the 4th and 24th hours and 7th day. As a result, using more varieties resulted in less realization of the bread enthalpy value and they became less stale. After the bread was baked, an analysis was made to determine the sensory properties of the panelists consisting of 10 people at the 4th and 24th hours and on the 7th day. As a result of the sensory test, breads numbered *L. plantarum*+*P. acidilactici*+*L. paraplantarum*+*E. faecalis*+*S. cerevisiae*+*P. kudriavzevii*+*C. tropicalis*+*W. anomalus*, *L. brevis*+*L. pentosus*+*L. plantarum*+*E. hira*+*P. kudriavzevii*+*K. unispora*+*K. marxianus* and *L. brevis*+*L. mesenteroides* subsp. *mesenteroides*+*P. acidilactici*+*S. cerevisiae*+*K. marxianus* were the most preferred breads.

Keywords: Sourdough bread, Texture, Calorimetric properties, LAB, Yeasts.

1. INTRODUCTION

Sourdough has been known and used since ancient times for improving texture, quality and staling of bread. Sourdough proces is one of the oldest biotechnology proces related to leavening in the food industry (Arendt et al., 2007). Sourdough has a large application for bakery products, for examples the production of sourdough bread, classical bread, snacks, pizza and sweet baked products (Aplevicz et al., 2014). Yeasts and LAB maintain a symbiotic life in sourdough fermentation. LAB are a group of microaerophilic or anaerobic Gram-positive bacteria that are unable to form spores or produce catalase. The optimum temperature for the growth is between 27 and 30°C, the lowest and highest temperatures are 1-3°C and 40°C, respectively. It provides maximum growth in the pH 4-5 (Küçükçuban, 2012). As a result, yeasts and heterofermentative LABs are responsible for dough rising, while

homofermentative LABs affect the elasticity, acidity and flavor of the bread (Bakırcı & Köse, 2017).

In the sourdough technique, which has been used since ancient times, this practice was based on the natural flora, as yeast and bacteria worked together. So sourdough bread; it was preferred because of its suitable volume, strong aroma, good crumb structure and long shelf life. In order to increase the quality of bread and to prevent wastage by extending its shelf life, it is necessary to use starter cultures consisting of pure LAB produced under controlled conditions (Küçükçuban, 2012). The aim of the study was to determine pH, total titrable acidity, moisture, height, dry matter, crust and inner color, volume, specific volume, texture properties, calorimetric properties and sensory analysis on sourdough that by combining with LAB and yeasts.

2. MATERIAL AND METHOD

2.1. Determination of combination LAB and yeasts

Eighteen different starter combinations were used as inoculums during sourdough bread production. Starter combinations were prepared as Table 1.

Table 1. Combination LAB and yeasts to prepare sourdough bread

1	<i>L. brevis</i> + <i>L. paraplantarum</i> + <i>S. cerevisiae</i>
2	<i>L. pentosus</i> + <i>L. paraplantarum</i> + <i>P. kudriavzevii</i> + <i>S. cerevisiae</i>
3	<i>L. brevis</i> + <i>L. plantarum</i> + <i>E. hirae</i> + <i>P. kudriavzevii</i> + <i>W. anomalus</i>
4	<i>L. pentosus</i> + <i>P. acidilactici</i> + <i>S. cerevisiae</i> + <i>P. kudriavzevii</i>
5	<i>L. plantarum</i> + <i>P. acidilactici</i> + <i>E. faecalis</i> + <i>K. unispora</i> + <i>C. tropicalis</i> + <i>C. glabrata</i>
6	<i>L. plantarum</i> + <i>P. acidilactici</i> + <i>L. paraplantarum</i> + <i>E. faecalis</i> + <i>S. cerevisiae</i> + <i>P. kudriavzevii</i> + <i>C. tropicalis</i> + <i>W. anomalus</i>
7	<i>L. brevis</i> + <i>L. pentosus</i> + <i>P. kudriavzevii</i>
8	<i>L. plantarum</i> + <i>L. pentosus</i> + <i>P. kudriavzevii</i> + <i>G. candidum</i>
9	<i>L. plantarum</i> + <i>L. pentosus</i> + <i>K. unispora</i>
10	<i>P. acidilactici</i> + <i>L. brevis</i> + <i>K. marxianus</i>
11	<i>L. brevis</i> + <i>P. acidilactici</i> + <i>E. hira</i> + <i>K. unispora</i> + <i>P. kudriavzevii</i> + <i>C. Kefyr</i>
12	<i>L. brevis</i> + <i>L. pentosus</i> + <i>L. plantarum</i> + <i>E. hira</i> + <i>P. kudriavzevii</i> + <i>K. unispora</i> + <i>K. marxianus</i>
13	<i>Lb. brevis</i> + <i>L. mesenteroides</i> subsp. <i>cremoris</i> + <i>S. cerevisiae</i>
14	<i>L. plantarum</i> + <i>L. brevis</i> + <i>K. marxianus</i>
15	<i>L. brevis</i> + <i>L. mesenteroides</i> subsp. <i>cremoris</i> + <i>S. cerevisiae</i> + <i>K. marxianus</i>

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- 16 *P. acidilactici* + *L. mesenteroides* subsp. *mesenteroides* + *K. marxianus*
- 17 *L. brevis* + *P. acidilactici* + *L. mesenteroides* subsp. *mesenteroides* + *S. cerevisiae*
- 18 *L. brevis* + *L. mesenteroides* subsp. *mesenteroides* + *P. acidilactici* + *S. cerevisiae* + *K. marxianus*
-

2.2. Method

pH, total titrable acidity, moisture, height, dry matter, crust and inner color, volume, specific volume, texture properties, calorimetric properties and sensory analysis were made. Analyzes were made in the following ways:

pH: In the analysis, 90 mL distilled water was added to 10 g sample and homogenized for 1 min and the pH value was measured with a pH-meter (Erkmen, 2015).

Total titrable acidity (TTA): On the homogenized 10 mL sample, 3-4 drops of 3% phenolphthalein indicator were dropped and titrated with 0.1 N NaOH until the light red (pink) color remained constant for 1 min. The amount of 0.1 N NaOH consumed was calculated as the amount of acid to be consumed for 100 g sample.

Moisture and dry matter: 5 g of the sample was weighed into the dried containers brought to a constant weight by drying at 135°C and cooled in a desiccator. The samples were placed in drying ovens open and dried at 135°C for about 2 hours until they reached a constant weight. At the end of the period, it was placed in the desiccator with the lids closed, cooled and weighed. Then, the moisture content and dry matter content were calculated.

Height: The maximum height of each loaf of bread was measured in cm with a standard ruler at its highest point.

Crust and inner color: Color analysis of bread crumb and bread crust was performed on bread slices 4 and 24 hours after bread production. L, a and b values were measured using the Hunter (Color Meter/HunterLab ColorŞex, a60-1010-615) color analyzer (Elgün et al., 2002).

Volume and specific volume: The weight and volume of the breads were measured 1 hour after the oven exit. Bread volume was determined on the basis of replacement with rapeseed. The specific volume was obtained by dividing the volume value by the weight (Elgün et al., 2002).

Texture properties: Texture profile analysis (TPA) in breads was performed 4 and 24 hours after bread production with a Texture device (TA-XT2i). The hardness, stickiness and chewiness properties of breads were determined (Elgün et al., 2002; Bircan et al., 2017).

Calorimetric properties: The calorimetric properties of the breads were determined using the Differential Scanning Calorimetric (DSC) Perkin Elmer Pyris-6 (PerkinElmer Inc., Istanbul) device.

Sensory analysis: In order to determine the characteristic sensory properties of bread samples, a trained panelist group consisting of 10 people from Gaziantep University was determined. Bread produced with commercial yeast was used as a control. Panelist analyzes were made at 4, 24 and 7 days after the bread was baked (Ertop, 2014).

3. RESULTS

pH and TTA: The pH of the sourdough breads varied between 3.68 and 4.84. It was determined that the breads with the lowest pH were 6th, 12th and 18th sourdough bread. Titratable acidity of sourdough breads varied between 3.15 and 4.05.

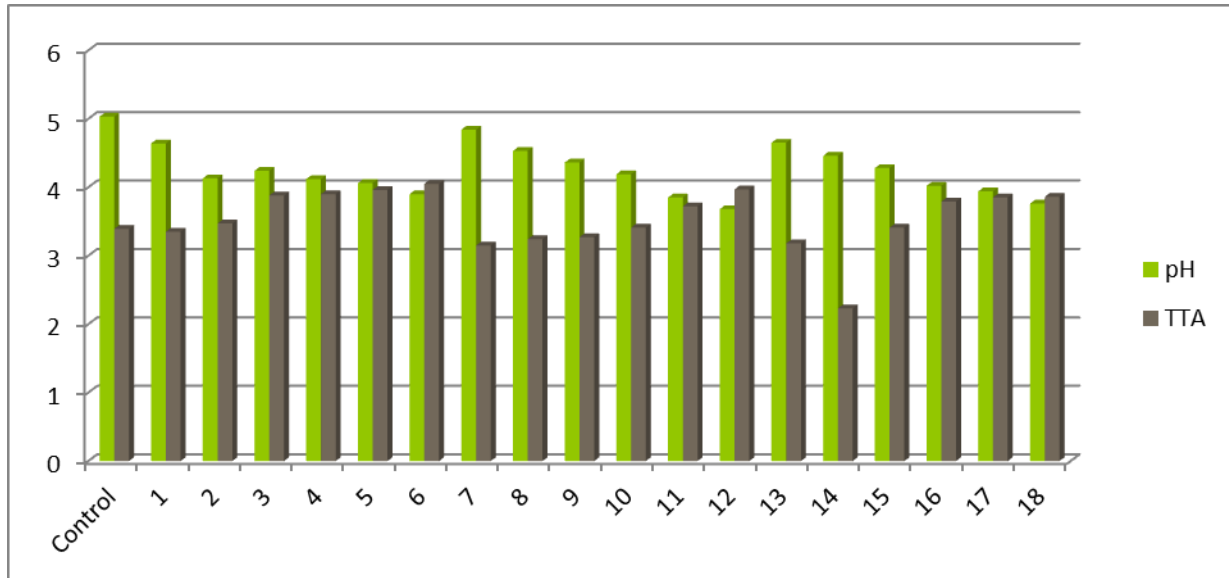


Figure 1. pH and TTA results of sourdough bread

Moisture and dry matter: Breads were stored at 4°C for 7 days. It was determined that the moisture content of the breads decreased during the 7-day storage period at 4°C. In other words, the moisture content of all breads decreased during the staling process. Moisture content of breads varied between 23.93 and 29.84%. The amount of dry matter varied depending on the moisture content. As the moisture holding capacity increased, the dry matter content was found to be low.

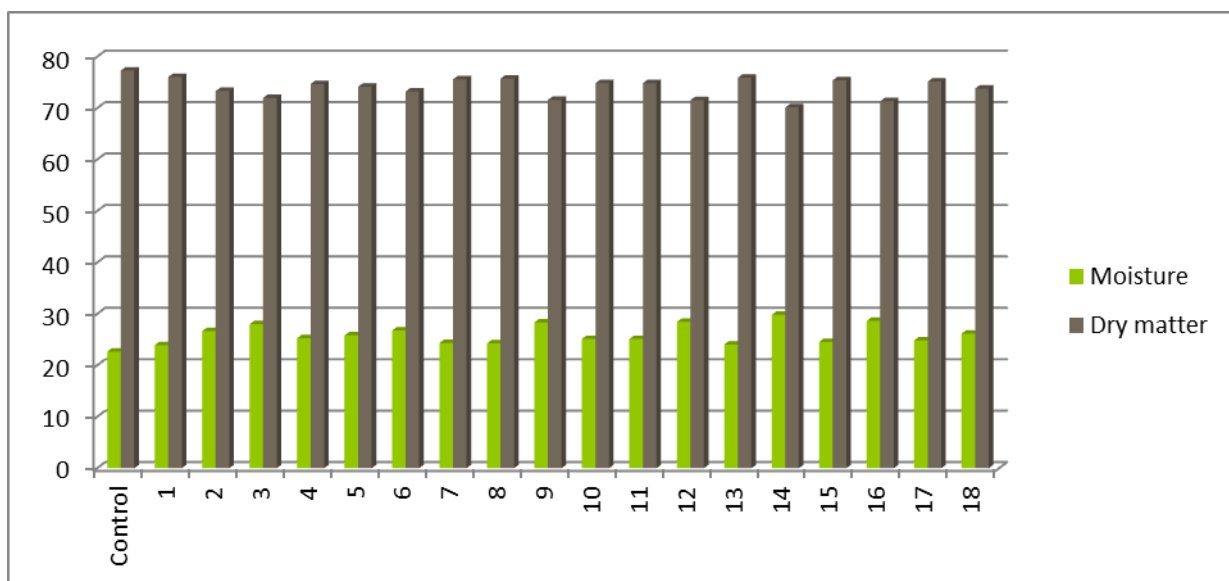


Figure 2. Moisture and dry matter results of sourdough bread after 7 days of storage

Height: Height, which was measured as an indicator of volume increase, was measured based on the highest point of the bread in sourdough breads. The sourdough bread height varied between 6.2 and 8.2. It was determined that the loaf height increased in breads produced from *S. cerevisiae* and other yeast cultures with heterofermentative LAB. These types of breads were determined to be 6th, 12th and 18th sourdough breads.

Crust and inner color: Crust and inner color values of breads were determined at 4 and 24 hours. The results of the analysis performed at the 4th hour are given in Table 14. According to these values, the crust with the highest brightness value (L^*) in breads was found to be 46.17 in bread number 8, and the lowest value was found as 24.78 in bread number 5. According to the inner color of the bread, the highest L^* value was determined as 59.74 for the bread number 5 and the lowest value as 50.94 for the bread number 3.

While the redness parameter a^* value was found to be 12.05 in the bread number 13, the lowest value was found as 4.03 in the bread numbered 5. For the yellowness indicator b^* value, bread number 8 has the highest value with 20.75, while bread number 5 has the lowest value with 6.27. In the study, no relationship was found between color changes in sourdough breads due to LAB and yeast changes. It was determined that the crust and crumb values of the control breads were not different from the others.

Volume and specific volume: The highest volume value in sourdough breads was determined in breads (6, 12 and 18) in which LAB and yeast species were used the most. The bread with the highest volume is 18 in 1760 cm^3 and 6 in 1700 cm^3 , and the lowest volume is 1030 cm^3 in bread number 13. In the study, more voluminous breads were obtained by using homofermentative, heterofermentative and yeasts together. However, these volumes did not affect the appearance and structure of the bread. The specific volume was found by dividing the bread volume by the weight of the bread. The highest and lowest specific volume values were determined as 6 ($4.85 \text{ cm}^3/\text{g}$) and 7 numbered bread ($2.55 \text{ cm}^3/\text{g}$), respectively.

Texture properties: The hardness, stickiness, flexibility, gumminess and chewiness values obtained at the 4th and 24th hours of the texture analysis of the bread dough are determined. In the research sourdough breads, an increase was observed in the hardness of the breads at the end of the 24th hour compared to the 4th hour. The hardness values of sourdough breads changed between 1009.2 and 6801.7 after 24 hours. In the study, using heterofermentative LAB cultures as well as yeast and homofermentative bacteria resulted in less staling due to lower hardness. After 24 hours, the breads with the lowest hardness were determined as 6, 12 and 18 breads. The elasticity of the breads varied between 0.527 and 0.946 after 24 hours. The lowest gumminess was determined in breads 6, 12 and 18. The highest gumminess was determined in breads (bread numbered 1, 7, 11, 13 and 15) used only or less homofermentative. The chewiness value of the control bread was found to be significantly higher ($p < 0.05$). There was a statistically significant increase in the chewiness values of sourdough breads after 24 hours ($p < 0.05$). The chewiness value of the control bread was higher ($p < 0.05$).

Table 2. Texture properties of sourdough bread

Sourdough bread	Time (hour)	Hardness		Stickiness	Elasticity (mm)	Gumminess (g)	Chewiness (mj)
		(g)					
Control	4	3452.5±30.6	0.910±0.05	0.946±0.05	3141.7±50.2	2972.0±45.2	
	24	6879.1±54.3	0.572±0.03	0.802±0.09	3934.8±48.0	3155.7±30.1	
1	4	2392.1±50.2	0.812±0.06	0.835±0.09	1942.4±50.2	1621.9±34.2	
	24	5648.1±54.3	0.666±0.09	0.788±0.03	3761.6±34.5	2964.2±28.0	
2	4	1586.6±30.8	0.773±0.02	0.825±0.09	1226.4±38.1	1011.8±28.5	
	24	4814.4±38.1	0.709±0.02	0.744±0.03	3413.4±26.9	2539.6±40.1	
3	4	1924.4±30.8	0.739±0.02	0.848±0.09	1422.1±27.6	1205.9±34.6	
	24	2089.4±50.0	0.661±0.09	0.780±0.03	1381.0±50.2	1077.2±28.0	
4	4	2048.3±50.2	0.735±0.02	0.862±0.09	1505.5±45.5	1297.7±28.5	
	24	2853.8±50.2	0.645±0.09	0.810±0.09	1840.7±45.2	1490.9±28.0	
5	4	2046.8±50.2	0.600±0.09	0.787±0.03	1228.0±28.0	966.5±45.2	
	24	2440.8±50.2	0.527±0.03	0.795±0.03	1286.3±50.2	1022.6±40.8	
6	4	1029.3±30.2	0.769±0.02	0.792±0.03	791.5±27,6	626.8±34.6	
	24	1734.4±30.8	0.648±0.09	0.890±0.09	1123.8±38.1	1000.2±28.0	
7	4	3301.8±30.5	0.595±0.03	0.767±0.03	1964.5±50.2	1506.8±45.2	
	24	5801.7±54.3	0.592±0.03	0.765±0.03	3434.6±26.9	2627.5±30.1	
8	4	1720.2±30.2	0.592±0.03	0.884±0.09	1018.3±38.1	900.2±28.0	
	24	3097.2±38.1	0.559±0.03	0.669±0.01	1731.3±50.2	1158.2±28.0	
9	4	874.5±29.5	0.615±0.09	0.814±0.09	537.8±45.2	437.8±34.6	
	24	2328.4±50.2	0.500±0.03	0.799±0.03	1164.2±50.2	930.1±28.0	
10	4	2788.1±50.0	0.554±0.03	0.773±0.03	1544.6±45.2	1193.9±28.0	

	24	4543.8±38.1	0.530±0.03	0.618±0.01	2408.2±50.2	1488.3±28.0
11	4	1411.8±30.8	0.664±0.09	0.853±0.09	937.4±50.2	799.6±38.1
	24	4086.2±38.1	0.620±0.09	0.773±0.03	2533.4±26.9	1958.3±40.1
12	4	953.7±29.5	0.668±0.09	0.849±0.09	637.0±45.2	540.8±34.6
	24	2129.0±50.0	0.631±0.09	0.788±0.03	1343.3±50.1	1058.5±28.0
13	4	2276.8±50.2	0.730±0.02	0.781±0.03	1662.0±45.5	1298.0±28.0
	24	4777.1±38.1	0.563±0.03	0.772±0.03	2689.5±26.9	2076.3±40.1
14	4	1378.5±30.8	0.626±0.09	0.813±0.09	862.9±28.0	701.5±38.1
	24	2256.8±50.3	0.544±0.03	0.769±0.03	1227.6±38.1	944.1±28.0
15	4	3700.3±30.4	0.645±0.09	0.799±0.03	2386.6±50.2	1906.9±40.1
	24	6301.8±54.3	0.632±0.09	0.727±0.03	3982.7±26.9	2895.4±30.1
16	4	1665.7±30.2	0.624±0.09	0.726±0.03	1039.3±28.0	754.6±38.1
	24	2540.0±50.0	0.545±0.03	0.709±0.03	1384.3±50.2	981.4±28.0
17	4	3560.4±30.8	0.617±0.09	0.807±0.09	2196.7±50.1	1772.7±45.2
	24	4763.8±38.3	0.475±0.01	0.727±0.03	2262.8±50.2	1645.0±45.8
18	4	1009.2±30.8	0.542±0.03	0.765±0.03	546.9±38.1	418.4±38.5
	24	2032.8±50.4	0.609±0.09	0.883±0.09	1237.9±38.1	1093.1±34.6

Calorimetric properties: The enthalpy value (ΔH), initial transition temperature (T_0), peak transition temperature (T_{peak}) and final transition temperature (T_{final}) of the breads were given as calorimetric properties. These values show the gelatinization start peak and end temperatures and gelatinization enthalpy value of the breads. Endothermic transition thermogram was seen in all samples. In the measurements made on the first day, the initial gelatinization temperature (T_0) varied between 29.50-109.31°C. While these values were between 33.87-103.43°C in the analyzes performed on the 3rd day, the initial gelatinization temperature of the breads changed between 35.62-105.15°C at the end of the 7th day of storage.

T_{final} temperatures ranged from 66.13 to 121.15°C on day 0, between 52.54-116.63°C on day 3 and between 57.32 and 120.08°C on day 7. Typical temperatures varied between 51.39-111.46°C on day 0, 61.95-107.86°C on day 3 and 39.64-110.73 on day 7.

Sensory analysis: Sensory properties of sourdough breads are given in Table 19. At the 4th and 24th hours and 7th day after the bread was baked, an analysis was conducted to determine

the sensory properties of 10 panelists. Breads were sliced and a rating was requested for the external and internal properties of the bread. Although the results of the sensory properties of the breads at the 4th, 24th hours and 7th days were parallel, a decrease in taste was observed with the storage time. As a result of the sensory test, breads 6, 12 and 18 were the most preferred breads.

In the study, the panelist evaluations of 13, 14, 15, 16 and 18 sourdough breads due to the use of more than one LAB and yeast were found to be statistically different from other doughs ($p < 0.05$). These breads gained more acclaim. No statistical difference was found between other breads ($p > 0.05$). In the study, no difference could be determined between the sensory analysis of breads numbered 1, 2, 4 and 5 and the control bread ($p > 0.05$), while it was determined that other breads were different from the control bread ($p < 0.05$).

4. DISCUSSION AND SUGGESTIONS

The pH of sourdough breads increased due to the increase in the number of LAB species. In the research, it was determined that the pH results of homofermentative LABs cause more pH decrease. Because the pH of the breads to which this bacterium was added was generally lower. While the titration acidity of breads with homofermentative LABs was higher, the titration acidity was found to be lower in breads with mostly heterofermentative LABs.

In the study, when heterofermentative and homofermentative bacteria were used together and three or more species together in the production of bread, it was determined that sourdough breads retained more moisture after 7 days of storage. This is because different groups of microorganisms have different metabolic activities (homofermentative and heterofermentative). Again, yeasts have their own metabolic activities. It has been determined that bread structure increases the water holding capacity because different microorganisms break down proteins and polysaccharides more. Another reason for this may be the removal of water from the breads in the form of steam during storage. The amount of dry matter varied depending on the moisture content. As the moisture holding capacity increased, the dry matter content was found to be low.

The elasticity of bread may vary depending on the amount of flour in the bread. The desired porous and elastic texture in bread is associated with the presence of insoluble glutenins and globulins, a surface-active protein found in flour (Bhol and Bosco, 2014). It is expressed as the product of gumminess, hardness and stickiness (Gerçekaslan et al., 2007). The results we obtained in the research determined that the gumminess value increased with the prolongation of the storage period. In this case, the increase in gumminess value increased due to the increase in hardness value in breads. In the calculation of chewability, it is expressed as the value obtained by multiplying the hardness, stickiness and flexibility values (Gerçekaslan et al., 2007). There was a statistically significant increase in the chewiness values of sourdough breads after 24 hours ($p < 0.05$).

As the storage time increases, the area and enthalpy values increase. The enthalpy value obtained from the DSC curve indicates the amount of energy measured during the gelatinization transition. An increase in ΔH indicates increased recrystallization of amylopectin, ie an increase in enthalpy during storage indicates staling. The enthalpy values increased in the study. However, this value difference was less due to more species combinations of LABs with yeasts. In other words, the use of more species caused less enthalpy of bread and they became less stale.

REFERENCES

1. Aplevicz KS, Mazo JZ, Ilha EC, Dinon AZ, Sant'Anna ES., 2014. Isolation and characterization of lactic acid bacteria and yeasts from the Brazilian grape sourdough. *Brazilian Journal of Pharmaceutical Sciences*, 50(2), 321–327.
2. Arendt EK, Ryan LAM, Dal Bello F., 2007. Impact of sourdough on the texture of bread. *Food Microbiology*, 24(2), 165–174.
3. Bakırcı F, Köse E., 2017. Isolation and identificaiton of lactic acid bacteria and yeasts from sourdough. *Akademik Gıda*, 15(2), 149–154 (in Turkish).
4. Bhol S, Bosco SJD., 2014. Influence of malted finger millet and red kidney bean flour on quality characteristics of developed bread. *LWT – Food Science and Technology*, 55, 294-300.
5. Bircan D, Güray CT, Bostan K., 2017. Studies on Sour Dough Bread Making by Different Methods, *Aydın Gastronomy*, 1(1), 1-8 (in Turkish).
6. Elgün A, Ertugay Z., 2002. Grain Processing Technology. Atatürk University, Faculty of Agriculture Publications, Ankara (in Turkish)
7. Erkmen O., 2015. Basic Methods for the Microbiological Analysis of Foods. 3th Press, Nobel Akademik Yayıncılık, Ankara.
8. Ertop MH., 2014. The effect of formula optimization of sourdough on the aromatic profile, bioactive properties and shelf-life of the bread. Erciyes University, Graduate School of Natural and Applied Sciences, Ph. D. Thesis, Kayseri (in Turkish).
9. Gerçekaslan KE, Kotancılar HG, Karaoğlu MM., 2007. Bread staling and methods for measuring degree of staling-I. *Gıda*, 32 (6), 305-315 (in Turkish).
10. Küçükçuban A., 2012. Determination of proper lactic acid bacteria combination for liquid sourdough system. Pamukkale University, M. Sc. Thesis (in Turkish).

SHIFTING RESONANCE AND ANTI-RESONANCE FREQUENCIES OF A SHAFT-DISC-BEARING ROTOR SYSTEM TO DESIRED VALUES BY USING FREQUENCY RESPONSE FUNCTIONS

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ABSTRACT

In engineering applications, in design and product improvement studies, it is sometimes desired that the resonance or anti-resonance frequencies of the system under study are at certain values or be within or outside a certain frequency band. This is an even more important issue in moving systems such as rotors. In this study, a method is presented to shift resonance and anti-resonance frequencies of rotor systems by using Sherman-Morrison based structural modification technique. In the presented method the frequency response functions of the system are used directly and there is no need a mathematical, finite element or modal model of the system. Considerably good results were obtained for mass and grounded spring modifications in some numerical applications.

Keywords: Structural modification, Frequency response function, Sherman-Morrison Formula, Mass modification, Stiffness modification

ÖZET

Mühendislik uygulamalarında, tasarım ve ürün iyileştirme çalışmalarında bazen incelenen sistemin rezonans veya anti-rezonans frekanslarının belirli değerlerde olması veya belirli bir frekans bandı içinde veya dışında olması istenmektedir. Bu, rotorlar gibi hareketli sistemlerde daha da önemli bir konudur. Bu çalışmada, Sherman-Morrison tabanlı yapısal modifikasyon tekniği kullanılarak rotor sistemlerinin rezonans ve anti-rezonans frekanslarının kaydırılması için bir yöntem sunulmaktadır. Sunulan yöntemde sistemin frekans tepki fonksiyonları doğrudan kullanılmakta olup sistemin matematiksel, sonlu eleman veya modal modeline ihtiyaç duyulmamaktadır. Bazı sayısal uygulamalarda kütle ve yere bağlı yay modifikasyonları için oldukça iyi sonuçlar elde edilmiştir.

Anahtar Kelimeler: Yapısal değişiklik, Frekans tepki fonsiyonu, Sherman-Morrison Formülü, Kütle değişikliği, Yay değişikliği

1. INTRODUCTION

Rotors are defined as rotating structures combined with a shaft and different machine elements like disc, gear, propeller and belt-pulley placed on the shaft and housed with different kinds of bearings and bearing conditions. They have a wide usage in engineering from power turbines, industrial machines, electric motors, automotive to marine and aircrafts.

Since the rotors are moving systems, they can be exposed to many dynamic effects under working conditions. While designing a rotor system, the forces and moments to be carried by the shaft and bearings should be taken into account as well as the operating frequencies of the rotor. Instabilities and serious damage will occur if the rotational speed of the rotor coincides

with the natural frequencies of the rotor system. The operating cycle at these frequency values at which the rotor system will resonate is called the ‘critical speed’. While designing a rotor system, taking into account the strength calculations, the cross-sectional area of the rotor shaft, the type of the material, the position of the bearings, the positions and dimensions of the elements such as the disc, pulley, gear and fan on it are of great importance. Because these properties affect the dynamic behavior of the rotor system (natural frequencies, mode shapes and damping). However, the dynamic behavior of the systems affected by the operating conditions and the changes in the mass, damping and stiffness are affected as a result of some repairing operations so different instability situations may occur. In addition, a similar situation may arise when an improvement or a design update is made by adding or removing some mass from an existing system. In this respect, it is of vital importance to determine the frequency bands where the rotor will operate safely. Although the rotor critical speeds are not unique, it is important that the rotor be operated below or above these critical speed values. For this, determining the critical speed values can be a problem that must be overcome at the design stage.

Designing a system in a way to provide the desired dynamic properties is the subject of structural modification [1-8]. Structural modification can be applied with direct or inverse structural modification which can be explained for the former to obtain the dynamic properties of a structure after some modifications (mass, stiffness, damping) and for the latter to calculate the modification parameters to obtain the desired dynamic properties of a structure. There are different approaches for structural modification studied by researchers and have been applied for engineering applications for a few decades [9-16]. In most of the existing methods, FRFs obtained numerically or experimentally are used [17-22]. FRF based structural modification methods are very powerful due to there is no need a mathematical, finite element (FE) or modal model of a structure.

Methods based on Sherman-Morrison (SM) [23] formula known from matrix theory have also been developed for solving structural modification problems. This formula is used to calculate the inverse of a modified matrix by using the inverse of the original matrix and the modifications and it has been adapted to structural modification problems based on FRFs and used effectively in many studies [24-28].

Although rotors are used in a very wide area in engineering and there are many studies on rotor dynamics [29-36], structural modification studies for rotors are very limited in the literature [37-42]. Most researchers use magnetic bearings for active control of rotors to overcome critical speeds [43-46]. In this study, a passive control method is presented for shifting resonance and anti-resonance frequencies of rotor systems by using FRF based structural modification technique. The proposed method uses the FRFs of the system directly and the frequencies can be shifted to desired values or safe operating speed bands. With this study, it is aimed to contribute to the modification studies for rotor systems.

2. MATERIAL AND METHOD

2.1. Sherman-Morrison Based Structural Modification

In this part of the study, SM based structural modification is presented.

Reseptance of a modified system [α^*] with the reseptance of the original system and the modifications can be expressed as [26-29],

$$[\alpha^*] = [\alpha] - \frac{([\alpha]\{u\})(\{v\}^T[\alpha])}{1 + \{v\}^T[\alpha]\{u\}} \quad (1)$$

Here, $\{u\}$ and $\{v\}$ are vectors with all elements of which are zero except the element corresponding to the modification coordinate. These vectors can be given for a mass modification on the coordinate r and for a stiffness modification between the coordinate r and the ground as [30]:

$$\begin{aligned} \{u\} &= \{\dots 1 \dots\}^T, & \{v\} &= \{\dots -\omega^2 m_r \dots\}^T \\ \{u\} &= \{\dots 1 \dots\}^T, & \{v\} &= \{\dots k_{r0} \dots\}^T \end{aligned} \quad (2)$$

The receptance matrix $[\alpha]$ includes all FRFs belonging to the structure. However, in practice, measuring all FRFs of structure is a very laborious and time consuming process. In real applications, a limited number of FRF measurements are made on the structure. In most applications in practice, FRFs consisting of a row or column of the receptance matrix are measured. Therefore, Equation 1 can also be written including the coordinates excitation, response and modification, that is, only for active coordinates [30].

$$[\alpha_{aa}^*] = [\alpha_{aa}] - \frac{([\alpha_{aa}]\{u_a\})(\{v_a\}^T[\alpha_{aa}])}{1 + \{v_a\}^T[\alpha_{aa}]\{u_a\}} \quad (3)$$

By rearranging Equation 3 and defining p , q and r for response, excitation and modification active coordinates respectively, one can obtain;

$$\alpha_{pq}^* = \frac{\alpha_{pq} + v_r (\alpha_{rr} \alpha_{pq} - \alpha_{pr} \alpha_{rq})}{1 + v_r \alpha_{rr}} \quad (4)$$

By using Equation (4), one can obtain the modified FRFs for active coordinates by using the FRFs of the original system (before modification) and the modifications.

2.2. Sherman-Morrison Based Structural Modification for Rotors

In this section, Sherman-Morrison based structural modification technique for rotors is given. Firstly, it will be convenient to give a simple Jeffcott rotor model which can be modelled as a rigid shaft on flexible bearings as shown in Figure 1, on which the translational and rotational coordinates are shown.

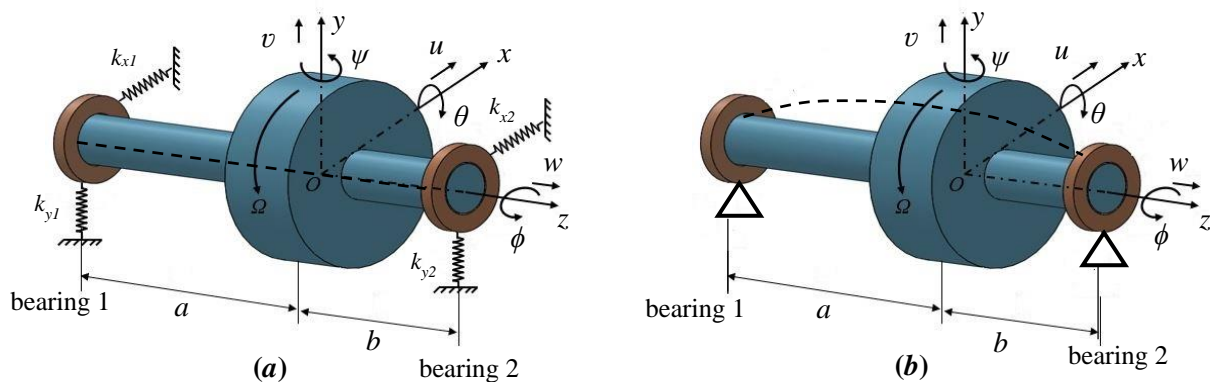


Figure 1. Simple Jeffcott rotor model a) with a rigid shaft on flexible bearings b) with a flexible shaft on rigid bearings

For a rotor system the equation of motion can be expressed as the following form.

$$[M]\{\ddot{q}(t)\} + [C]\{\dot{q}(t)\} + \Omega[G]\{\dot{q}(t)\} + [K]\{q(t)\} = \{f(t)\} \quad (5)$$

Here, $[M]$, $[C]$, $[G]$ and $[K]$ denote the mass, damping, gyroscopic and stiffness matrices of the system, respectively. Ω (rad/s) refers to the rotor rotational speed and $f(t)$ refers to the generalized force vector. Also, $q(t)$ denotes the generalized coordinates with 2 translations (u_i, v_i) and 2 rotations (θ_i, ψ_i) as written below.

$$\{q(t)\} = [u, v, \theta, \psi]^T \quad (6)$$

By using the mass-normalized mode shapes (ϕ_{ij}) , the receptances of the system (α_{ij}) can be obtained for translational vibrations by summing the effects of all modes as follows [47].

$$\alpha_{ij}(\omega) = \sum_{r=1}^N \frac{\phi_{ir} \phi_{jr}^T}{j\omega - \lambda_r} + \frac{\phi_{ir}^* \phi_{jr}^{*T}}{j\omega - \lambda_r^*} \quad \left(\lambda_r, \lambda_r^* = -\zeta_r \omega_r \pm j\omega_r \sqrt{1 - \zeta_r^2} \right) \quad (7)$$

2.2.1. Shifting resonance and anti-resonance frequencies by adding mass onto a disc located at any r coordinate on a rotor system

In Figure 2, a simple rotor system with n number of discs and modification masses located on the shaft is given.

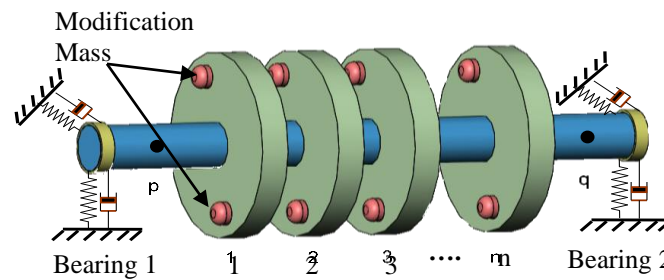


Figure 2. Mass modification on a rotordynamic system

Here, it is assumed that some modification masses can be added onto the discs. The FRFs of the modified system can be expressed for any p, q and r (response, excitation and modification) coordinates for n number of mass modifications at n number of frequencies with SM formula as follows.

$$\alpha_{pq}^{(i)} = \frac{\alpha_{pq}^{(i-1)} - \omega_s^2 m_i (\alpha_{pp}^{(i-1)} \alpha_{qr}^{(i-1)} - \alpha_{rr}^{(i-1)} \alpha_{pq}^{(i-1)})}{1 - \omega_s^2 m_i \alpha_{rr}^{(i-1)}}; (s = s_1, s_2, \dots, s_n); (i = 1, 2, \dots, n) \quad (8)$$

If one resonance frequency is wanted to shift a desired ω_s value with one mass modification on a disc, the denominator of Equation (8) can be equated to zero.

$$1 - \omega_s^2 m_r \alpha_{rr} = 0 \quad (9)$$

Similarly, if one anti-resonance frequency is wanted to shift a desired ω_s value with one mass modification on a disc, the numerator of Equation (8) can be equated to zero.

$$\alpha_{pq} - \omega_s^2 m_r (\alpha_{rr} \alpha_{pq} - \alpha_{pr} \alpha_{rq}) = 0 \quad (10)$$

2.2.2. Shifting resonance and anti-resonance frequencies by adding a grounded spring to any r coordinate on a rotor system

In Figure 3, a simple rotor system with n number of grounded springs located on the shaft is given.

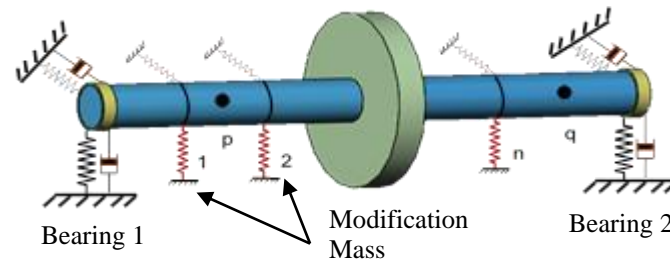


Figure 3. Stiffness modification on a rotordynamic system

The FRFs of the modified system can be expressed for any p , q and r (response, excitation and modification) coordinates for n number of grounded spring modifications at n number of frequencies with SM formula as follows.

$$\alpha_{pq}^{(i)} = \frac{\alpha_{pq}^{(i-1)} + k_i (\alpha_{pp}^{(i-1)} \alpha_{qr}^{(i-1)} - \alpha_{rr}^{(i-1)} \alpha_{pq}^{(i-1)})}{1 + k_i \alpha_{rr}^{(i-1)}}; (s = s_1, s_2, \dots, s_n); (i = 1, 2, \dots, n) \quad (11)$$

If one resonance frequency is wanted to shift a desired ω_s value with one grounded spring modification, the denominator of Equation (11) can be equated to zero.

$$1 + k_r \alpha_{rr} = 0 \quad (12)$$

Similarly, if one anti-resonance frequency is wanted to shift a desired ω_s value with one grounded spring modification, the numerator of Equation (11) can be equated to zero.

$$\alpha_{pq} + k_r (\alpha_{rr} \alpha_{pq} - \alpha_{pr} \alpha_{rq}) = 0 \quad (13)$$

3. RESULTS

In this section, some numerical examples of structural modification applications are given by using the presented method. In the numerical applications, two different (mass and stiffness) structural modifications are examined and these conditions are listed below and presented together with their results. The rotor system consists of a disc, a flexible shaft and two rigid bearings. The mechanical and physical properties of the system are given in Table 1.

Table 1. The physical and mechanical properties of the rotor system

Parameter	Value
Shaft diameter (mm)	14
Shaft length (mm)	800
Disc diameter (mm)	150
Disk width (mm)	15
Shaft density (kg/m ³)	7800

Shaft Elasticity Modulus (GPa)	210
Disc density (kg/m ³)	2700
Disc Elasticity Modulus (GPa)	70

For numerical studies a FE model of rotor system is created by using Euler-Bernoulli approach as a flexible shaft on rigid bearings at both ends. The shaft is created with 20 intervals and 21 nodes were determined on it. The disc is assumed to be located at the middle of the shaft (node 11). No structural or viscous damping are considered in numerical simulations. The translational FRFs are obtained for the first four natural frequencies and a few anti-resonance frequencies of the rotor system in 0-800 Hz bandwidth with 0.1 Hz intervals for bending vibrations by using Matlab[®]. Also, a point FRF (α_{66}) is preferred since an anti-resonance frequency can be seen after each natural frequency due to also anti-resonance frequencies are shifted in this study. The bearings are assumed to be long rigid bearings corresponding to clamped boundary condition.

3.1. Shifting one of the resonance and anti-resonance frequencies to desired values by adding mass onto a disc located at any coordinate on the rotor system

In this application, it is tried to shift the resonance and anti-resonance frequencies to the desired values by making mass modifications on the disc located on the rotor given in Figure 4 below.

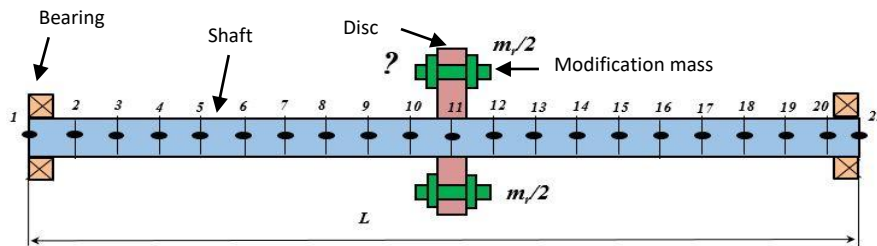


Figure 4. Adding mass onto a disc of a rotordynamic system

It is assumed that the masses will be added to the regions determined on the disc, taking into account the balance condition. (It is assumed that there are holes on the disc where masses can be added by screwing.) For this application, both stationary and 10000 rpm rotating speed conditions of the rotor are handled. The disc is located at the middle of the shaft (coordinate 11), so node 11 is selected as the mass modification coordinate assuming to attach the mass onto the disc. The results obtained are given in Figure 5, 6 and Table 2 below. In Figure 6, 7 the FRFs of the original system (before modification) and the FRFs of the modified system are drawn in red dash lines and blue straight lines respectively.

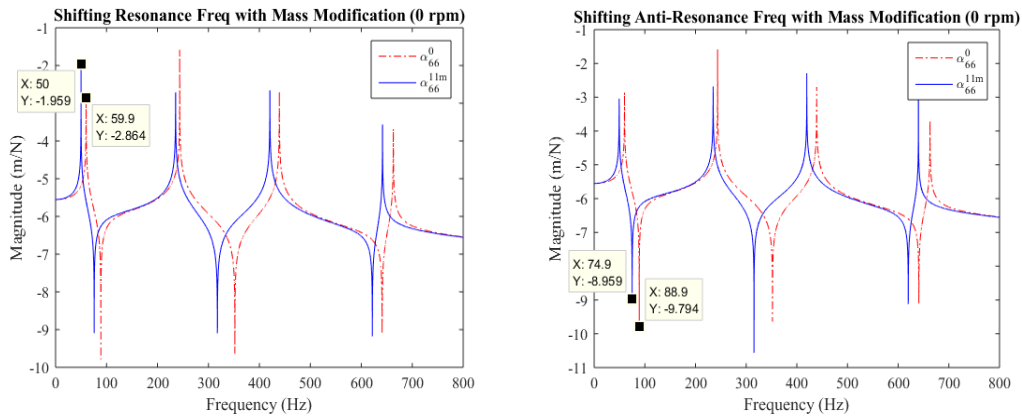


Figure 5. The FRFs (α_{66}) of the original and mass modified system for stationary condition

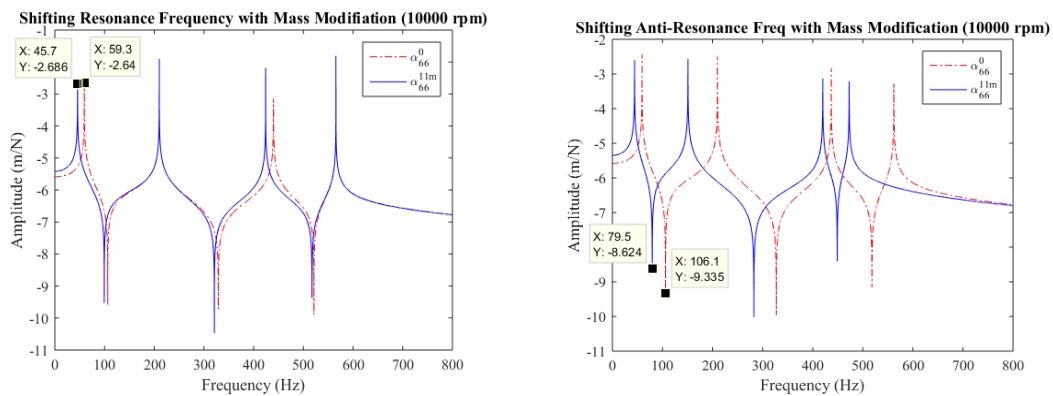


Figure 6. The FRFs (α_{66}) of the original and mass modified system for 10000 rpm rotor speed condition

Table 2. The results of the mass modification obtained for (α_{66}) at stationary and 10000 rpm rotor speed condition

Rotational Speed (rpm)	Resonance Frequency (Hz)			Anti-Resonance Frequency (Hz)		
	Target (Hz)	Obtained (Hz)	Calculated Mass (g)	Target (Hz)	Obtained (Hz)	Calculated Mass (g)
0	50	50	464	75	74.9	504
10000	45	45.7	735	80	79.5	855

3.2. Shifting one of the resonance and anti-resonance frequencies to desired values by adding a grounded spring to any coordinate on the rotor system

In this application, structural modification studies are carried out by adding a grounded spring to a coordinate on the rotor system given in Figure 7.

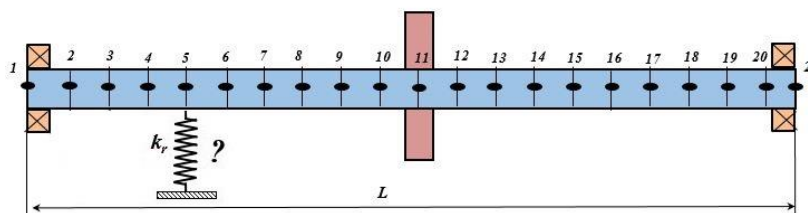


Figure 7. Adding grounded spring on a rotordynamic system

Also, for this application, both stationary and 10000 rpm rotating speed conditions of rotor system are handled. There is no restriction of degrees of freedom at the point where the spring is attached. Node 5 is chosen as the modification coordinate randomly. The results obtained in this application are presented in Figure 8, 9 and Table 3 below.

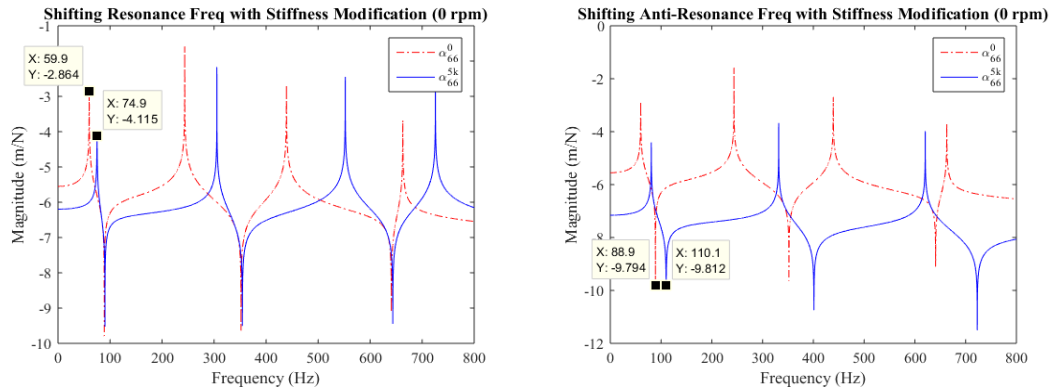


Figure 8. The FRFs (α_{66}) of the original and stiffness modified system for stationary condition

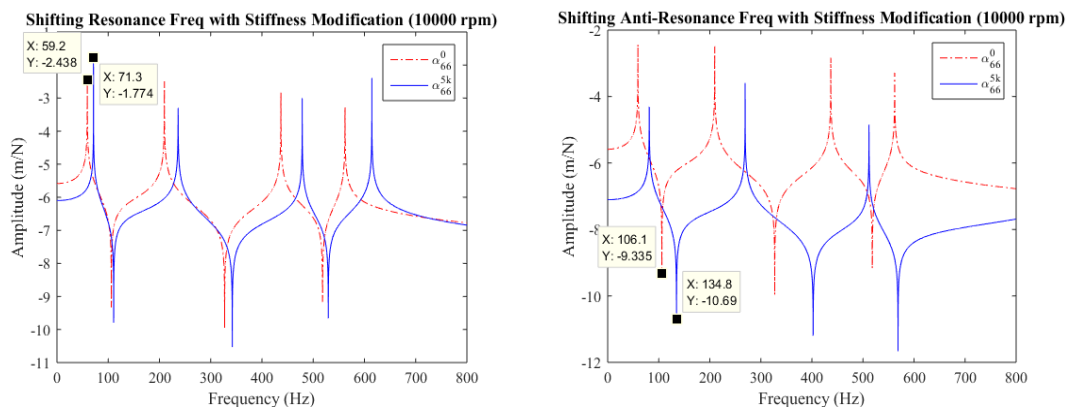


Figure 9. The FRFs (α_{66}) of the original and stiffness modified system for 10000 rpm rotor speed condition

Table 3. The results of the mass modification obtained for (α_{66}) at stationary and 10000 rpm rotor speed condition

Rotational Speed (rpm)	Resonance Frequency (Hz)			Anti-Resonance Frequency (Hz)		
	Target (Hz)	Obtained (Hz)	Calculated Stiffness (kN/m)	Target (Hz)	Obtained (Hz)	Calculated Stiffness (kN/m)
0	75	74.9	2164	110	110.1	59890
10000	70	71.3	982	130	134.8	83622

4. DISCUSSION, RESULTS AND SUGGESTIONS

In engineering applications, in design and product improvement studies, it is sometimes desired that the resonance or anti-resonance frequencies of the system under study be at certain values

or be within or outside a certain frequency band. This is an even more important issue in moving systems such as rotors. In this study, a method is presented to shift resonance and anti-resonance frequencies of rotor systems by using SM based structural modification technique. In the presented method the FRFs of the system are used directly and there is no need a mathematical, FE or modal model of the system. Numerical studies give considerably good results. It should be noted that sometimes applicable results can not be found for the system. The calculated mass or stiffness values may be negative or may be very big for the system. So it may be suitable to use an optimization technique for determining the modification coordinates for feasible solutions. Presented method can also be used for more than one modification by using the presented modification formula sequentially and is left to another study.

REFERENCES

1. Braun, S. G., Ram, Y. M., 2001. Modal modification of vibrating systems: some problems and their solutions. *Mech. Syst. Signal Process*, vol. 15, no. 1, pp. 101–119.
2. Kyprianou, A., Mottershead, J. E., Ouyang, H., 2004. Assignment of natural frequencies by an added mass and one or more spring, *Mech. Syst. Signal Process.*, vol. 18, no. 2, pp. 263–289.
3. Ram, Y. M., 1996. Dynamic Structural Modification, *The Shock and Vibration Digest*, 32(1): 11-17.
4. Sivan, D. D., Ram, Y. M., 1996. Mass and stiffness modifications to achieve desired natural frequency, *Commun. Numer. Methods Eng.*, vol. 12, no. 9, pp. 531–542.
5. Mottershead, J. E., Kyprianou, A., Ouyang, H., 2005. Structural modification. Part 1: Rotational receptance, *J. Sound Vib.*, vol. 284, no. 1–2, pp. 249–265.
6. Kyprianou, A., Mottershead, J. E., Ouyang, H., 2005. Structural modification. Part 2: Assignment of natural frequencies and antiresonances by an added beam, *J. Sound Vib.*, vol. 284, no. 1–2, pp. 267–281.
7. Bucher, I., Braun, S., 1993. The Structural modification inverse problem: An exact solution, *Mechanical Systems and Signal Processing*, 7(3): 217-238.
8. Mottershead, J. E., Mares, C., Friswell, M. I., 2001. An inverse method for the assignment of vibration node, *Mechanical Systems and Signal Processing*, 15(1), 87-100.
9. Mottershead J. E., Lallement G., 1999. Vibration Nodes, and the Cancellation of Poles and Zeros by Unit-Rank Modifications to Structures, *Journal of Sound and Vibration*, 222(5), 833-851.
10. Tsuei, Y. G., Yee, E. K. L., 1989. A method for modifying dynamic properties of undamped mechanical systems, *J. Dyn. Syst. Meas. Control. Trans. ASME*, vol. 111, no. 3, pp. 403–408.
11. Yee, E. K. L., Tsuei, Y. G., 1991. Method for Shifting Natural Frequencies of Damped Mechanical Systems, *AIAA Journal*, Vol. 29, No. 11, November.
12. Sivan, D.D., Ram Y. M., 1996. Mass and Stiffness Modifications to Achieve Desired Natural Frequencies. *Comm. in Numerical Methods in Engineering*, 12: 531-542.
13. Tao, L., Jimin H., 1999. Local structural modification using mass and stiffness changes. *Engineering Structures*, 21(11):1028-1037.

14. Farahani, K., Bahai H., 2004. An inverse strategy for relocation of eigenfrequencies in structural design. Part I: first order approximate solutions. *Journal of Sound and Vibration*, 274:481–505.
15. Mottershead, J. E., Ram Y. M., 2006. Inverse eigenvalue problems in vibration absorption: Passive modification and active control, *Mechanical Systems and Signal Processing* 5–44.
16. Ouyang, H., Zhang J., 2015. Passive modifications for partial assignment of natural frequencies of mass–spring systems, *Mechanical Systems and Signal Processing* 50-51-214–226.
17. Ouyang, H., Richiedei, D., Trevisani, A., Zanardo, G., 2012. A convex-constrained modification method based on receptances, *Mechanical Systems and Signal Processing*, 27, 397–409.
18. Özgüven, H. N., 1990. Structural Modifications Using Frequency Response Functions. *Mechanical Systems and Signal Processing*, 4(1):53-63.
19. Chang, K. J., Park Y.P., 1998. Substructural Dynamic Modification using Component Receptance Sensitivity. *Mechanical Systems and Signal Processing*, 12: 525-541.
20. Park, Y. H., Park, Y. S., 2000. Structural modification based on measured frequency response functions: an exact eigenproperties reallocation, *J. Sound Vib.*, vol. 237, no. 3, pp. 411–426.
21. Mottershead, J. E., 1998. On the Zeros of Structural Frequency Response Functions and Their Sensitivities, *Mechanical Systems and Signal Processing* 12 (5), 591-597.
22. Liu, Z., Li, W., Ouyang, H., Wang, D., 2015. Eigenstructure assignment in vibrating systems based on receptances, *Arch. Appl. Mech.*, vol. 85, no. 6, pp. 713–724.
23. Sherman, J., Morrison, W. J., 1950. Adjustment of an inverse matrix corresponding to a change in one element of a given matrix, *Annals of Mathematical Statistics*, 21 (1), 124–127.
24. Çakar, O., Sanlitürk, K. Y., 2005. Elimination of transducer mass loading effects from frequency response functions, *Mech. Syst. Signal Process.*, vol. 19, no. 1, pp. 87–104.
25. Çakar, O., 2011. Mass and stiffness modifications without changing any specified natural frequency of a structure, *JVC/Journal Vib. Control*, vol. 17, no. 5, pp. 769–776.
26. Huseyinoglu, M., Çakar, O., 2017. Determination of stiffness modifications to keep certain natural frequencies of a system unchanged after mass modifications, *Arch. Appl. Mech.*, vol. 87, no. 10, pp. 1629–1640.
27. Çakar, O., 2017. Bir Sistemin Doğal Frekanslarının Kütle Eklenecek Kaydırılması Üzerine Bir Çalışma, 18. Ulusal Makina Teorisi Sempozyumu, Trabzon.
28. Hüseinoğlu M., 2017. Yapısal dinamik analiz için sonlu elemanlar modellerinin frekans tepki fonksiyonlar kullanılarak doğrulanması ve güncellenmesi, Doktora tezi, Fırat Üniversitesi, Fen Bilimleri Enstitüsü.
29. Adams Jr., M. L., 2010. *Rotating Machinery Vibration From Analysis To Troubleshooting*, Ohio: Case Western Reserve University Cleveland.
30. Rao, J. S., 2011. *History of Rotating Machinery Dynamics*, Chennai/India: Scientific Publishing Services Pvt. Ltd.
31. Vance, J., Zeidan, F., Murphy, B., 2010. *Machinery Vibration and Rotordynamics*,

- Canada: John Wiley & Sons, Inc.
32. Chen, S., Tang, J., Zhou, C., Hu, Z., 2014. Modal and whirling analysis of coupled lateral and torsional vibration of herringbone gear, *Int. J. Dyn. Control*, vol. 2, no. 3, pp. 404–414.
 33. Knight, J. D., Virgin, L. N., Plaut, R. H., 2016. Predicting Critical Speeds in Rotordynamics: A New Method, *J. Phys. Conf. Ser.*, vol. 744, no. 1, 1-8.
 34. Tamrakar, R., Mittal, N. D., 2015. Experimental Investigation of Shaft Whirl Carrying 3 Rotors, *Trends Mech. Eng. Technol.*, vol. 5, no. 2, pp. 17–21.
 35. Tamrakar, R., Mittal, N. D., 2016. Campbell diagram analysis of open cracked rotor, *Eng. Solid Mech.*, vol. 4, no. 3, pp. 159–166.
 36. Jahromi, A. F., Bhat, R. B., Xie, W. F., 2015. Forward and Backward Whirling of a Rotor with Gyroscopic Effect, *Vibration Engineering and Technology of Machinery, Mechanisms and Machine Science*, 23, 879-887.
 37. Birchfield, N. S., 2013. Structural modification of a coupled rotor dynamic system from transfer functions, Master of Science Thesis, Miami University, Oxford, Ohio.
 38. Tsai, S. H., Ouyang, H., Chang, J. Y., 2018. Inverse structural modifications of a geared rotor-bearing system for frequency assignment using measured receptances, *Mech. Syst. Signal Process.*, vol. 110, pp. 59–72.
 39. Chendrudu, C., Reddy, V. M., Reddy, H. C., 2020. Structural dynamic modification for rotors using FEM, *Journal of Critical Reviews*, vol 7, Issue 19.
 40. Skingle, G. W., 1989. Structural dynamic modification using experimental data, Phd Thesis, Imperial College of Science, Technology and Medicine, London.
 41. Myrick S. T., Crawford, W. B., Schumpert G. L., DuPont, E. I. 2004. Changing and controlling the first critical speed of overhung centrifugal fans, *Proceedings of the Thirty-third Turbomachinery Symposium*, pp 33-40.
 42. Abdul, Wahab, A. M., Rasid, Z. A., Abu, A., Mohd, Noor, Rudin, N. E., Yakub, F., 2017. The effect of changing disk parameters on whirling frequency of high speed rotor system, *IOP Conf. Series: Materials Science and Engineering* 270-012031.
 43. Ran, S., Hu, Y., Wu, H., 2018. Design, modeling, and robust control of the flexible rotor to pass the first bending critical speed with active magnetic bearing, *Advances in Mechanical Engineering*, Vol. 10(2), 1-13.
 44. Lei, S., Palazzolo, A., 2008. Control of flexible rotor systems with active magnetic bearings, *Journal of Sound and Vibration*, 314, 19-38.
 45. Heindel S., 2017. Unbalance and Resonance Elimination on General Rotors with Active Bearings, Phd Thesis, Darmstadt Technical University, Germany.
 46. Hutterer, H., Schrödl, M., 2017. Control of active magnetic bearings in turbomolecularpumps for rotors with low resonance frequencies of the blade wheel, *Lubricants*, 5, 26.
 47. Lancaster, P., 1966. *Lambda-matrices and Vibrating Systems*, Pergaman Press Ltd., Headington Hill Hall, Oxford.

MORPHOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF ISOLATED YEAST AND LACTIC ACID BACTERIA SPECIES FROM SOURDOUGH SAMPLES

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ÖZET

Ekşi hamurdan ekmek yapımı 5000 yıl öncesine dayanmaktadır. Türkiye’de de tahıla dayalı beslenmede ilk sırayı ekmek almaktadır. Ekşi hamur, un ve su karışımının laktik asit bakterileri (LAB) ve maya ile fermente edilmesi ile meydana gelmektedir. Laktik asit bakterileri hamurun asitliğini arttırırken hamur ortamında serbest amino asitlerin salınımına neden olurlar ve ortaya çıkan bu amino asitler diğer mikroorganizmaların gelişimini ve metabolik aktivitelerini arttırır. LAB ekmekte tat ve aroma üzerinde olumlu etki bırakmasının yanı sıra ekmeğin bayatlamasını, küf ve bakteriyel bozulmaları geciktirmektedir. Mayaların en önemli özelliği ise CO₂ üretebilmeleridir. Bu CO₂ hamurun kabarmasına neden olur. Bazı çalışmalarda maya türlerinden *Saccharomyces cerevisiae* ve laktik asit bakterilerinden *Lactobacillus sanfranciscensis*, *Lactobacillus brevis* ve *Lactobacillus plantarum*'un en uygun mikrofloraya sahip olanlardır. Bu çalışmada Gaziantep ve Mardin ilinden 24 adet ekşi hamur örneği toplanarak, bu ekşi hamur örneklerinin mikroflorasından laktik asit bakterilerinin izole edilmesi ve tanımlanması amaçlanmaktadır. Çalışmada laktik asit bakterilerinin izolasyonu için MRS ortamında 37°C'de 2 veya 3 gün inkübe edildi. Mayaların izolasyonu için PDA ortamında 25°C'de 2 gün inkübe edildi. LAB bu çalışmada Gram pozitif, hareketsiz, katalaz negatif ve kok veya basil şeklindedir. Bu çalışma sonucunda Gaziantep ve Mardin'den elde edilen izolatlarda basil ve heterofermentatif özellik, kok ve homofermentatife göre daha fazla sayıda gözlenmiştir.

Anahtar Kelimeler: Ekşi hamur, İzolasyon, Laktik asit bakterisi

ABSTRACT

Bread making from sourdough dates back 5000 years. Bread takes the first place in grain-based nutrition in Turkey. Sourdough is produced by fermenting a mixture of flour and water with lactic acid bacteria (LAB) and yeast. While lactic acid bacteria increase the acidity of the dough, they cause the release of free amino acids in the dough environment and these amino acids that emerge increase the development and metabolic activities of other microorganisms. LAB not only have a positive effect on the taste and aroma of bread, but also delay the staleness of bread, mold and bacterial spoilage. The most important feature of yeast is that they can produce CO₂.

This CO₂ causes the dough to rise. Some studies have shown that yeast species *Saccharomyces cerevisiae* and lactic acid bacteria *Lactobacillus sanfranciscensis*, *Lactobacillus brevis* and *Lactobacillus plantarum* have the most suitable microflora. In this study, it is aimed to isolate and identify lactic acid bacteria from the microflora of these sourdough samples by collecting 24 sourdough samples from Gaziantep and Mardin provinces. In the study, for the isolation of LAB, they were incubated in MRS medium at 37°C for 2 or 3 days. For the isolation of yeasts, they were incubated in PDA medium at 25°C for 2 days. Then, bacteria and yeasts growing on these media were classified according to their morphological structure and observed by gram staining under the microscope. LAB are Gram-positive, non-motile, catalase-negative and have cocci or bacilli shape in this study. As a result of this study, higher number of bacilli and heterofermentative than cocci and homofermentative was observed in isolates obtained from Gaziantep and Mardin.

Keywords: Sourdough, Isolation, Lactic Acid Bacteria

1. INTRODUCTION

Bread is obtained by mixing and kneading wheat flour, yeast, salt and water in certain proportions as the main ingredient and baking the dough after fermentation. Bread is a nutrient rich in carbohydrates, as well as being a satisfying and good source of energy. In recent years, sourdough with rich aroma and microflora has been used to prolong the shelf life of bread and increase its nutritional quality. It is formed by fermenting a mixture of sourdough, flour and water with LAB and yeast, producing lactic acid, alcohol, acetic acid and some flavor compounds (Bakırcı and Köse, 2017). The basis of the sourdough method is to use a piece of dough in which lactic, acetic and acid-producing bacteria are active, as well as wild yeasts from the air and the dough components used, as yeast in the next dough (Akgün, 2007).

The number and variety of species found in sourdough; it depends on some factors such as the type of grain used, dough yield and fermentation temperature (Küçükçuban, 2012). Acidic conditions, proteolysis and microbial hydrolysis of starch induced by sourdough. It causes some physico-chemical changes during the shelf life of the bread and as a result, the staleness of the bread slows down (Bakırcı and Köse, 2017). LAB isolated from sourdough belong to the genera *Leuconostoc*, *Weissella*, *Pediococcus*, *Lactococcus*, *Enterococcus* and *Streptococcus*, mainly *Lactobacillus*. Yeasts isolated from sourdough are *S. cerevisiae*, *S. exiguus*, *S. delbrueckii*, *S. ovarum*, *Candida humilis*, *C. guillermondii*, *C. stellata*, *Issatchenkia orientalis*, *Pichia anamola*, *Pichia norvegensis*, *Pichia polymorpha*, *Pichia saitoifaci* and *Debaryomyces hanseii* (Erkmen, 2013). Yeasts are single-celled microorganisms that can convert sugar to alcohol and CO₂ and reproduce by budding. Yeasts are generally eukaryotic organisms with a spherical, oval or cylindrical structure. It is a good source of B vitamins and protein and is included in the succulent mushrooms (Özlem, 2017).

In a study conducted in Italy, phenotypic and molecular identification of LABs isolated from sourdough samples obtained from wheat bran. As a result of incubation, *L. plantarum*, *L. sakei*, *L. curvatus*, *L. citreum*, *L. brevis*, *P. pentosaceus* and *L. mesenteroides* species were isolated (Manini, Casiraghi, et al., 2015). In a study on sourdough in Lithuania, it was determined that *L. sanfranciscensis*, *L. plantarum*, *P. pentosaceus* species were dominant species. (Nuobariene, Cizeikiene, et al., 2015).

14 sourdoughs were collected from different bakeries in the Isparta region and the identification of LAB and yeasts was carried out. *Lb. divergens* (6.1%), *Lb. brevis* (15.1%), *Lb. amylophilus* (6.1%), *Lb. sake* (6.1%), *Lb. acetolerance* (6.1%), *Lb. plantarum* (3.0%), *P. halophilus* (3.0%), *P. pentosaceus* (6.1%) and *P. acidilactici* (6.1%) were isolated as lactic acid bacteria, as well

as *S. cerevisiae* (27.0%), *S. delbrueckii* (2.7%), *T. holmii* (10.8%) and *T. unisporus* (2.7%) were isolated as yeast strain. (Bakırcı ve Köse, 2017).

The aim of this study is to isolate LAB and yeasts from sourdough samples collected from Gaziantep and Mardin regions and to determine their fermentation capacity. Morphological and biochemical properties of microorganisms to be isolated from sourdough samples were determined. Then, the fermentation characteristics were determined.

2. MATERIAL AND METOD

2.1. Sourdough Collection and Microorganism Isolation

24 homemade sourdoughs from Gaziantep and Mardin regions were collected and brought to the laboratory. 25 grams of the samples were weighed, added to 225 ml of peptone water (0.1%) and homogenized by mixing. After sequential dilution with homegenate peptone water, sowings were made into the medium. 1 ml was inoculated into PDA agar for yeasts and MRS agar for LAB. It was incubated at 25°C for 3-4 days for yeast growth. It was incubated at 30°C for 3 days in anaerobic conditions for the growth of LAB. After LAB and yeast incubations, colonies formed on petri dishes were counted based on colony morphology.

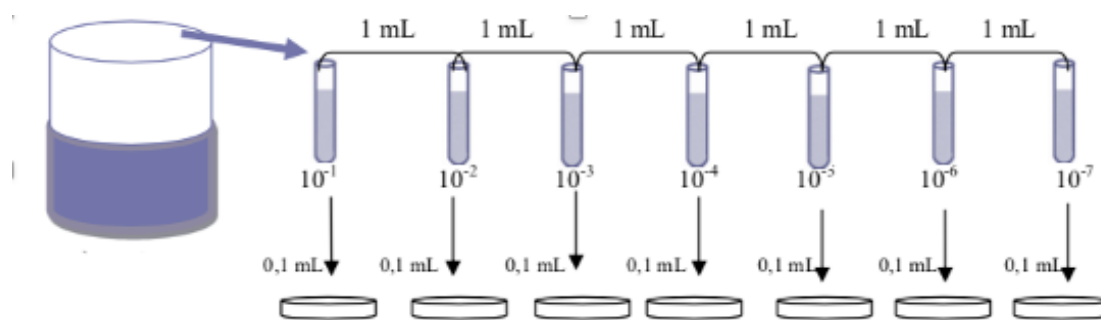


Figure 1. Sequential dilution with peptone water (İpek, 2017)

2.2. Characterization and Identification of Isolates

2.2.1. Morphological Analyzes

For LAB, Gram stain (Gram reaction, cell shape and appearance of cells), direct microscope view (motility analysis), for yeast direct microscope view, morphological features, motility, pseudohyphae formation, cell size were examined.

2.2.1.1. Gram Stain Method

Purified LAB and yeast colonies were taken from the medium with a loop and spread on the slide, allowing the bacterial culture to dry in the air and physical determination was made by passing it through the flame 3 times. Crystal violet was dropped onto the slide (preparation) and stained for 1-2 minutes. Afterwards, iodine and 95% ethyl alcohol were added respectively, waited for 1-2 more minutes and washed with water until the paint did not flow, and then safranin was poured onto the slide (preparation) and waited for 1 minute. Then slide was washed and dried. Finally, a drop of immersion oil was added and LAB and yeasts were examined with a microscope according to their shapes, structures and colors.

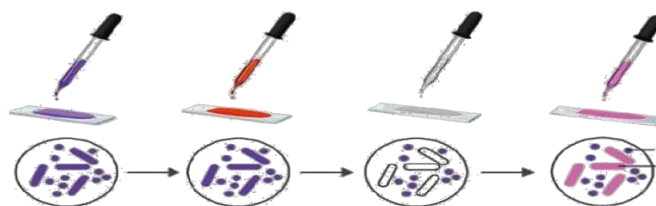


Figure 2. Gram staining (Gümüő, 2015)

2.2.2. Biochemical Analysis (Technological Properties)

2.2.2.1. Catalase Test

LAB and yeast colonies were placed on the slide and then a drop of 3% H₂O₂ was placed on the colony. Air bubble formation was evaluated as catalase positive.

2.2.2.2. Oxidase Test

Tetramethyl-p-phenylenediamine hydrochloride was poured over LAB colonies that grew on TSA agar, and Oxidase positive colonies developed a pink color that became sequentially dark red, purple, and black within 10-30 minutes.

2.2.2.3. Oxidative-fermentation (O-F) Test

Oxidative-fermentation broth containing 0.5% sugar was added to test tubes. After the microorganism was inoculated, the surface of one of the media was covered with sterile liquid paraffin. It was incubated at 35°C for up to 5 days.

2.2.2.4. Homofermentative and Heterofermentative Test

Homofermentative and heterofermentative LAB test was performed using HHD medium. In this medium, heterofermentative LAB reduce fructose to mannitol (white colony), but homofermentatives do not (blue green colony).

2.2.2.5. Temperature Test

MRS broth was used for LABs and PDB broth for yeasts and their growth at 15, 25, 30, 37 and 45 °C, respectively, was observed.

2.2.2.6. Salt tolerance Test

4, 6.5, 7 and 10% salts were added to MRS broth for LABs and to PDB broth for yeasts and it was determined at what salt concentration LABs and yeasts grew.

2.2.2.7. Urease Test

Urease test was performed using urease agar.

2.2.3. Identification of LAB and Yeasts

The isolated LAB and yeasts were identified by the “Laser desorption ionization end-time mass spectroscopy (MALDI-TOF MS) device.

3. RESULTS

3.1. Colony Structures of LAB and Yeasts Isolated from Sourdough Samples

In order to obtain pure culture, LAB were inoculated into MRS and yeasts inoculated to PDA solid media, and after incubation, LAB and yeast counts were made in the growing petri dishes.

Counts were made from plate containing 30 to 300 colonies. In Table 1, LAB and yeast results obtained from some sourdoughs are given. It was observed that the LAB load of the additional dough sample with GH number was higher than the other samples. While it was observed that the LAB load was high in Gaziantep sourdough samples, it was determined that the yeast load was higher in Mardin sourdough samples.

Table 1. LAB and Yeast Number

Sourdough No	LAB (log cfu/g)	Yeast (log cfu/g)
GH (GAZIANTEP)	10.2	4.8
GM (GAZIANTEP)	9.2	6.3
MA (MARDIN)	7.9	7.8
MD (MARDIN)	9.2	9.1

Colony morphology and microscopic cell morphology of LAB was given in Table 2. As a result of the studies, LAB were gram positive and catalase negative. Then, the color, bright-opacity, shape and microscope view of the LAB and yeasts were examined. As a result of these tests, it has been observed that LAB are generally in the form of cocci.

Table 2. Colony morphology and microscopic cell morphology of LAB

LAB No	Color	Opacity	Shape	Microscope	Gr Reaction
MMA2	White	Bright	Round	Cocci	Gr pozitif
MMA6	White	Bright	Round	Cocci	Gr pozitif
MGB2	White	Matte	Round	Cocci	Gr pozitif
MGF4	White	Bright	Round	Bacilli	Gr pozitif

Colony morphology and microscopic cell morphology of yeasts were examined in Table 3. The general characteristics of yeasts are cream-colored, smooth and oval.

Table 3. Colony morphology and microscopic cell morphology of yeasts

Yeast No	Color	Opacity	Shape	Microscope
PGM1	Cream	Bright	Smooth	Oval
MGL1	Cream	Bright	Smooth	Oval
PMB1	Brown	Bright	Smooth	Oval
PMF5	Cream	Bright	Rough	Oval

3.2. Biochemical Test Results of LAB and Yeasts

In Table 4, gas and acid formation is observed in most isolated bacteria in the environment where glucose is present. Some species of LAB can use carbohydrates but cannot produce gases and acids. While the rate of bacteria showing homofermentative properties was 19%, the rate of bacteria showing heterofermentative properties was 81%. These results were seen at the same rate in the oxidative fermentative test. In addition, all of the LAB oxidase and urease tests were negative.

Table 4. Results of biochemical analysis for LAB

LAB No	Homo/ Hetero	Oxidase	O-F	Urease	G. gr./gas/a.	L. gr./gas/a.	M. gr./gas/a.	S. gr./gas/a.
MMA2	Hetero	-	F	-	+/+/+	+/-/+	+/+/+	+/+/+
MMA6	Hetero	-	F	-	+/+/+	+/-/+	+/+/+	+/+/+
MGB2	Homo	-	O	-	+/-/+	+/+/-	+/-/+	+/+/-
MGF4	Hetero	-	F	-	+/+/-	+/+/-	+/-/+	+/-/-

Homo: Homofermentative Hetero: Heterofermentative O: Oxidative F: Fermentative

gr.: Growth formation, gas: Gas formation, (+): growth, (-): no growth, a.: Acid Formation

As seen in Table 5, yeasts did not grow in lactose and did not form gas. The most growth and gas formation were observed in glucose. Yeasts gave catalase negative results. While all yeasts showed growth at 20°C and 28°C, growth differences were observed at 37°C.

Table 5. Carbohydrate and temperature test results for yeasts

Yeast No	G. gr./gas	L. gr./gas	M. gr./gas	S. gr./gas	20°C	28°C	37°C
PGM1	++	--	--	++	+	+	-
MGL1	++	--	--	++	+	+	-
PMB1	++	--	+/-	++	+	+	+
PMF5	++	--	+/-	++	+	+	+

gr. Growth formation, gas: Gas formation, (+): growth, (-): no growth

In the Table 6 while all of the LAB showed growth at 15°C and 28°C, 45°C was important in terms of the distinguishing feature of the bacteria. All of the LAB grew at 1.5% and salt concentrations, but no growth was observed at high salt concentrations.

Table 6. Temperature and salt concentration test results of LAB

LAB No	15°C	28°C	45°C	1.5% NaCl	4% NaCl	6.5% NaCl	7% NaCl	10% NaCl
MMA2	+	+	-	+	+	+	-	-
MMA6	+	+	-	+	+	+	-	-
MGB2	+	+	+	+	+	+	+	-
MGF4	+	+	-	+	+	+	-	-

(+): growth, (-): no growth

3.3. Identification of LAB and Yeasts Using MALDI-TOF Technique

Leuconostoc mesenteroides, *Pediococcus pentosaceus*, *Lactobacillus brevis*, *Enterococcus faecium*, *Pediococcus acidilactici*, *Lactobacillus fermentum*, *Lactobacillus plantarum* strains were isolated from sourdough collected from Mardin region. *Lactobacillus plantarum*, *Lactobacillus pentosus*, *Lactobacillus brevis*, *Pediococcus pentosaceus*, *Lactobacillus kimchii* strains were isolated from Gaziantep region. The most isolated strain was found as *Lb. brevis* (31.3%) and *Lb. plantarum* (27.3%). In addition, *Pediococcus pentosaceus* was isolated (17.2%) with high percentage in this study. The least isolated strains were determined as *Lb. pentosus* (1.0%), *Lb. fermentum* (1.0%) and *Lb. paralimentarius* (1.0%) in this study. In this study, it was determined that the most frequently isolated species was *S. cerevisiae* (53.6%).

In another sourdough study, some LAB and yeast strains were isolated. *L. divergens* (6.1%), *L. brevis* (15.1%), *L. amylophilus* (6.1%), *L. sake* (6.1%), *L. acetolerans* (6.1%), *L. plantarum* (3.0%), *P. halophilus* (3.0%), *P. pentosaceus* (6.1%) and *P. acidilactici* (6.1) strains were isolated and identified as lactic acid bacteria. In addition, *S. cerevisiae* (27.0%), *S. delbrueckii* (2.7%), *T. holmii* (10.8%) and *T. unisporus* (2.7%) were identified as yeast strain (Akgün, 2007).

16 traditional French sourdoughs were investigated the microbiota of yeast and LAB. *L. plantarum*, *L. mesenteroides*, and *L. sanfranciscensis* isolated as LAB. They isolated *C. humulis* and *S. cerevisiae* species as yeast (Lhomme et al., 2015).

4. DISCUSSION

In this study, LAB and yeasts found in the microflora of sourdoughs collected from Gaziantep and Mardin regions were examined and classified according to their morphological structures. In addition, it was observed that LAB have cocci or bacilli forms, which are in the gram positive group. Likewise, as a result of gram staining applied to yeasts, it was observed that yeasts were mostly oval in shape. As a result of the catalase test performed on LAB and yeasts in sourdough, LAB catalase gave negative results, while yeasts gave catalase positive results. According to the results of the carbohydrate test applied to the sourdough, bacteria and yeasts fermented the appropriate carbohydrates, causing acid formation in the broth and gas formation in the durham tube. As a result of the temperature test, it was observed that the majority of LAB grew at 28°C and yeasts at 20-28°C. In the salt concentration analysis, it was observed that the growth of bacteria slowed down at high salt concentrations, and the highest growth was observed at 1.5 and 4% salt concentrations. Fast and reliable results were obtained with MALDI-TOF-MS technique. The identification of LAB and yeasts in the dough is very important for the detection of the appropriate microflora. The dough with the appropriate microflora adds characteristic taste and aroma to the bread and helps to extend the shelf life of the bread.

REFERENCES

1. Akgün FB., 2007. Production of sourdough powder and its potential use in bread production. Pamukkale University, M. Sc. Thesis in Food Engineering (in Turkish).
2. Bakırcı F, Köse E., 2017. Isolation and identificaiton of lactic acid bacteria and yeasts from sourdough. Akademik Gıda, 15(2), 149–154 (in Turkish).
3. Erkmén O., 2013. Food Microbiology, 4th Edition, Efil Publishing House, ISBN 978-605-4334-02-5 (in Turkish).
4. Gümüştaş, A., (2015). Isolation and characterization of lactic acid bacteria and bacteriophages from various sources. Ankara University, Institute of Health Sciences, Department of Pharmaceutical Microbiology, M. Sc. Thesis (in Turkish).
5. İpek Ö., 2017. Technological properties of some baker's yeast isolated from turkish sourdough. Ankara University, Graduate School of Natural and Applied Sciences, M. Sc. Thesis (in Turkish).
6. Küçükçuban A., 2012. Determination of proper lactic acid bacteria combination for liquid sourdough system. Pamukkale University, M. Sc. Thesis (in Turkish).
7. Lhomme E, Lattanzi A, Dousset X, Minervini F, De Angelis M, Lacaze G, Onno B, Gobbetti M., 2015. Lactic acid bacterium and yeast microbiota sixteen French traditional sour doughs. International Journal of Food Microbiology 215: 161-170.

8. Nuobariene L, Cizeikiene D, Gradzeviviute E, Hansen SA, Rasmussen KS, Juodeikiene G, Vogensen KF., 2015. Phytase-active lactic acid bacteria from sourdoughs: Isolation and identification. *Food Science and Technology* 63: 766-772.

**STUDIES on REPRODUCTION of ENDEMIC SPECIES and THEIR ADAPTATION
to NATURAL CONDITIONS at FIRAT UNIVERSITY PLANT TISSUE CULTURE
LABORATORY and GREENHOUSE**

ENDEMİK TÜRLERİN ÇOĞALTIMI ve DOĞA ŞARTLARINA ADAPTASYONU
ÜZERİNE FIRAT ÜNİVERSİTESİ BİTKİ DOKU KÜLTÜRÜ LABORATUVARI ve
SERASINDA YAPILAN ÇALIŞMALAR

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ABSTRACT

Turkey ranks first in the world in terms of floristic richness due to its geography and climatic characteristics. Of the more than 12 thousand plant varieties in Turkey, approximately 3642 are endemic. In addition to the production of endemic species with economic values, it is very important for the continuation of biodiversity to produce and bring into nature the endemic species that have no economic value. In the production of endemic species, studies to be carried out in plant tissue culture, unlike classical methods, are very important. In this study, the endemic species of *Hyacinthus orientalis* subsp. *chionophilus*, *Rosularia blepharophylla*, *Ajuga xylorrhiza*, *Orchis* sp.(Karabük), *Crocus sativus*, *Orchis* sp. (Elazığ) and *Fritillaria baskilensis* Behçet species. The areas where the studied species spread were determined, and researches were carried out on the climatic characteristics in which they grow. Hypocotyl explants were taken and micropropagation was started by applying appropriate sterilization protocols to *Hyacinthus orientalis* subsp. *chionophilus* grown in climate chambers. After breaking the dormancy of the *Ajuga xylorrhiza* seeds and achieving the desired germination dimensions, subcultures were prepared for suitable explant sources and the soil acclimation stages were successful. Appropriate protocols have been determined for the germination and

sterilization of *Rosularia blepharophylla* seeds, and germination has begun to be used as an explant source. By breaking the seed dormancy of *Fritillaria baskilensis* Behçet and determining the correct concentration of plant growth regulators, young shoots and roots were formed after callus formation, and the acclimatization process was successful. It is aimed to increase the number of explant sources by providing ex vitro reproduction of *Crocus sativus* tubers with plant growth regulators. Tuber studies on *Orchis* sp.(Karabük and Elazığ) are being investigated. With these studies, it is aimed to lead the studies to be carried out for the protection of our biodiversity with the studies on the protection of our endemic species, which have difficulties in production.

Keywords: endemic species, micro propagation, plant tissue culture, ex situ, acclimatization

ÖZET

Türkiye, coğrafyası ve sahip olduğu iklim özellikleri sebebiyle floristik zenginlik bakımından dünya sıralamasında ilk sıralarda yer almaktadır. Türkiye’de bulunan 12 bin adetten fazla bitki çeşitinin yaklaşık 3642’si endemik türdür. Ekonomik değerleri olan endemik türlerin üretiminin yanı sıra biyoçeşitliliğin devamı için de ekonomik değeri olmayan endemik türlerin üretilip doğaya kazandırılması oldukça önemlidir. Endemik türlerin üretilmesinde klasik metodların dışında bitki doku kültüründe yapılacak çalışmalar oldukça önemlidir.

Bu çalışmada, endemik tür olan kaya sümbülü (*Hyacinthus orientalis sbusb. chionophilus*), Dicle kuruğu (*Rosularia blepharophylla*), kaba mayasılı (*Ajuga xylorrhiza*), Karabük salebi (*Orchis sp.*), safran (*Crocus sativus*), Elazığ salebi (*Orchis sp.*) ve Baskil ters lalesi (*Fritillaria baskilensis* Behçet) türleri üzerine çalışmalar yapılmıştır. Çalışılan türlerin yayılış gösterdiği alanlar tespit edilmiş, yetiştiği iklim özelliklerine dair araştırmalar yapılmıştır. İklim odalarında yetiştirilen kaya sümbüllerine (*Hyacinthus orientalis sbusb. chionophilus*) uygun sterilizasyon protokolleri uygulanarak hipokotil eksplantları alınmış ve mikroçoğaltımına başlanmıştır. Kaba mayasılı (*Ajuga xylorrhiza*) tohumlarının dormansisini kırıp çimlenme boyutları istenilen şekilde olduktan sonra uygun eksplant kaynakları için alt kültürleri hazır hale getirilmiş ve toprağa alıştırma aşamalarında başarılı olunmuştur. Dicle kuruğu (*Rosularia blepharophylla*) tohumlarının çimlenmesi ve sterilizasyonu için uygun protokoller tespit edilmiş, eksplant kaynağı olarak kullanılmak üzere çimlendirilmelere başlanmıştır. Baskil ters lalesi (*Fritillaria baskilensis* Behçet) tohum dormansisinin kırılması, bitki büyüme düzenleyicilerinden doğru konsantrasyonun tespiti ile kallus oluşumu sonrası genç sürgün ve kökler oluşturulmuş, toprağa alıştırma sürecinde başarılı olunmuştur. Bitki büyüme düzenleyicileri ile safran (*Crocus sativus*) yumrularının ex vitro çoğaltımı sağlanarak öncelikle eksplant kaynaklarının sayısının artırılması hedeflenmiştir. Karabük salebi (*Orchis sp.*) ve Elazığ salebine (*Orchis sp.*) dair yumru çalışmaları araştırılmaktadır. Yapılan bu çalışmalar ile üretiminde zorluk yaşanan endemik türlerimizin koruma altına alınmasına dair çalışmalar ile biyoçeşitliliğimizin korunmasına yönelik yapılacak çalışmalara öncülük etmesi hedeflenmiştir.

Anahtar kelimeler: endemik türler, mikro çoğaltım, bitki doku kültürü, ex situ, aklimatizasyon

INTRUDUCTION

When Turkey is evaluated in terms of annual and perennial plant species, it has a rich potential in different biogeographic regions and different growing conditions. Our country is very rich in terms of plant species diversity as it is divided into various regions with different climate and soil conditions. Of the more than 12 thousand plant taxa in our country, 3642 are endemic (Akdoğan, 1972). According to the CITES agreement signed in 1996 to protect this rich

diversity and to which our country also joined; participating countries have accepted that the protection of all wild animal and plant species is mandatory for the next generations (Yiğit et al., 2002).

Endemic species of plants can be used in cosmetics, medicine, food, paint and chemical industries, as well as in the field of landscape architecture recently. The wide range of usage areas causes some difficulties in the production of endemic species and increases the danger of extinction of the species (Galle, 1987). In order to overcome these difficulties, effective biotechnological methods other than classical methods should be developed. Tissue culture methods are important in the production of endemic species, which are difficult to produce, because they are very fast. Contrary to vegetative reproduction, in vitro production of endemic species has been found to be more effective (Gökbunar et al. 2007). Because it has been reported that plants grown in vitro are more resistant to diseases, pathogens and stress factors than plants grown in natural environment (Kaya, 1988).

In these studies, which we carried out in the Plant Tissue Culture Laboratory of Fırat University, it is aimed to reproduce our endemic species that are in danger of extinction, to adapt them to natural conditions in our greenhouse and to bring them back to nature.

1. *Fritillaria baskilensis* Behçet

The genus *Fritillaria*, which has a total of 165 species in the world, has been recorded to have 48 taxa in Turkey. 27 of these taxa are endemic species. *Fritillaria baskilensis* is an important species in the genetic diversity of the genus in Behçet, within this endemism rate, which corresponds to 36.53% of the flora of Turkey. *Fritillaria baskilensis* Behçet, which is an endemic species of Elazığ, is known to grow in the province of Elazığ-Baskil and is only found in one region in Eastern Anatolia (Pınar and Behçet, 2012).

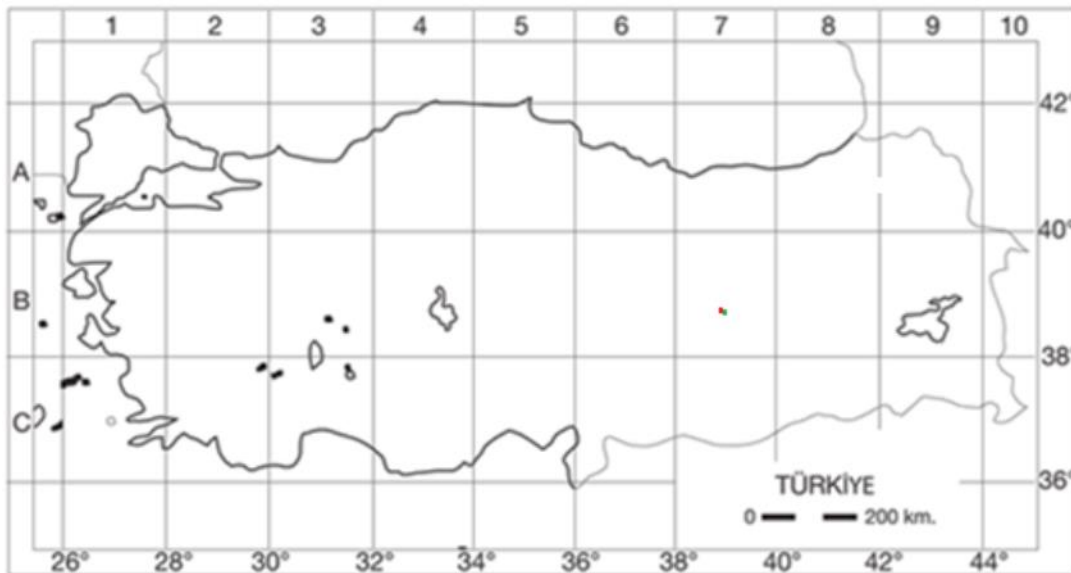


Figure 1. Localities with *Fritillaria baskilensis* (Baskil Inverted Tulip) plant (Sarı, 2016)

B7 Elazığ: Baskil. Yukari Kulushagi village. Selil mountain. 1300 m.

41° B7. Elazığ. baskil. Hassan mountain. Step, 2000-2100 m

Onions of *Fritillaria* species contain a thin tunic. Thanks to this tunic, it has developed a defense mechanism against extreme drought in summer. It completes the time of flowering and seed setting before the summer drought begins. The importance of *Fritillaria* species in the pharmaceutical industry is due to the steroidal alkaloids they contain. Compounds such as saponin, terpenoid, steroid, succinic acid (amber acid), tymidine, adenosine, imperiillin, peiminie and peiminine are some of the compounds stored in *Fritillaria* species (Wang et al. 2005).



Figure 2. The view of *Fritillaria baskilensis* Behçet plant in its natural environment

Alkaloids contained in *Fritillaria* species are used in the treatment of Alzheimer's disease (Arslan, 2014).

There are reports that some *Fritillaria* species also help lower blood sugar (Paek and Murthy 2002). *Fritillaria* species, which are used in the food industry and landscape architecture as well as their pharmacological effects, reintroducing it to nature by in vitro production under tissue culture conditions is very important for the continuation of the species.

In this study, which we conducted in our laboratory, first of all, the seeds, whose surface sterilization was completed, were placed in MS medium to break the seed dormancy and kept at +4 °C for 90 days. Seeds whose dormancy was broken and germinated were transferred to MS medium supplemented with plant growth regulators at different concentrations, transferred to climatic chambers and expected to form callus. After the determination of the correct concentration in callus formation, young shoots and roots were formed. The plants that reached the appropriate growth size were taken into the soil by staggering and the acclimatization process was successful.

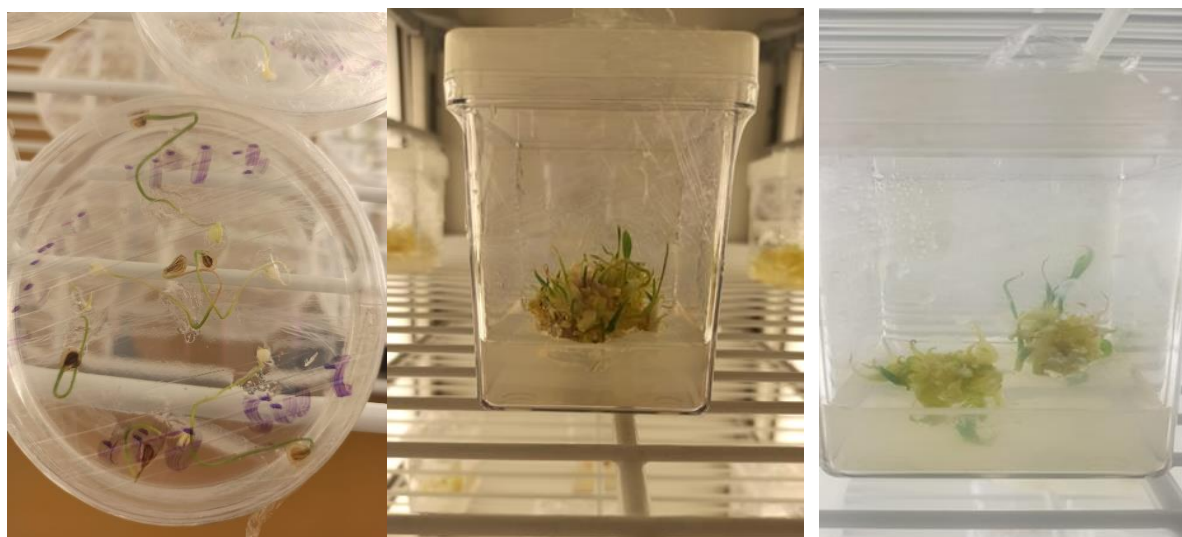


Figure 3. Onion and shoot view of *Fritillaria baskilensis* Behçet's seeds.

2. *Rosularia blepharophylla* (Dicle Koruğu)

Crassulaceae, they are annual, biennial or perennial, usually succulent herbaceous plants. The leaves are undivided, opposite or spirally arranged, sometimes rosette. Inflorescence (inflorescence) is cymous, spike or cluster. Represented by 33 genera and 1500 species in the world (Mabberley, 1997). Crassulaceae family has 8 genera, 79 species and 93 taxa in Turkey (Güner et al. 2012a; 2012b).

In many members of the Crassulaceae family, the mother plant is capable of vegetative reproduction by forming juvenile rosettes. Root formation is ensured by transferring the juvenile rosettes separated from the mother plant to a separate container.

Rosularia is a small genus with 28 species distributed in arid and semi-arid regions of the Eastern Mediterranean, Central Asia and North Africa (Mabberley, 2008). The genus *Rosularia* are rosette, perennial, sometimes monocarpic (once-in-a-lifetime) herbaceous plants.

According to the flora of Turkey, the genus *Rosularia* is reproduced in Turkey with 11 species and 17 taxa (Chamberlain and Muirhead, 1972; Davis et al., 1988, Duman, 2000). 5 taxa of the genus *Rosularia* are endemic, and the endemism rate of the genus is around 24.4%.

Rosularia is a genus of *Crassulaceae* family. The genus, which is represented by 25 species in the world, grows in 11 species and 8 subspecies in Turkey (Chamberlain & Muirhead, 1972; Davis ve ark., 1988; Güner ve ark., 2012a).

According to the flora of Turkey, the genus *Rosularia* is reproduced in Turkey with 11 species and 17 taxa (Chamberlain and Muirhead, 1972 ; Davis et al., 1988, Duman, 2000). 5 taxa of the genus *Rosularia* are endemic, and the endemism rate of the genus is around 24.4%. In recent studies, some *Rosularia* species have been transferred to the *Prometheum* genus: *Rosularia aizoon*, *Rosularia chrysantha*, *Rosularia muratdaghensis*, *Rosularia pilosa*, *Rosularia rechingeri*, *Rosularia sempervivoides*, *Rosularia serpentinica* taxa are now included in the *Prometheum* genus (Güner et al., 2012a).

In many members of the Crassulaceae family, the mother plant is capable of vegetative reproduction by forming juvenile rosettes. Root formation is ensured by transferring the juvenile rosettes separated from the mother plant to a separate container.

The *Rosularia blepharophylla* is a species that prefers rocky habitats, usually on cliffs or rocky slopes in open areas. The species, which grows in the cracks of calcareous rocks, blooms between the end of April and mid-June and grows at altitudes of 670-1500 meters. your kind. In Diyarbakir province, six habitats where it grows were determined.

Rosularia blepharophylla are perennial, rosette, succulent, herbaceous plants. Its roots are short, cylindrical, solidly built and adjacent to the stem, 3-6 cm long, 1-1.5 cm in diameter. It grows in the cracks of the Tigris woods, at an altitude of 670-1500 meters. It blooms at different times depending on the altitude and location of the plant where it grows.

The shoots that develop from the sides of the rosettes develop between April and June, forming a leafy body. The 10-15 cm tall stems have a cluster-shaped flower board made up of helical branches, and they continue to bloom from the end of April until mid-June. Tigris grove continues to produce fruit and seeds from the end of June until the end of July. Since the seeds are very small, the endosperm (nutritive tissue) development is insufficient (Thiede and Eggli, 2007). For these reasons, vegetative (rosette) propagation is more successful than seed propagation in the plant.

It is aimed to reproduce the *Rosularia blepharophylla* endemic plant in Firat University Tissue Culture Laboratory by micropropagation and bring it into nature. Therefore, *Rosularia blepharophylla* seeds were allowed to germinate in MS0 medium and the development of these seeds was observed.

3. *Orchis* sp. (Karabük- Elazığ Salebi)

Salep is the name given to the tubers of Orchidaceae species that grow in different regions. Orchidaceae family is one of the richest families in terms of species, it has more than 20 thousand species. Most of them live in the tropics. They show a wide distribution around the world. Despite its wide distribution, species of this family are never seen as the dominant species in plant communities. It is represented by 24 genera and 187 taxa (species, subspecies, varieties) in our country. About 125 of them are tuberous, and 120 species, including the genera *Ophrys*, *Orchis*, *Himantoglossum*, *Anacamptis*, *Barlia*, *Serapias*, *Comperia*, *Dactylorhiza*, *Aceras*, *Neotinea*, are collected to obtain salep. The genus *Ophrys* ranks first with 60 species and *Orchis* with 30 species (Tamer et al., 2014).

Salep is a beverage consumed in Turkey, Middle East Countries and Southeastern Europe. It originates from West Asia, has tuberous, herbaceous, straight and long leaves, and flowers in white, pink, red and purple colors (Figure 4). 24 genera and about 90 species belonging to *Orchidacea* family, including salep plants, were determined. Salep is the name of the tuber, powder and beverage of the plant. *Orchid tubers* are used in many areas as a raw material for food, medicine, beverage, ice cream and perfume production. In our country, “salep”, which is highly consumed in winter months, is obtained from orchid tubers in our country. Salep has been used for a long time (Arslan , 2014).

In salep production, there are *Anacamptis pyramidalis*, *Dactylorhiza romana*, *Dactylorhiza osmanica*, *osmanica*, *Himantoglossum affine*, *Ophrys fusca*, *Ophrys holosericea*, *Ophrys mammosa*, *Orchis anatolica*, *Orchis coriophora*, *Orchis italica*, *Orchis mascula* ssp. *pinetorum*, *Orchis morio*, *Orchis palustris*, *Orchis simia*, *Orchis spitzelii*, *Orchis tridentata* and *Serapias vomeracea* ssp. tubers of orientalis species are used (Öğretmen et al., 2014).



Figure 4. *Orchid* sp. flowers view of

Orchids spreading in Turkey are in danger of extinction by being removed from nature for the purpose of urbanization, agricultural activities, industrialization, overgrazing, fires, tourism activities, foreign and domestic use. Approximately 30-50 tons of orchid tubers are removed from nature every year (Arslan, 2014).

The species we studied in the laboratory is *Orchis* sp. Our aim is to obtain the endemic salep plant by micropropagation in tissue culture. It is among our goals to protect the endemic species and to obtain seeds in a short time.

4. *Ajuga xylorrhiza* KIT TAN

Ajuga xylorrhiza KIT TAN plant is a regional endemic species located in Çermik district of Diyarbakır province. This plant species, which was introduced to the scientific world in 1984, was named "xylorrhiza" because of its woody roots.

According to the Turkish plant list, it is also called 'Kabamayasıl' (Ubenis, 2013). This locally endemic species usually grows in steep rock cracks at an altitude of 900 meters. While no flower formation is seen on the stems in the first years of the plant, stems with flowers occur after the first year and these stems are called productive stems. The stem and leaves of the plant are densely covered with fine, and soft feathers. The flowers of the plant are white in color and the flowering period lasts from early may to mid-june. Forms fruits and seeds from early June.

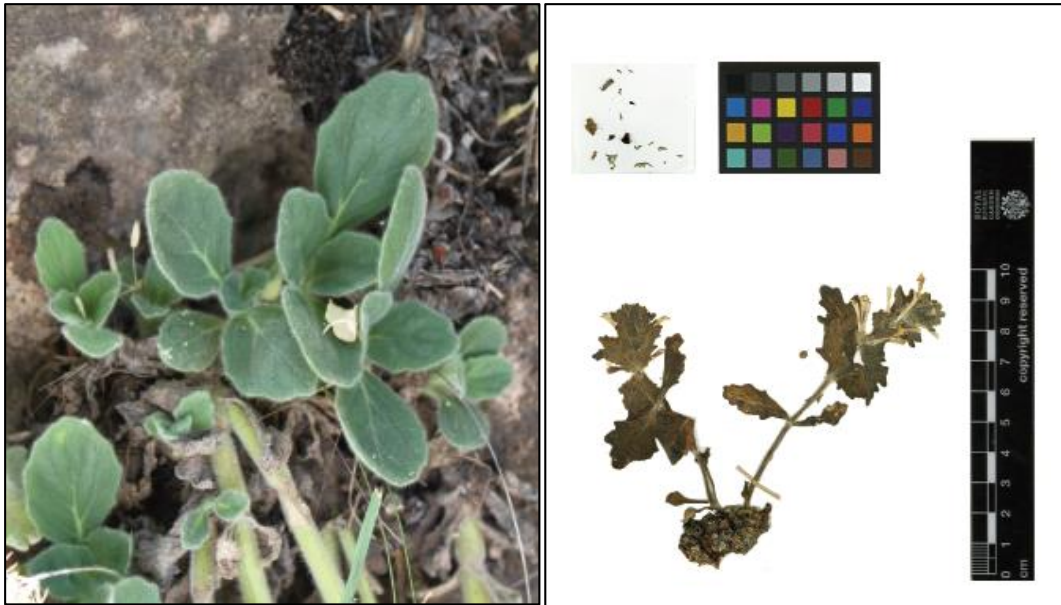


Figure 5. Image of *Ajuga xylorrhiza* from nature and photo of type specimen

There are 4 seeds in total in the flowers of the plant. The mature seeds with the dimensions of 2-2.5 x 1-1.3 mm are black, and the color of the undeveloped seeds is white. The shape of the seeds of the *Ajuga xylorrhiza* species is usually oblong and there are prominent pits on the surface.



Figure 6. Shape of mature seeds of the species *Ajuga xylorrhiza*

The pharmacological and medicinal effects of *Ajuga xylorrhiza* species have been proven by many studies by scientists. As a result of studies such as bioactivity tests, separation and purification of the extracts and essential oils obtained from the plant, it has been concluded that it has a positive effect on digestive tract diseases and is a natural anti-inflammatory. In addition, studies showing that the biological activity of *Ajuga xylorrhiza* KIT TAN species have a wide effect are included in the literature (Israeli and Lyoussi, 2009).

Ajuga xylorrhiza are found in rocky habitats in oak groves. There is a dense and dense feather cover on the roots, stems and leaves for adaptation to the arid climate. It is thought that the seeds are very small, about 2-2.5 mm, and the plant cannot spread to larger areas, which may be due to dormancy occurring in the seeds of the plant. Both the climatic conditions and the

difficulty of overcoming the dormancy occurring in the seed are among the reasons why this species is a locally endemic species.

In this study, which we carried out in the plant tissue culture laboratory, first of all, dormancy breaking studies of *Ajuga xylorrhiza* were carried out. Afterwards, it was transferred to suitable nutrient media and then *Ajuga xylorrhiza* plant was developed in pots in the climate room. As a result of the studies carried out by our laboratory, *Ajuga xylorrhiza* continues to be grown in a 3:1 perlite soil mixture at 22 ± 2 °C in climate chambers.

5. *Crocus sativus* L. (Saffron)

Turkey is one of the richest countries in the world in terms of endemic plants (Şahinalp, 2017). One of our important endemic plants under threat is saffron. Saffron is a plant known in Anatolia from the Hittites to this time, and exported abroad during the Ottoman period. It is distributed in tropical and subtropical climate zones in the northern hemisphere. It is a perennial herbaceous plant cultivated mostly in countries with Mediterranean coasts such as Italy, Spain, Greece, Morocco, Egypt, Israel, Turkey and Japan, China, India, Pakistan, Iran and Azerbaijan (Parray et al., 2012). Saffron is a bulbous cultivar of the *Crocus* genus, 20-30 cm tall, blooming in autumn, in the iris family (Iridaceae). Onion part is spherical, slightly flattened from the top and bottom, covered with brown crusts, its size is 2-4 cm in diameter (Ahmad et al., 2014). In the upper part of the plant, there are needle-shaped, thin long leaves. Flowering begins from the third or fourth week of October and lasts until November 15. An average of 7-8 flowers are taken from each plant. There are three male organs in the flower. Male organs are yellow in color. The most important organ of the flower is the female organ. The female organ, which is one, consists of ovary, egg tube and stigma. The stigma part is divided into three parts with a length of 2.5–3.5 cm, also called filaments, with a threadlike appearance. The stigma (stigma) is dark red in color. The used organ of the plant is this three-part stigma.

Saffron (*Crocus sativus* L.) is distributed worldwide in tropical and subtropical regions of the northern hemisphere (Vurdu et al., 1997). It is still cultivated in an area of 650 m² 'in Davutobası village of Safranbolu district of Karabük province in Turkey (Vurdu, 1993) and in an area of 800 m² in Kuruyer village in Harran plain in Şanlıurfa province. Saffron, one of the most expensive spices in the world, is obtained from the *Crocus sativus* L. plant, whose bright red neck (stylus) and stigma (stigma) parts are used (McGimpsey et al., 1997). This species is sterile and triploid. Saffron; It is used as a fabric dye in the industry, as a spice and colorant in foods, and also in the pharmaceutical and perfumery industry. The name saffron is used both as a herb and as a spice and has been grown as a spice plant for 4300 years (Escribano et al., 2000). Safran gives the smell of saffron, its taste is 'picocrocin' and its color is 'crocin', which is present in the 3-part stigma (Negbi et al., 1989). Due to the fact that the production of saffron by traditional methods cannot fully meet the demand, its cultivation is difficult, and the problems of disease agents, research has focused on the reproduction of saffron by in vitro culture techniques under laboratory conditions as an alternative to natural production techniques. The aim of these studies was to optimize the conditions for large scale and disease-free production of saffron and to produce secondary metabolites in vitro (Sharma and Piqueras, 2010; Gantait and Vahedi, 2015).

We made the saffron we used in our studies in pots as corm reproduction.



Figure 7. *Crocus sativus* L. general view (Şahinalp, 2017)



Figure 8. Tubers of Safranbolu saffron

6. *Hyacinthus orientalis* L. (Rock Hyacinth)

There are approximately 12.000 plant taxa in the flora of Turkey and the number of endemic taxa is more than 3750. Kahramanmaraş province has a very rich geography in terms of plant diversity (Avcı, 2005). There are 1.056 taxa bulbous, rhizome and tuberous plant species in Turkey (Kahraman, 2015). These plants, such as rock hyacinth, called geophytes; Above-ground organs such as stems, leaves, and flowers dry up after completing the development season and continue their lives underground in summer (Altan, 1985; Aksu et al., 2002; Zencirkıran, 2002; Avcı, 2005). Geophytes, which are also known for their natural bulbs, contribute to our country's exports every year (Kahraman, 2015). The rock hyacinth (*Hyacinthus orientalis* subsp. *chionophilus*) collected in Kahramanmaraş is a completely unique subspecies of our country and grows in the provinces of Adana, Kahramanmaraş, Kayseri, Malatya, Sivas and Tunceli in Central Anatolia and the Eastern Taurus Mountains, generally in the mountains above 1.500 meters. Rock hyacinth, also known as "snow-loving", is used as an ornamental plant with its beautiful scent and beautiful flowers. Rock hyacinths reproduce by seeds in their natural habitat. It takes approximately 2-3 years for the plants obtained from seeds to reach the size of an onion that will bloom. In addition to this long period, the presence of hyacinths is decreasing day by day due to the removal of the newly formed seedlings and the immature bulblets with the removal of the plant from the nature. For this

reason, the General Directorate of Nature Conservation and National Parks was obtained from the province of Elazig. This study should determine the feasibility of growing rock hyacinth bulbs in a controlled manner outside their natural distribution areas and the effects of different altitudes on the number of flowers and leaves of the plant (Kaya et al., 2017).

In our study, we made rock hyacinth bulbs as corm propagation in pots as in figure 9.



Figure 9. Rock hyacinth flowering and shoot appearance

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REFERENCES

- Ahmad, M., Zaffar, G., Habib, M., Arshid, A., Dar, N. A., & Dar, Z. A. (2014). Saffron (*Crocus sativus* L.) in the light of biotechnological approaches: A review. *Scientific Research and Essays*, 9(2), 13-18.
- Akdoğan, G., (1972). “Orta Anadolu Step Bitki Örtüsünde Bulunan Bazı Otsu Bitkilerin Peyzaj Planlamasında Değerlendirme İmkanları Üzerine Bir Araştırma” Köy İşleri Bakanlığı.
- Aksu E, Eren K, Kaya E, (2002). Exported Natural Flower Bulbs. Ataturk Garden Cultures Research Institute, Yalova, 84, 39.
- Altan T, 1985. The potential of some commercially important natural geophytes in our country, their utilization and export problems. Certified and Controlled Seed Production and Distribution Problems Symposium in Turkey, İzmir, 623–630s.
- Arslan, N., (2014), Endemik Tıbbi Bitkilerimiz, II. Tıbbi ve Aromatik Bitkiler Sempozyumu , Yalova.
- Arslan, N., (2014). “Ülkemizde Cites Listesinde Olan Bitki Türleri Ve Salep” Türkiye 2. Orkide ve Salep Çalıştayı, İzmir , 45-55.
- Avcı M, (2005). Turkey's vegetation in terms of diversity and endemism. *Istanbul University Faculty of Arts and Sciences Journal of Geography*. İstanbul, 13: 27–55.

- Chamberlain, D. F. and Muirhead C. W. (1972). *Rosularia* (DC.) Stapf in P.H. Davis (ed.). Flora of Turkey and the East Aegean Islands, Edinburgh University Press, Edinburgh, 4: 214-224.
- Davis P.H., R.R. Mill and K. Tan, (1988): Flora of Turkey and the East Aegean Islands, 10: 210. Edinburgh University Press. Edinburgh.
- Duman, H. (2000): *Rosularia* (DC.) Stapf in Güner, A., Özhatay N., Ekim, T., Başer, K.H.C., (eds.). Flora of Turkey and the East Aegean Islands, Edinburgh University Press, Edinburgh, 11: 122-127.
- Escribano, J., Diaz-Guerra, M.J., Riese, H.H., Alvarez, A., Proenza, R., Ferná'ndez, J.A., (2000). The cytotoxic effect of glucoconjugate extracted from corms of saffron plant (*Crocus sativus*) on human cell lines in culture. *Planta Medica* 66, 157–162.
- Galle, F.C., (1987)“Azaleas” Timber Press.
- Gantait S, Vahedi M, (2015). In vitro regeneration of high value spice *Crocus sativus* L.: A concise appraisal. *Journal of Applied Research on Medicinal and Aromatic Plants*, 2:124-133.
- Gökbunar, L., (2007), “Alıç (*Crataegus* sp.)’ın in vitro Mikroçoğaltımı” *Master's thesis*, Kahramanmaraş Sütçü İmam University, Institute of science, Kahramanmaraş.
- Güner, A., Akyıldırım, B., Alkayış, M.F., Çingay, B., Kanoğlu, S.S., Özkan, A.M., Öztekin, M. ve Tuğ, G.N. (2012b). Türkçe Bitki Adları. Şu eserde: Güner, A., Aslan, S., Ekim, T.
- Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, M.T., (edlr.), (2012a). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını. İstanbul.
- Israili, Z.H., Lyoussi, B. (2009), Ethnopharmacology of The Plants of Genus *Ajuga*, Pak. J. Pharm. Sci, 22(4): 425-462.4.
- Kahraman, Ö., (2015). The Effects of Different Growing Media on Onion Performance of Taurus Snowdrop (*Galanthus elwesii* Hook.). *COMU J. Agric. Fac.*, 3(1): 109–114.
- Kaya, A. R., Uslu, Ö. S., Özkan, Ç. Ö. and Kalinkütük, H. (2017). The Effects of Different Cultivation Environments on the Characteristics of Rock Hyacinth (*Hyacinthus orientalis* subsp. *Chionophilus*). *Journal of the Institute of Science and Technology*, 7(4), 243-247.
- Kaya, Z., (1988), “Doku Kültürünün Orman Ağaçları Islah Çalışmalarındaki Yeri” Orman Müh. of Journal, 25, 5, 12-19.
- Mabberley, D. J. (1997). *The plant-book: a portable dictionary of the vascular plants*. Cambridge university press.
- Mabberley, D. J. (2008). *Mabberley's plant-book: a portable dictionary of plants, their classifications and uses* (No. Ed. 3). Cambridge University Press.
- McGimpsey, J. A., Douglas, M. H., & Wallace, A. R. (1997). Evaluation of saffron (*Crocus sativus* L.) production in New Zealand. *New Zealand journal of crop and Horticultural Science*, 25(2), 159-168.
- Negbi, M. (1989). Theophrastus on geophytes. *Botanical Journal of the Linnean Society*, 100(1), 15-43.
- Öğretmen, N.G., Özcan, İ.İ., Arabacı O., (2014). “Orkide’nin Gizemi ve Salep Orkideleri” Türkiye 2. Orkide ve Salep Çalıştayı, İzmir, 55-67.

- Parray, J. A., Kamili, A. N., Hamid, R., & Husaini, A. M. (2012). In vitro cormlet production of saffron (*Crocus sativus* L. Kashmirianus) and their flowering response under greenhouse. *GM crops & food*, 3(4), 289-295.
- Pinar, S. M. and Behçet, L. (2012). Anatomical, morphological and palynological study on Turkish endemic *Fritillaria baskilensis* (Liliaceae). *Boccone*, 24, 305-310.
- Sarı, T., (2016), “ Baskil Ters Lalesi (*Fritillaria baskilensis* Behçet)’nin Doku Kültürüyle Çoğaltılması”, *Master's thesis*, Institute of science, Firat university, Elazığ.
- Sharma KD and Piqueras A, (2010). Saffron (*Crocus sativus* L.) Tissue Culture: Micropropagation and Secondary Metabolite Production. *Functional Plant Science and Biotechnology*, 4 (Special Issue 2), 15-24.
- Şahinalp, A. (2017). Micropropagation of Saffron (*Crocus sativus* L.), *Master's thesis*, Institute of Science, Firat University, Elazığ.
- Tamer, C.E., İncedayı, B. and Çopur, Ö.U., (2014)” Salep ve Bileşiminde Yer Alan Hidrokolloidlerden Glukomannan’ ın Özellikleri”, *Türkiye 2. Orkide ve Salep Çalıştayı*, İzmir, 25-33.
- Thiede J., Egli U. (2007) Crassulaceae. In: Kubitzki K. (eds) *Flowering Plants Eudicots. The Families and Genera of Vascular Plants*, Springer, Berlin, Heidelberg, 9, 83-119.
- Vural M. & Babaç, M.T. (edlr.) *Türkiye Bitkileri Listesi (Damarlı Bitkiler)*. Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını. İstanbul.
- Vurdu, N., Allahverdiev, S. and Vurdu, H. (1997). Growth of saffron (*Crocus sativus* L.) effect of hormones. *Kastamonu Journal of Education*, 4, 85-89.
- Yiğit, N., Çolak, E., Ketenoğlu, O., Kurt, L., Sözen, M., Hamzaoğlu, E., Karataş, A., Özkurt, Ş., (2002). “Çevre Etki Değerlendirme (ÇED)” Çevre Ve Orman Bakanlığı, Ankara.
- Zencirkıran M, (2002). Geophytes. *Uludağ Rotary Association Publications*, Bursa, 1, 105.

THE EFFECTS OF DIFFERENT APPLICATIONS ON THE BREAKING OF SEED DORMANCY IN ENDEMIC *Ajuga xylorrhiza* KIT TAN

ENDEMİK BİR TÜR OLAN *Ajuga xylorrhiza* KIT TAN TOHUM DORMANSİSİNİN KIRILMASINDA FARKLI UYGULAMARIN ETKİLERİ

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ABSTRACT

Ajuga xylorrhiza KIT TAN, an endemic species belonging to Turkey in the Lamiaceae family, is a perennial herbaceous plant. At the same time, *Ajuga xylorrhiza* KIT TAN endemic type occupies an important place in scientific studies due to its use in different fields such as medical ornaments and pharmacology. In endemic species, seed germination is slower due to the fact that dormancy is not broken. In this study, fast seed germination was aimed by hydropriming and treatment with HCl acid to break the dormancy of *Ajuga xylorrhiza* KIT TAN species. Hydropriming and 30% HCl acid treatment were performed as 3 black and 3 white *Ajuga xylorrhiza* KIT TAN seeds from each application group. Seeds were kept for 1 night in hydropriming application and 15 minutes in 30% HCl acid treatment. Then, the testa of these seeds were cracked under a stereo microscope and placed in a hormone-free MS medium and pot. The treated *Ajuga xylorrhiza* KIT TAN seeds were taken into conditioning chambers at 22 ± 2 °C, 16/8 photoperiod. As a result, a significant germination was observed in the hydroprimed black seeds both in the MS medium and in the pot. No germination was observed in black and white seeds that were not cracked with all HCl acid treatments. The endemic type *Ajuga xylorrhiza* KIT TAN seeds were reproduced by breaking the dormancy in vitro conditions. As a result, it is thought that the results obtained will contribute to the ex situ

conservation studies of this species, which has a narrow distribution only in Diyarbakır in our country.

Keywords: *Ajuga xylorrhiza* KIT TAN, dormancy, endemic species, plant tissue culture

ÖZET

Lamiaceae familyasında Türkiye'ye ait endemik tür olan *Ajuga xylorrhiza* KIT TAN çok yıllık otsu yapıya sahip bir bitkidir. Aynı zamanda ülkemizde *Ajuga xylorrhiza* KIT TAN endemik türü tıbbi süs ve farmakolojik gibi farklı alanlarda kullanılması sebebiyle bilimsel çalışmalarda önemli bir yer teşkil etmektedir. Endemik türlerde genellikle dormansinin kırılmamasından dolayı tohum çimlenme aşaması daha yavaş gerçekleşmektedir. Bu çalışmada *Ajuga xylorrhiza* KIT TAN türünün dormansisinin kırılması için hidropriming ve HCl asit ile muamele yapılarak hızlı tohum çimlenmesi amaçlanmıştır. Her uygulama grubundan 3 siyah ve 3 beyaz *Ajuga xylorrhiza* KIT TAN tohumları olmak üzere hidropriming ve % 30' luk HCl asit muamelesi yapılmıştır. Tohumlar hidropriming uygulamasında 1 gece, % 30' luk HCl asit muamelesinde ise 15 dk bekletilmiştir. Daha sonra bu tohumların testası stereo mikroskop altında çatlatılarak hormonsuz MS besiyeri ortamına ve saksıya alınmıştır. Uygulama yapılan *Ajuga xylorrhiza* KIT TAN tohumları 22 ± 2 ° C, 16/8 fotoperiyotta olan iklimlendirme odalarına alınmıştır. Sonuç olarak, hidropriming uygulanan siyah tohumlar hem MS besiyeri ortamında hem de saksı da önemli derecede çimlenme gözlenmiştir. Yapılan tüm HCl asit muameleleri ile çatlatılmamış siyah ve beyaz tohumlarda herhangi bir çimlenme gözlemlenmemiştir. Endemik tür olan *Ajuga xylorrhiza* KIT TAN tohumların in vitro şartlarda dormansisi kırılarak çoğaltımı sağlanmıştır. Sonuç olarak, elde edilen sonuçların ülkemizde sadece Diyarbakır yöresinde dar bir yayılış gösteren bu türün ex situ koruma çalışmalarına katkıda bulunacağı düşünülmektedir.

Anahtar Kelimeler: *Ajuga xylorrhiza* KIT TAN, dormansi, endemik türler, bitki doku kültürü

1. INTRUDUCTION

"*Ajuga xylorrhiza* KIT TAN", belonging to the Lamiaceae family, is a perennial herbaceous plant that generally grows in vertical rock cracks (approximately 900 m high) and blooms in June. "*Ajuga xylorrhiza* KIT TAN", an endemic plant specific to Turkey, is located in Çermik district within the borders of Diyarbakır (Haşimi, 2012) (Table 1, Figure 1).

Table 1. Taxonomic hierarchy of *Ajuga xylorrhiza* KIT TAN (Ertekin, 2013)

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Lamiales
Family	Lamiaceae

Genus	Ajuga
Species	Ajuga xylorrhiza KIT TAN

For the plant *Ajuga xylorrhiza* KIT TAN, when the endemic species criteria are evaluated, it is in the EN “Endangered” category in the National Red List (Ertekin, 2013). *Ajuga* plant has risen an important place in scientific studies because it can be used in different fields such as medicinal, ornamental, and pharmacological. The medicinal significance of the *Ajuga* species has been explored by many researchers. As a result of the findings, anti-inflammatory and antifungal effects as well as the healing effect of high blood pressure and gastrointestinal system diseases were determined (Israeli and Lyoussi 2009).

As a result of the scientific researches, the uncontrolled collection of many plants from the nature and the small number of agricultural activities cause a decrease in number and a threat to the plant generation (Haşimi, 2012).

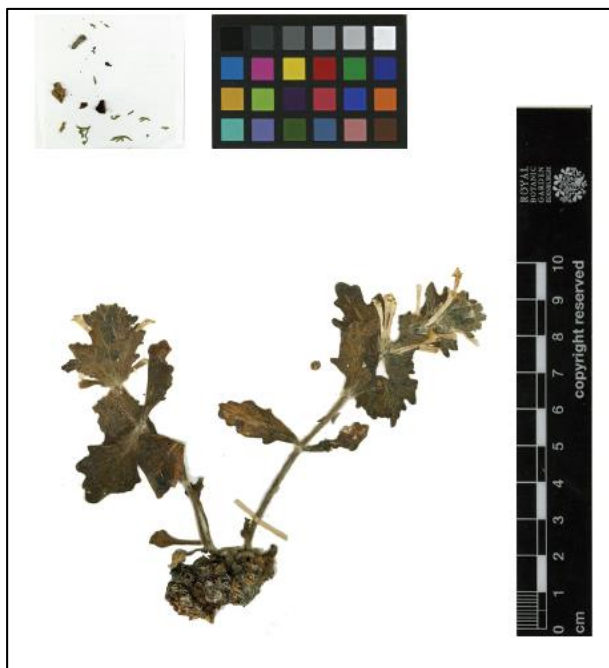


Figure 1. Photograph of the Type Sample of *Ajuga xylorrhiza* (Ertekin, 2013) (Taken from http://eol.org/data_objects/16008595)

The popularization of the use of modern methods of processing and preserving medicinal plants helps to preserve plants in a quality and efficient manner. One of the methods applied to increase the production and numbers of endemic species is plant tissue culture method (Özen and Onay, 2013).

Plant tissue culture is the technique of producing explants taken from plants in sterile conditions, in a suitable nutrient medium indefinitely and innumerably *in vitro*. In addition to being a study carried out in a short time, plant tissue culture also enables the production of millions of plants with identical genetic characteristics (Özen and Onay, 2013). Developing plants with new genetic characteristics and creating genetic differences in existing plant species

are among the studies of tissue culture. Many tissue culture procedures are routinely used to reproduce difficult-to-produce species and to protect endemic species. In addition, tissue culture methods are used in the production of many valuable chemicals belonging to plants (pharmaceuticals, phytochemicals, industrial) (Babaoğlu et al., 2002).

One of the most important stages of the plant's life period is seed germination (El-Keblawy and Al-Rawai, 2005). Bir bitkinin çimlenme performansı bitki büyüme ve gelişimine de etki eder (Hilooğlu et al., 2016). In many plants, the seed germination phase occurs easily, while in some plants this process occurs more slowly due to dormancy (Bu et al., 2008). The word dormancy is often used for seeds that do not germinate under optimal conditions and within a certain time period (Hilhorst, 1995, Baskin and Baskin 1993). Environmental and genetic factors are determining factors in dormancy and seed germination as well as influencing plant growth and development (Sarmandnia, 1996). The presence of germination-inhibiting chemicals in the seed (seed coat, embryo) is one of the factors that most closely affect seed dormancy (Latifi, 2001; Elamin et al., 2013). Another factor affecting seed dormancy is environmental factors (light, temperature, humidity) (Hazerbroek and Metzger, 1990; Tursun,2019).

Seeds of endemic plants are quite susceptible to environmental conditions and therefore their germination is more difficult than other plants. Endemic species can be produced in culture medium by providing optimal conditions in order to break the dormancy of the seeds (Tursun,2019).

Sustaining genetic diversity, which is among the issues of worldwide concern in the last two decades, is carried out especially for plant species that are under threat and grow in a small area. It is a fact that the germination studies carried out on the plants that have been decided to be protected will be beneficial for the development of these species. In order to eliminate seed dormancy, it is used in various chemicals such as potassium nitrate and gibberellic acid, as well as physical processes such as sanding on the seed, soaking in boiling or cold water (Hilooğlu et al., 2016).

The aim of this study is to determine the effect of different conditions (acid, hydropriming, seed type) on seed germination in an endemic plant *Ajuga xylorrhiza* KIT TAN. In addition, the micro-propagation of the germinated seeds in tissue culture studies and the transfer to the soil as a result of this study is a preliminary study for our large-scale studies to be carried out in the future. It is thought that the data to be obtained will contribute to the *ex situ* conservation studies of this species, which has a narrow distribution only in the Diyarbakir region in our country.

2. MATERIAL AND METHOD

The seeds used in this study were collected from Diyarbakır province Çermik district, Çermik-Çüngüş road 0.8 – 9.5 km (Figure 2) and delivered to our laboratory by the Elazığ National Parks and Nature Conservation Directorate. The collected seeds were kept in petri dishes in the refrigerator at 4 °C until the study started.

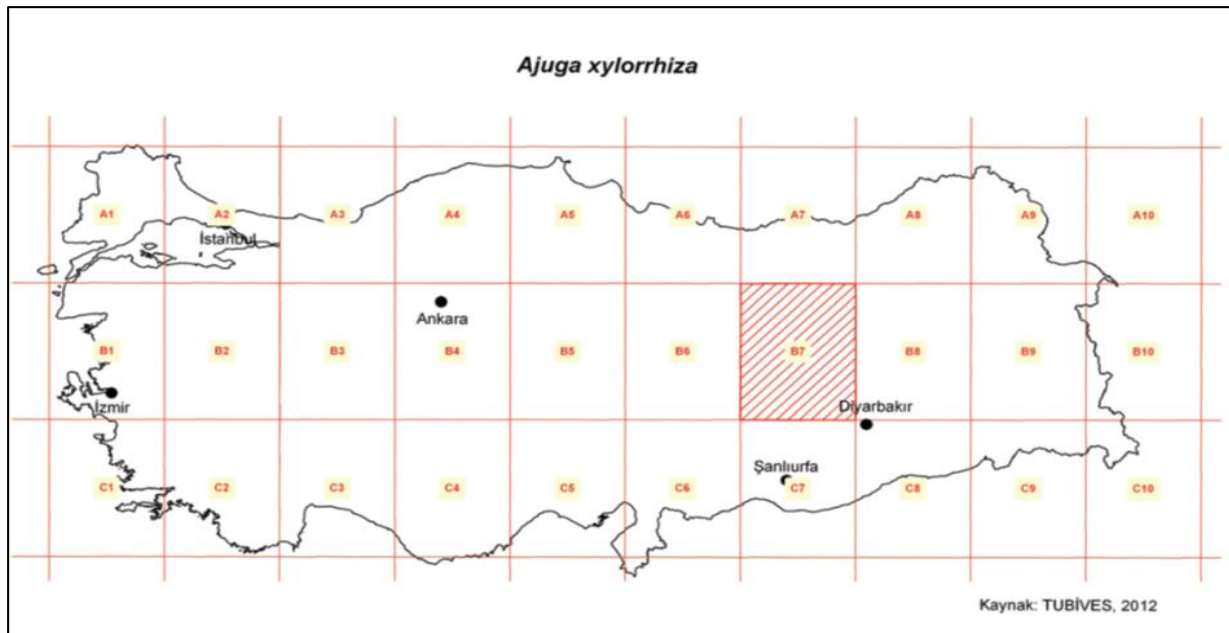


Figure 2. Distribution Area of the Species (Tübives, 2021)

This study was followed for 30 days in the climatic chambers of Elazığ Fırat University Plant Tissue Culture Laboratory and Greenhouse, by keeping it in a light period of 8 hours at 22±2 °C and a dark period of 16 hours at 18±2 °C.

In order to determine the effects of seed colors on germination, to break dormancy in seeds and to reveal the differences between treatments (Table 2), three replications were applied. Before these applications, the seeds were divided into black and white. After surface sterilization of the seeds with hydropriming, microscopic examination (Figure 3) showed that the seed testa was thick, and testa cracking was performed in some groups after sterilization.

Hydropriming was applied to some of the seeds for 24 hours. The other part was treated with 30% hydrochloric acid (HCl) for 10 minutes.

Table 2. WS=White Seed BS=Black Seed CWS= Cracked White seed CBS= Cracked Black Seed

	<i>Ex vitro</i>		<i>In vitro</i>	
<i>Hydropriming</i>	WS	BS	WS	BS
	CWS	CBS	CWS	CWS
<i>HCl treatment</i>	WS	BS	WS	BS
	CWS	CBS	CWS	CBS

In this study, the seeds to be planted in pots (*ex vitro*) were taken into pots with a 3:1 peat: perlite mixture both by cracking and without cracking the seeds after hydropriming and HCl

treatment. The pots that were given the first water were stretched and placed in the climate room.

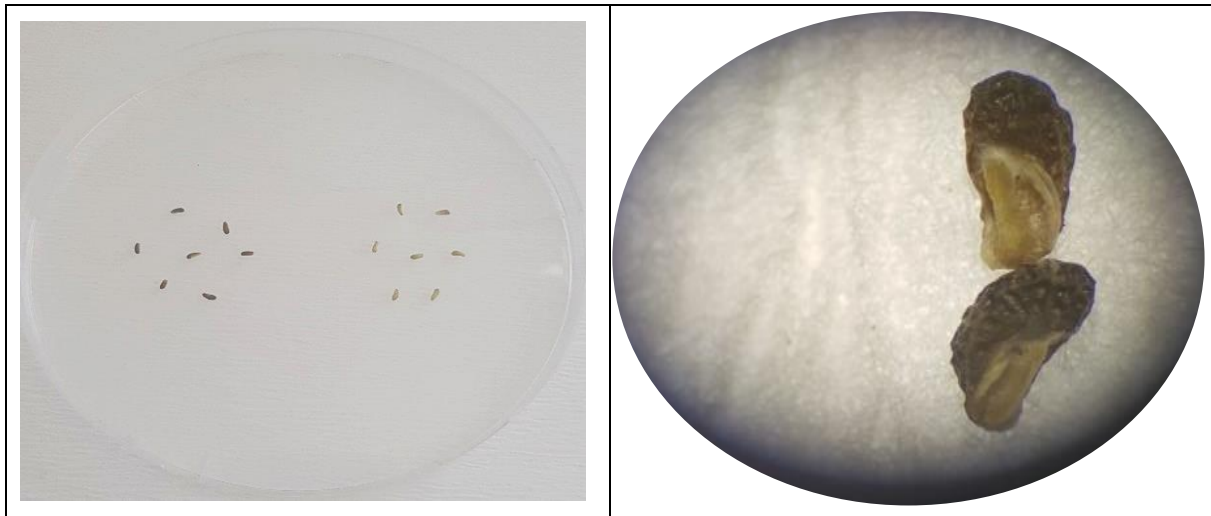


Figure 3. Seed image of *Ajuga xylorrhiza* KIT TAN (Firat University Plant Tissue Culture Laboratory, 2021)

In this study, MS medium, which is frequently used in plant tissue culture, was prepared for seeds to be planted (*in vitro*) in magenta (Murashige and Skoog, 1962). In the preparation of the media, 4.4 g/L MS, 30 g/L sucrose were weighed and dissolved with the help of a magnetic stirrer. The soluble media pH was adjusted to 5.7-5.8 and 8 g / L plant agar was added to solidify. The black and white seeds, which have undergone hydropriming, were taken into laminar flow after surface sterilization and kept in 70% ethyl alcohol for 60 seconds. After this process, it was kept in 5% sodium hypochlorite solution for 10 minutes and passed through distilled water 3 times at intervals of 5 minutes and the chemicals were removed. The testa of white and black seeds, in which all sterilization steps were applied, were cracked under a stereo microscope and planted in MS medium.

In the groups that were followed for 30 days, the seeds were considered to be germinated with the epicotyl emerging on the peat:perlite surface in the pots placed in the climate rooms. On the other hand, seeds in MS mediums were recorded as germinated when 1 mm radicle/rootlet emerged.

3. RESULTS AND DISCUSSION

Black and white seeds of *Ajuga xylorrhiza* KIT TAN were used for this study. Some of these seeds are first grown in 30% HCl acid for 15 minutes. The remaining seeds were kept in hydropriming for 1 night. A total of 6 seeds, 3 white and 3 black seeds, were planted in pots for the treatment with HCl acid. Then, 3 white and 3 black seeds, a total of 6 seeds were planted in MS medium without hormones. In the intervention with HCl acid, 3 white and 3 black seeds were cracked under microscope and planted in pots. Then, with the same intervention, 6 seeds were planted in MS medium without hormones.

A total of 6 seeds, 3 white and 3 black seeds inflated with hydropriming, were planted in pots. Then, 3 white and 3 black seeds, a total of 6 seeds were planted in the MS medium without hormones. The seeds inflated with hydropriming were cracked under the microscope as 3 white

and 3 black seeds and planted in pots. Then, again with the same intervention, 6 seeds were planted in MS medium without hormones. Germination of cracked testa-cracked black seeds in water overnight was observed both in hormone-free MS medium (one week) and in pots (one month later) (Table 3)

Table 3. Responses to applications for breaking dormancy of *Ajuga xylorrhiza* KIT TAN seeds

Application to seeds	Potting of Testa cracked black seeds	Taking the black seeds with cracked testa into MS medium	Potting of Testa uncracked black seeds	Taking the black seeds with uncracked testa into MS medium
30% HCl acid application	x	x	x	x
Application with hydropriming seed inflation	√	√	x	x
No germination: x, Germination:√				

The dormancy in mature seeds can also start with the intake of water due to the effect of light + gibberellin. Here, while ABA inhibits endosperm cracking, it does not inhibit shell cracking. Gibberellic acid (GA), ethylene and brassinosteroids (BRs) provide endosperm cracking by eliminating the inhibitory effect of ABA. I β -1,3-glucanase gene (β Glu I) inhibits the effect of ABA by activating by transcription in the micropylar endosperm just before endosperm cracking. This induction takes place especially in the micropylar endosperm where there is a radicle exit. While light, GA and ethylene promote endosperm cracking; ABA inhibits low turgor and dark and β Glu I expression (Boyras et al., 2019). Seeds sense environmental signals that affect the metabolism and different signaling pathways of gibberellins (GA) and abscisic acid (ABA), the main hormones that regulate seed dormancy and germination with their antagonistic effects (Garcia et al., 2014). It is noted that overcoming secondary dormancy is driven by increased levels of GA rather than decreased levels of ABA. Moreover, during incubation, ABA synthesis inhibits dormant seeds germination, while GA4 synthesis associated with ABA catabolism promotes germination of dormant seeds (Garcia et al., 2020; El-Barghathi ve Asoyri, 2007).

Germination status of *Ajuga xylorrhiza* KIT TAN seeds treated with HCl acid and kept in hydropriming were compared. Accordingly, no germination was observed in the seeds that were not cracked in HCl acid treatment and hydropriming. However, germination was detected in the seeds that were inflated and cracked under the microscope in hydropriming. No germination was observed in any of the white seeds. In untreated seeds, germination is almost completely inhibited and germination is delayed (Yildiztugay and Kucukoduk, 2012).

In the study, two different studies were conducted in air conditioning rooms, *in vitro* and *ex vitro* (Figure 4). The *in vitro* stages of this study are shown in Figure 5. It was observed that the cracked seeds germinated significantly in hormone-free MS medium. The acclimation process of the ajuga seedlings developed in the medium was carried out. In the *ex vitro* study, the black

and white ajuga seeds (Figure 6) cracked under the microscope were taken directly into the pot and it was determined that there was a significant germination.



Figure 4. General view of *Ajuga xylorrhiza* KIT TAN seeds taken into the applied MS medium and potted (Firat University Plant Tissue Culture Laboratory, 2021)



Figure 5. Steps of potting *Ajuga xylorrhiza* KIT TAN seeds with broken dormancy from MS medium (Firat University Plant Tissue Culture Laboratory, 2021)



Figure 6. Microscopic view of cracked *Ajuga xylorrhiza KIT TAN* seeds (Fırat University Plant Tissue Culture Laboratory, 2021)

As a result, seed germination, which is the first stage of plant development, decreases or does not occur at all as a result of the inhibitory substances in the seed itself, the hard and impermeable structure of the seed, various technical mistakes made during seed planting and negative environmental factors. For this reason, taking into account the changing seed characteristics and environmental conditions according to plant species and varieties, some preliminary applications that will optimize seed germination will directly affect seed germination and indirectly plant growth (Karakurt et al., 2010).

CONCLUSION

The testa of the seeds of the endemic plant *Ajuga xylorrhiza KIT TAN* cannot be easily reproduced in nature due to its very hardness. The seeds are eroded by rubbing against hard surfaces such as rocks, stones and soil by being dragged by the wind effect. Thus, the germination of eroded seeds takes a very long time. For this, it is necessary to reproduce the seeds by breaking the dormancy of the testa under *in vitro* conditions. In addition, seed reproduction can be supported by collecting seeds, sending them to seed banks, germinating/receiving cuttings, planting trials and transferring them. It is thought that the results obtained will contribute to the ex situ conservation studies of this species, which has a narrow distribution only in the Diyarbakir region in our country.

ACKNOWLEDGEMENTS

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REFERENCES

- Babaoğlu, M., Gürel, E., Özcan, S. (2002), “Bitki Biyoteknolojisi I, Doku Kültürü ve Uygulamaları” II. Baskı, Konya, Selçuk Üniversitesi Basımevi.
- Baskin CC, Baskin JM (1993). After-ripening Pattern During Cold Stratification of Achenes of Ten Perennial Asteraceae from Eastern North America, and Evolutionary İmplication. *Plant Species Biology*, 8: 61–65.
- Boyras, M., Korkmaz, H., and Durmaz, A. (2019). Seed dormancy and germination. *Black Sea*

- Journal of Engineering and Science*, 2(3), 92-105.
- Bu H , Du G, Chen X, Xu X, Liu K, Wen S (2008). Community-wide Germination Strategies in an Alpine Meadow on the Eastern Qinghai-Tibet Plateau: Phylogenetic and Life-History Correlates. *Plant Ecology*, 195:87-98.
- Elamin K, Abdelfatah M, Abdel Atti K, Malik H, Dousa B (2013). Effect of Feeding Processed Hyacinth Bean (*Lablab purpureus*) Seeds on Broiler Chick Performance. *International Journal of Pure and Applied Biological Research and Sciences*, 1(1): 9-14.
- El-Barghathi, M., H. Asoyri. 2007. Effect of phenol, naphthol and gibberalic acid on seed germination of *Allium cepa* L. (Onion). Garyonis University Pres, *Journal of Science and its Applications*, Vol. 1, No. 1, pp 6-13.
- Ertekin, S. (2013) “Ajuga xylorrhiza Tür Koruma Eylem Planı”. TC Orman ve Su İşleri Bakanlığı Doğa Koruma ve Milli Parklar Genel Müdürlüğü XV, Bölge Müdürlüğü Diyarbakır Şube Müdürlüğü Ankara.
- Garcia, Q. S., Barreto, L. C. and Bicalho, E. M. (2020). Environmental factors driving seed dormancy and germination in tropical ecosystems: A perspective from campo rupestre species. *Environmental and Experimental Botany*, 178, 104164.
- Garcia, Q.S., Oliveira, P.G. and Duarte, D.M. (2014). Seasonal changes in germination and dormancy of buried seeds of endemic Brazilian Eriocaulaceae. *Seed Sci. Res.* 24, 113–117.
- Haşimi, N. (2012), Ajuga Vestita ve Ajuga Xylorrhiza Bitkilerinin Petrol Eteri, Aseton ve Metanol Ekstrelerinin Bazı Biyolojik Aktivitelerinin Belirlenmesi, Doktora Tezi, Diyarbakır.
- Hazerbroek JP, Metzger JD (1990). Environmental Control of Seed Germination in *Thlaspi arvense* (Cruciferae). *American Journal of Botany*, 77: 945-953.
- Hilhorst HWM (1995). A Critical Update on Seed Dormancy. I. Primary dormancy. *Seed Sci. Res.*, 5: 61-73.
- Hilooğlu, M., Yücel, E., Kandemir, A., & Sözen, E. (2016). Endemik *Teucrium leucophyllum* (Lamiaceae) tohumlarında *in vitro* çimlendirme çalışmaları. *Sinop Üniversitesi Fen Bilimleri Dergisi*, 1(1), 53-61.
- Israili, Z.H., Lyoussi, B. (2009), Ethnopharmacology of The Plants of Genus Ajuga, *Pak. J. Pharm. Sci*, 22(4): 425-462.4.
- Karakurt, H., Aslantaş, R. and Eşitken, A. (2010). Environmental factors affecting seed germination and plant growth and some preliminary applications. *Journal of Uludağ University Faculty of Agriculture*, 24(2), 115-128.
- Latifi N. (2001). *Techniques in Seed Science and Technology*. University of Agriculture Science and Natural Resources Gorgan, 310 pp.
- Murashige, T., and F. A. Skoog. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Plant Physiology* 15: 473-97.
- Özen, H.Ç., Onay, A. (2013), *Bitki Fizyolojisi Ders Kitabı 2. Basım*, Nobel Akademik Yayıncılık.
- Sharma AD, Thakur M, Rana M, Singh K, (2004). Effect of plant growth hormones and abiotic stresses on germination, growth and phosphatase activities in *Sorghum bicolor* (L.) moench seeds. *African Journal of Biotechnology*, 3(6), 308-312.

Tursun, A. Ö. (2019). *Salvia verticillata* L. (Dadıracak)'nın Tohum Dormansisinin Kırılmasında Farklı Uygulamaların Etkileri. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, 22, 30-37.

TUBIVES, 2004. Turkish Plants Data Service.
http://194.27.225.161/yasin/tubives/index.php?sayfa=1&tax_id=7425=2438, Erişim: 31.05.2021.

Yildiztugay, E. and Kucukoduk, M. (2012). Dormancy breaking and germination requirements for seeds of *Sphaerophysa kotschyana* Boiss. *Journal of Global Biosciences*, 1, 20-27.

THE EFFECTS OF SOURDOUGH ON THE OF MORPHOLOGICAL STRUCTURE OF BREAD

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ABSTRACT

The sourdough is a traditional method that has been used in bread making from ancient times and positively affects the quality and shelf life of bread. It occurs as a result of spontaneous fermentation of dough through the microorganisms from flour, water and environment; or it is produced by adding lactic acid bacteria (LAB) as a starter to the flour and water mixture. In both methods, the formed metabolites depending on the sourdough microflora affect the nutritional, flavor, textural and color characteristics of the bread. In the acceptability or selection of foods, their physical properties are of most importance as well as their chemical properties. Bread crust color, texture and softness of the bread crumb are the most important criteria by consumers to evaluate the quality characteristics of bread. Changes in physical properties usually occur with decaying during shelf life. These changes are changing in taste and smell, increasing in hardness, losing of the vitality of the bread crust, the crumbly structure of the bread crumb, increasing in the opacity of the crumb, decreasing in the moisture-holding capacity of the crumb, decreasing in the sensitivity of the starch to the amylase enzyme, decreasing in the content of dissolved starch extractable from the bread, bread taste and smell flavor reduction due to the loss of its compounds can be determined as microbial spoilage due to mold growth. Thanks to the LAB found in bread made with sourdough, the shelf life of the bread can be extended. Generally, LAB ensures that fermented foods are prevented from being spoiled by microorganisms. Breads made with sourdough have a stronger and more pleasant aroma than breads made with other yeasts.

Keyword: Sourdough, Bread, Morphological Structure

1. INTRODUCTION

Bread has an important place in food consumption as it is a basic nutrient and a good source of energy. In our country, bread is an indispensable food for our meals because it is more economical and satisfying than other foods due to our nutritional habits.

While grain-based nutrition maintains its importance in Turkey, bread takes first place in nutrition. In our country, 66% of the energy consumed per capita comes from cereals, 56%

from bread, and 50% of protein from bread. Bread consumption, which varies according to different regions, age and income groups, is between 100-800 grams per day in our country, with an average of 400 grams (Elgün and Türker 2000).

Generally, high-quality and fresh breads are preferred. Bread crust color, texture and softness of the bread crumb are the most commonly used criteria by consumers to evaluate the acceptability of bread. The quality of bread, which has a slightly moist and spongy structure, inevitably deteriorates gradually over time following production and this is generally called staling. Bread has a complex and variable structure and is a food that goes stale quickly. Staling of bread does not affect its composition and nutritional value but negatively affects its consumability. Thus, stale bread is not demanded by the consumer, which causes excessive bread wastage. In our country, stale bread takes the most important share among other factors in the loss of bread, especially in big cities (Ercan and Bildik 1993).

Bread production should be done in a way to improve the quality to reduce the loss, which has reached great dimensions in our country. As it is not always possible for the flour, which is one of the most important factors affecting the structure of bread, to be of the desired quality, it is tried to compensate for this deficiency with various additives.

To delay staling, various additives are used in our country and in the world. These substances are generally malt flour, microbial enzymes, soy flour, emulsifiers, fats, dairy products and potato flour.

Sourdough and lactic starters are some of the additives used to increase the quality of bread and to prevent wastage by extending its shelf life.

Since yeast and bacteria operate together in the sourdough technique used before, this application is based on natural flora and sourdough bread. It is preferred because of its suitable volume, strong aroma, good crumb structure and long shelf life (Göçmen 2001). Based on the predominance of yeast and LAB in the dominant flora in sourdough, a starter culture consisting of pure LAB was used to control and secure fermentation (Hansen *et al.*, 1989).

2. RESULTS

LAB plays a key role in sourdough fermentation. LAB is an important family used in directing and accelerating fermentation, in the production of fermented food. In addition to increasing the acidity in the dough, it increases the development and metabolic activities of other microorganisms by releasing various amino acids and small peptides in the dough medium. At the same time, they have a positive effect on the rheological properties of the dough and the taste and aroma. In addition, they delay bread staling, mold and bacterial spoilage.

Even if the bread flavor is not excessive in terms of sensory properties, its components are formed as a result of complex chemical reactions. The characteristic taste and aroma of bread are not related to the taste and aroma of the components that make it up, but to the fact that some substances in their composition react with each other to form new products. As a result, studies have shown that the development of aroma is very low in breads made from unleavened dough; It has been shown that an unpleasant and bland taste occurs in breads that are fermented normally and baked without crusting by applying a special cooking technique.

Aroma components produced during sourdough fermentation are examined in two categories. The first category includes non-volatile aroma compounds containing organic acids produced by homofermentative and heterofermentative LAB. These organic acids are effective in

improving the aroma of bread dough and lowering the pH. The second category is volatile compounds, which include alcohols, aldehydes, ketones, and esters. All these components that contribute to the formation of aroma are produced by biological and biochemical events during fermentation. In addition, the free amino acids leucine, proline, phenylalanine, isoleucine and serine in the dough react with reducing sugars to form flavoring substances. During dough fermentation, the amount of sulfur-containing, aromatic, heteroaromatic and hydroxy amino acids and their derivatives increases by proteolysis, sugar and peptide metabolism, hydrogenation of ketoside derivatives and enzymatic synthesis (Göçmen, 2001; Kılıç, 2008).

The formation of the unique aroma substance of sourdough is based on a strong and long fermentation. Lactic acid, acetic acid, CO₂ and ethanol are formed by homofermentative and heterofermentative LAB. Acids (especially lactic acid and acetic acid), alcohols (ethanol, propanol, isoamyl alcohol, sobutanol, isopropanol, 3-methyl butanol, etc.), esters (acetoin, aldehyde and ketones in acid and alcohol form) that are effective on bread flavor during bread dough fermentation and various carbonyl compounds (diacetyl, 2 propanone, 2-methyl-1-butanol, 3-methyl-1-butanol, 2,3-butanedione, n-hexanal, 2-heptanone, 3-hydroxy-2-butanone).

As the yeast ferments the sugars in the dough, they leave metabolic by-products such as dissolved CO₂ and ethyl alcohol, lactic acid, acetic acid, amino acid, into the surrounding liquid environment. Fermentation products; lactic acid, acetic acid, ethanol, CO₂, amino acids. These components, which are formed by the effect of yeast, give taste and aroma to the bread.

The shelf life of bakery products is very short and the quality of the products depends on the time elapsed between cooking and consumption. The use of sourdough has a positive effect on the staling of bread. The decrease in pH that occurs with acid production increases the activity of amylase and protease enzymes in flour. In a study, it was reported that the addition of the optimum amount of protease increases the shelf life of bread. Proteases cause the release of water in the protein bond and thus an increase in amylase activity. Changes in the retrogradation properties of starch as a result of the effects of some enzymes produced by LAB on starch molecules slow down staling. However, it has been reported that the staling retarding effect of sourdough depends on the microflora's effectiveness in fermentation and the degree of acidification. As a result, acidic conditions, proteolysis and microbial hydrolysis of starch caused by sourdough cause some physicochemical changes during the shelf life of the bread, resulting in slower staling of the bread.

The texture of wheat bread depends heavily on the formation of the gluten network, which traps gas from yeast fermentation, and makes a direct contribution to the formation of the cellular crumb structure of the subsequent bread (Cauvain 2003). Gluten proteins of wheat create unique viscoelastic properties of dough, which allow the dough to expand due to the formation of carbon dioxide during fermentation and, at the same time, retain most of this gas inside the dough texture. Also, other biopolymers of flour, starch and pentosans, have to be swollen and solubilized in appropriate amounts to obtain the optimal bread texture.

The utilization of sourdough has been reported both to decrease and to increase bread volume. A key to improved volume has been proposed to be a type and level of acidification (Clarke *et al.* 2002).

The utilization of sourdough bread improved bread volume more efficiently in comparison to its chemically acidified counterpart (Clarke *et al.* 2002). Also, acidic sourdough is more effective in improving bread volume in comparison to yeasted preferment (Corsetti *et al.* 2000). However, if the acidity of sourdough is further increased, bread volume diminishes (Barber *et al.* 1992). Even though many sourdough microbes produce carbon dioxide, it is

generally assumed that the utilization of sourdough improves gas retention and not the gas production in bread dough (Hammes and Gánzle 1998, Clarke *et al.* 2002).

In addition to the amount of acidity, if the level of other metabolites and gluten degradation are at appropriate levels, it is possible to improve a certain volume by making use of wheat sourdough. Accordingly, fermentation conditions have a significant effect on bread volume.

3. CONCLUSION

Today, sourdough and lactic starter are used to increase the quality of bread, which has an indispensable place in terms of consumption habits of our people and to prevent wastage by prolonging its shelf life. This means that sourdough and lactic starters have curative effects on bread morphology. The use of sourdough and lactic starter will both improve bread and prevent waste, as it contributes to extending the shelf life of the bread.

REFERENCES

1. <http://acikerisim.pau.edu.tr/xmlui/handle/11499/1597>
2. <https://dergipark.org.tr/tr/pub/gida/issue/31926/328416>
3. <https://www.vttresearch.com/sites/default/files/pdf/publications/2005/P569.pdf>
4. Clarke CI, Schober TJ, Arendt EK., 2002. The effect of single strain and traditional mixed strain starter cultures on rheological properties of wheat dough and bread quality. *Cereal Chemistry* 79, 640-647.
5. Corsetti A, Gobbetti B, De Marco B, Balestrieri F, Paoletti F, Rossi J., 2000. Combined effect of sourdough lactic acid bacteria and additives on bread firmness and staling. *Journal of Agriculture and Food Chemistry* 48, 3044-3051.
6. Barber B, Ortola C, Barber S, Fernandez F., 1992. Storage of packaged white bread. III. Effects of sourdough and addition of acids on bread characteristics. *Zeitchrift f,r Lebensmittel Untersuchung und Forschung* 194, 442-449.
7. Hammes W, Gánzle M., 1998. Sourdough breads and related products. In: Wood, B.J (ed.). *Microbiology of fermented foods*. Vol. 1, Blackie Academic and Professional, London, pp. 199-216.
8. Cauvain S., 2003. Bread making: an overview In: Cauvain, S. (ed.). *Bread making, improving quality*. Woodhead Publishing Limited, Cambridge, pp. 8-20.
9. Göçmen D., 2001: Ekşi Hamur ve Laktik Starter Kullanımının Ekmekte Aroma Oluşumu Üzerine Etkileri, *Gıda*, 26, 13-16.
10. Kılıç S., 2008: Süt Endüstrisinde Laktik Asit Bakterileri, Ege Üniversitesi Ziraat Fakültesi Yayınları No: 542, Ege Üniversitesi Basımevi, Bornova, İzmir, 451s.
11. Elgün A, Türker S., 2000. Unlu Mamüllerde Un Kalitesi ve Ekmek Yapım İşlemleri. Selçuk Üniversitesi Mesleki Eğitim Seminerleri, Seminer No:1, Konya, 40s
12. Göçmen D., 1993. Un ve Katkı Maddelerinin Ekmek Kalite ve Bayatlamasına Etkileri. *Gıda*, 18:325-331.
13. Hansen A, Lund B, Lewis MJ., 1989. Flavour Production and Acidification of Sourdough in Relation to Starter Culture and Fermentation Temperature. *Lebensm. Wiss.*, 22:145-149.

THE EFFECT OF TRANSPORT PROCESS ON THE MICRONUCLEI FREQUENCY IN ERYTHROCYTES OF THE COMMON CARP *Cyprinus carpio* L.

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ABSTRACT

In this study, the effect of transport process on the micronucleus frequency in erythrocytes of common carp has been investigated. Blood samples taken from carps which after immediately from transport process (t0 group), after 6 hours from transport process (t6 group), after 12 hours from transport process (t12 group) and not applied transport process (control group) have been investigated and the results have been compared as statistically. The frequencies of both micronuclei and nuclear abnormalities were evaluated in peripheral erythrocytes. As result of the study, it is determined that the highest MN frequency is significantly observed in t0 group ($p < 0.01$). Besides, it is observed that the other nuclear abnormalities (NAs) in the blood samples of t0, t6 and t12 groups are significantly higher ($p < 0.01$) compared to the control group.

Key words: *Cyprinus carpio*, Fish transport, Micronucleus test.

INTRODUCTION

Fish farming practices often involve transports for various purposes and for variable periods of time. Appropriate transport protocols with the least stressful procedures are important for farmers because they can increase the profitability of their business by reducing fish mortality. Studies that characterize the response to stress in commercial fish are relevant to enable aquaculture as an economic activity. Therefore, objective criteria to assess the health and welfare of the fish are increasingly required. Most researches about the stress associated with fish transport refer to freshwater teleosts (Stieglitz *et al.* 2012, Skomal and Mandelman 2012, Sampaio and Freire 2016). Processes of fish transport can be variable. The main differences are related to the type of container, fish density inside the container, fish species and the duration of the transport. These characteristics are determined by the size and behaviour of the fish, and the distance between the source and their final destination. Fish can be transported in plastic bags, or in large tanks or vats. Fish density during transport is an important factor because high densities correspond to lower costs. However, if density increase causes mortality or a high degree of stress that may compromise fish health, high density turns out not to be economically viable (Reglero *et al.* 2013, Sampaio and Freire 2016).

Fish transport are one of the most common causes of acute and/or chronic stress in fish (Meinelt *et al.* 2008). Stress markers are used to evaluate how the transport and changes in fish environment (means of transport) defy fish extra- and intracellular homeostasis. The stress response in fish is accompanied by the activation of the stress hormones catecholamines (adrenalin, noradrenalin, etc.) and cortisol. It is believed that cortisol and its derivatives are

among the main stress hormones inducing the suppression of immunologic reactions, the activation of catabolic processes, erythropoiesis, and the mitotic division of cells. Catecholamines induce glycolysis, lipolysis, and enhanced thrombocytopoiesis. There are few published data in the character of the cortisol impact and of transport stress on the chromosomes of fish erythrocytes. Knowledge on this impact is important for understanding the effects of perturbing environmental factors on the stability of genetic apparatus of fish erythrocytes (Dang *et al.* 1997, Iwama *et al.* 2006, Gökalp Muranli and Güner 2011, Kamshilova *et al.* 2013)

The micronuclei test reflects the level of chromosome aberrations occurring under the impact of various stress factors in the erythrocytes of vertebrates, including fish (Kamshilova *et al.* 2013). Micronuclei can originate both from acentric fragments resulting from chromosomal breaks and from whole chromosomes delayed, which are not incorporated into the main nucleus during cellular division. These characteristics allow the detection of damage provoked both by clastogenic and aneugenic chemicals. This analysis has been used in different environmental assessment studies to detect genotoxic effects of pure chemicals or mixtures of chemicals (Dalzochio *et al.* 2016). The concomitant analysis of the occurrence of erythrocyte nuclear abnormalities (NA) allows for the evaluation of another toxicity biomarker, which has been successfully applied under field and laboratory conditions (Kawetsky *et al.* 2021). The goal of the present study is to determine the effect of transport process on the micronucleus frequency in erythrocytes of Common carp (*Cyprinus carpio* L.).

MATERIAL METHOD

The experiment was carried out with Common carp (average weight of 1.35 ± 0.11 g) in the Iskenderun Technical University, Faculty of Marine Sciences and Technology, Aquaculture Research and Development Center, Turkey. One-hundred carps have been transported from Republic of Turkey Ministry of Agriculture and Forestry Mediterranean Fisheries Research, Production and Training Institute to the Iskenderun Technical University, Faculty of Marine Sciences and Technology, Aquaculture Research and Development Center. Carps were caught from the culture pond and held in a depuration tank for 16 h to allow gastrointestinal emptying. Fish weight was not significantly different among treatments. They were then placed in 30-L polyethylene bags with 1/4 water/pure oxygen ratio during fish transport. After transportation, fish were transferred to 500-L tanks provided with continuous aeration and a water recirculation system for the recovery. Fish from each bag were kept in separate tanks for subsequent monitoring. Blood samples taken from carps which after immediately from transport process (t0 group), after 6 hours from transport process (t6 group), after 12 hours from transport process (t12 group) and not applied transport process (control group) have been investigated.

Peripheral blood smears were obtained from cardiac puncture using a heparinized syringe. The samples were fixed in absolute ethanol for 10 min and stained with 5% Giemsa for 10 min. The relative frequency of micronucleated cells was evaluated with a light microscope (1000x magnification) by scoring an average of 1000 erythrocytes per fish. Morphological nucleus irregularities by peripheral smear Carrasco *et al.* (1990); They were evaluated under five main groups: notched nucleus, kidney nucleus, budded nucleus, lobed nucleus and binucleus. All data were checked for normal distribution by the Kolmogorov-Smirnov test. One-way analysis of variance (ANOVA) was used for statistical comparisons of data among treatments, followed by a Duncan's MRT (Duncan's Multiple Range test) (Dalzochio *et al.* 2016). Differences were regarded as statistically significant at $P < 0.05$.

RESULTS AND DISCUSSION

Means and standard deviations of micronuclei and means of different classes of nuclear abnormalities counted in *C. carpio* from control and transport process groups are given in Table 1.

Table: 1 Means (%) and standard deviations of micronuclei and means of different classes of nuclear abnormalities counted in *Cyprinus carpio* obtained from control and transport process groups

Group	Micronucleus	Kidney	Binucleus	Notched	Lobed	Budded
Control	10.53±0.21 ^a	9.13±0.15 ^a	10.16±0.15 ^a	10.36±0.115 ^a	16.13±0.15 ^a	13.01±0.26 ^a
t0	21.20±0.20 ^b	14.16±0.12 ^b	17.86±0.06 ^b	14.40±0.360 ^b	15.43±0.12 ^b	16.80±0.11 ^b
t6	18.80±0.21 ^c	13.20±0.11 ^c	15.53±0.15 ^c	12.36±0.230 ^c	13.40±0.17 ^c	14.46±0.21 ^c
t12	17.03±0.06 ^d	11.26±0.06 ^d	17.36±0.12 ^d	11.06±0.057 ^d	11.50±0.21 ^d	12.20±0.11 ^d
<i>P</i>	***	***	***	***	***	***

No fish mortality was observed at transport process groups and the control during the experiment. In the erythrocytes of the fish, various nuclear abnormalities (micronucleus, binucleus, notched nucleus, lobbed nucleus and bud nucleus) were detected at treatment groups. Significant differences were observed ($P < 0.001$) in the frequency of micronucleus and other nuclear irregularities (notched nucleus, kidney nucleus, budded nucleus, lobed nucleus and binucleus) compared with the control group and transport process groups during the experiment (Table 1).

As result of the study, it is determined that the highest micronucleus frequency is significantly observed in t0 group ($p < 0.001$). Besides, it is observed that the other nuclear abnormalities (notched nucleus, kidney nucleus, budded nucleus, lobed nucleus and binucleus) in the blood samples of t0, t6 and t12 groups are significantly higher ($p < 0.001$) compared to the control group (Table 1).

The revealed rise in the share of erythrocytes with chromosome aberrations in the fish subjected to transportation compared to the parameters in the fish before the experiment suggests that the changes in the red blood cells are determined by the cortisol induced damage of the chromosome DNA. Cortisol acts at the level of genome, inducing somatic mutations in the hemato poietic cells, including erythrocytes, changing their hereditary properties and leading to their malfunctions (Wendelaar, 1997; Kelestemur and Ozdemir 2010, Kamshilova *et al.* 2013). It is likely that relatively low values of the number of erythrocytes with micronuclei revealed in the carp peripheral blood following the transportation from the Production-Training Institute to the Aquaculture Research-Development Center are induced by in the impact of native endogenous cortisol produced in response to the transport stress. Similarly, Kamshilova *et al.* (2013) studied the effect of transportation on the occurrence of micronucleus in erythrocytes of the peripheral blood of starlet, and reported that transport process increased the number of fish with micronucleus and the percentage of aberrant erythrocytes. Kelestemur and Ozdemir (2010) transported rainbow trout which has average weight of 40.5 ± 0.5 g from a commercial fish production plant to the Keban water produces production plant of DSI. they are observed that the Na, urea, uric acid and blood urea nitrogen levels in the blood samples of

t0 and t12 groups are significantly higher ($p < 0.05$) compared to the control group, but no significant difference between K and CI levels of the groups as statistically.

The study revealed that the increase in the number of fish with micronuclei in the peripheral blood erythrocytes and increase in the number of aberrant cells indicate the mutagenic effect of transportation on the stability of a genetic apparatus of red blood cells. An increased level of erythrocytes with chromosome aberrations in the group of fish subjected to transportation may be explained by the stress hormone induced lowering of the efficiency of the immune system. Consequently, it has been determined that stress formation in fish can be inevitable during transportation and that reversible or irreversible damage can occur by causing various physiological disorders.

REFERENCE

1. Carrasco KR, Tilbury KL, Myers MS., 1990. Assessment of the piscine micronucleus test as an in situ biological indicator of chemical contaminant effects. *Can J Fish Aquat Sci.*, 47(11), 2123-2136.
2. Dalzochio T, Goldoni A, Rodrigues GZP, Petry IE, da Silva LB, Gehlen G., 2016. Gill histopathology and micronucleus test of *Astyanax jacuhiensis* (Cope, 1894) (Teleostei, Characidae) to evaluate effects caused by acute exposure to aluminum. *Revista Biotemas*, 29,75-83.
3. Dang Z, Lock RAC, Flık G, Wendelaar Bonga SE. 1999. Metallothionein response in gills of *Oreochromis mossambicus* exposed to copper in fresh water. *The American Journal of Physiology*, Bethesda, v. 277, p. R320-331.
4. Gökalp Muranlı FD, Güner U, 2011. Induction of micronuclei and nuclear abnormalities in erythrocytes of mosquito fish (*Gambusia affinis*) following exposure to the pyrethroid insecticide lambda-cyhalothrin, *Gen Toxicol Environ Mut.*, 726, 104–108.
5. Iwama GK, Afonso LOB, Vijayan MM., 2006. Stress in fishes. In: *The Physiology of Fishes* (eds D.H. Evans and J.B. Claiborne). CRC Press, Boca Raton, FL, pp, 319–342.
6. Kamshilova TB, Mikryakoy VR, Mikryakov DV., 2013. The effect of a cortisol analogue and transport stress on the frequency of occurrence of micronuclei in erythrocytes of the peripheral blood of sterlet *Acipenser ruthenus* L. *Inland Water Biol.*, 6(2), 169-170.
7. Kavetsky T, Alipour M, Smutok O, Mushynska O, Kiv A, Fink D, Hasanzadeh M. 2021. Magneto-immunoassay of cancer biomarkers: Recent progress and challenges in biomedical analysis. *Microchem J* 167, 106320.
8. Keleştemur GT, Özdemir Y., 2010. Nakil işleminin gökkuşuğu alabalıkları (*Oncorhynchus mykiss*, W. 1792)'nın bazı kan parametre değerleri üzerine etkileri. *Süleyman Demirel Üniversitesi Fen Edebiyat Fakültesi Fen Dergisi*, 5(2), 187-193.
9. Meinelt T, Schreckenbach K, Pietrock M, Heidrich S, Steinberg CEW., 2008. Humic substances – Part 1: dissolved humic substances (HS) in aquaculture and ornamental fish breeding. *Environ Sci Pollut Res.*, 15, 17–22.
10. Reglero P, Balbın R, Ortega A., et al. 2013. First attempt to assess the viability of bluefin tuna spawning events in offshore cages located in an a priori favourable larval habitat. *Sci Mar.*, 77, 585–596.

11. Sampaio FD, Freire CA., 2016. An overview of stress physiology of fish transport: changes in water quality as a function of transport duration. *Fish Fish.*, 17(4), 1055-1072.
12. Skomal GB, Mandelman JW., 2012. The physio-logical response to anthropogenic stressors in marine elasmobranch fishes: a review with a focus on the secondary response. *Comparative Biochemistry and Physiology Part A, OJMIP.*, 162, 146–155.
13. Stieglitz JD, Benetti DD, Serafy JE, 2012. Optimizing transport of live juvenile cobia (*Rachycentron canadum*) effects of salinity and shipping biomass. *Aquacult.*, 364–365.
14. Wendelaar Bonga SE., 1997. The stress response in fish, *Physiol Rev.*, 1997, vol. 77, no. 3, pp. 591–625.

NANOTOXICOLOGICAL EFFECTS OF GRAPHENE BASED MATERIALS ON AQUATIC ORGANISM

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ABSTRACT

Intelligent nano materials, which are marvels of nanotechnology, make our lives easier with their effective and ergonomic features. These smart designs have unique physical, chemical and biological properties due to differences in size, distribution and morphology. With the potential benefits of nanotechnology and its products, it is expected to gain more momentum in the future. The development of nanotechnology will mean more contact of living things with nanoparticles. This situation causes some question marks in minds. Due to this situation, a new branch of nanotoxicology has been born. Graphene based materials are promising candidates for important biomedical applications because of their versatility. The potential use of graphene-based materials in a biological context requires a detailed comprehension of the toxicity of these materials. However, the extensive use and exposure to graphene based materials might pose a great threat to living organisms and ultimately to human health. The toxicity data for graphene-based materials are still insufficient to show adverse effects on different aquatic organisms. Their accumulation in the aquatic environment can create complex problems in aquatic food chains and aquatic habitats leading to debilitating health effects on humans. These studies investigated the effects of nanostructure / biological interactions on different organizational levels of the living system, from biomolecules to animals. In this review are discussed recent results based on in vitro and in vivo cytotoxicity and genotoxicity studies of graphene-related materials on the aquatic organism.

Key Words: Graphene, Graphene oxide, Toxicity, Aquatic Organism

INTRODUCTION

Nanotechnology is a science of technology that deals with the processes of designing and producing new functional materials, devices and assemblies by controlling matter at the nanoscale, that is, at the atomic, molecular and supramolecular level structures. Thanks to the features obtained in these studies, it is possible to develop new materials, structures, organisms, systems and devices that we have never known, which can fulfill the desired functions, can be designed by human hands and can be controlled at the molecular / atomic level. The physicochemical properties of nano-sized structures are important for the use of materials. When the materials are functionalized by applying different surface modification methods, their biocompatibility increases. When the biocompatible nanomaterials, nanodevices and nanosystems produced today are examined, it is seen that they contain popular and innovative approaches for medical applications (Sağlam and Emul 2016, Tüylek ,2019).

Nanotechnology has an important role in medical imaging, pharmacology, microbiology, wound healing, tissue regeneration, treatment of some chronic diseases, vaccines and genetics. Nanotechnological products are a useful platform for detecting and diagnosing cancer at an early diagnosis stage, identifying pathogens, detailed imaging and preventing infections by providing rapid diagnosis and diagnosis processes (Tüylek 2017).

Nanotechnology has also gained weight thanks to developments in pharmacology and drug delivery systems, patient follow-up devices and regenerative sciences. Nanotechnology, which has a solution approach in the health sector; increases its usage area day by day (Kuruca 2012).

These concerns have opened the doors of a new branch of science. The biological response of nanoparticles to living organisms has led to the emergence of Nanotoxicology, a sub-branch of toxicology (Turan et al., 2019). Upon the rapid spread of nanotechnology applications, which are considered with their advantages, nanoparticles also appear in our daily life with danger and risk assessment signals. However, while significant research is being conducted on the future benefits of nanotechnology, studies on its potential risks and biosafety are insufficient (Fan et al., 2010). On the other hand, genotoxic and cytotoxic studies to determine how NPs affect cells and genetic material is a new and comprehensive field of nanotoxicology. Since the exposure of individuals to NPs gradually increases, it is important to carry out studies that reveal the possible cytotoxic and genotoxic effects of these particles (Kumbiçak, 2013).

However, the impact of nanoparticles on health and the environment needs to be clearly resolved before large-scale production and application in various fields.

Studies on the toxicity caused by nanoparticles, changes in organ, tissue, cellular, subcellular and protein levels of these particles constitute the biological response. Nanoparticles can be more toxic due to their small size, and they can easily reach the lungs, skin and brain and cause adverse effects (Sharma et al, 2009). Exposure to nanoparticles causes the generation of reactive oxygen species, thus causing oxidative stress and cell damage. The toxicity of nanoparticles has been evaluated by a number of in vitro and in vivo studies. Genotoxicity, carcinogenicity and teratogenicity arise as a result of the effects of nanoparticles. Some nanoparticles cross the blood-brain barrier and cause significant damage to the brain (Jain et al, 2011).

Nanoparticles (NPs) today have wide applications in medicine, cosmetics, optics, catalysis, environmental purification and other fields. As the annual production of NPs increases, their risks to the environment and human health also increase. Our knowledge of the interaction mechanisms between NPs and living organisms is limited (Pikula et al, 2020).

Some new approaches are envisaged for nanotoxicology, which is a new branch of science. European Union (EU) and USA nano-specific databases and research projects, the development of modern omics, and some informatics-based statistical approaches to understand the potential risks of NPs (Turan et al, 2019).

The production of nanomaterials is carried out by many different methods and continues to be used in very wide areas today. Some developed countries support scientific research in this direction by considering the possible toxicological effects of these materials on the aquatic ecosystem. However, there is insufficient information on the toxicological aspects of nanomaterials. Aquatic ecosystems are environments where nanoparticles reach the marine environment directly or indirectly (Rotini et al, 2018). Extensive research has been conducted on freshwater species, and few studies and limited data have been reported to measure the ecotoxicological effects of NPs on marine life (Minetto et al, 2016).

Diversity in model organisms also allows us to compare differences and similarities of toxic effects between species, giving priority to our knowledge of the potential hazards of NPs (He et al., 2018).

GRAPHENE AND ITS DERIVATIVES

Graphene, which is defined as the “thinnest material in our universe” formed by the combination of sp² bonded carbon atoms with high thermal conductivity, strength, optical transmittance, chemical stability, and large surface area, attracts great attention due to these superior properties. Graphene and its types, which have been gaining in popularity recently, have been accepted as an important carbon material, being called “rising star” due to their superior properties, mechanical resistance, low density and high thermal conductivity. Various applications on its mechanical, electrical and chemical properties are gaining momentum day by day (Yola et al, 2015).

However, due to the difficulty of industrial scaling in its production and the high costs associated with it, graphene derivatives have been focused and studies have begun in this direction (Rowley-Neale et al, 2018).

rGO, another graphene derivative, is obtained by reducing the functional groups on GO by chemical, thermal, microwave, photochemical, photothermal or microbial / bacterial methods (Rowley-Neale et al, 2018).

It is possible to come across graphene and graphene oxide (GO) in many sectors; energy storage, sensors, generators, light processing, electronics and targeted drug delivery are some of them.

The biomedical applications of graphene and its derivatives are quite extensive; Studies on the biological responses to the living body are increasing (Sanchez et al, 2012); for example, graphene dispersed in the air may pose a hazard to people who use the materials on a daily basis, whether by inhalation or contact, and therefore further studies are required. However, exposure to graphene and GO can pose a major threat to living organisms and ultimately to human health. Studies on the toxicity data of graphene and GO and their biological responses to different living organisms are insufficient.

Their aquatic accumulation may pose potential risks to aquatic food chains and aquatic habitats. The potential toxic effects of graphene and GO are not fully understood. However, these materials have been reported to agglomerate, causing toxic effects that penetrate the cell membrane and interact with cellular components (Malthora et al, 2020).

GO contains many oxygen-containing groups, is dispersible in water, and can be transported in water through physical processing or the food chain. As a result, it may accumulate in the ecosystem and pose a threat to aquatic organisms and ultimately to human health (evaluated the effects and mechanisms related to its intake (Clemente et al, 2014);

There are many biomarkers of environmental toxicity. Density of blood, cell, and subcellular components, lysosomal membrane stability, apoptosis, micronucleation, cellular damage allow us to find the response of cytotoxic and genotoxic effects. In addition, behavioral changes and histopathological analyzes as effective parameters of toxicity screening in model invertebrates. On the other hand, fish is an important species in the aquatic food chain. Fish are potentially exposed to nanoparticles released into the environment via the food chain or by direct absorption/adsorption from the aquatic environment (Malthora et al, 2020).

It is also difficult to compare the toxicological effects of graphene and GO between different studies due to the diversity of nanoparticles in size, shape, surface modification, synthesis techniques, and model organisms. Therefore, it is important to understand the toxicity of graphene nanomaterials for aquatic organisms to facilitate practical applications of these promising new graphene-based nanomaterials (Malthora et al, 2020).

Nanomaterials in aquatic environments co-exist with other pollutants and can easily interact. The applications and uses of graphene and GO are clearly increasing in the fields of biomedical sciences, supercapacitors, sensors and construction materials. Waste materials from these industries can prove harmful to the environment, aquatic organisms and humans. Graphene-based nanomaterials interact with natural organic material (NOM), aggregates, adsorbs and colloids, which can cause toxicity to aquatic organisms through many different body mechanisms. Moreover, the physiochemical properties of graphene and GO such as particle size, surface functional groups, and oxygen content/surface charges may affect toxicity upon interaction with aquatic organisms (Turan et al., 2019).

We will try to draw attention to the toxic effects of the graphene family on the potential risks presented to aquatic organisms in the aquatic environment. We believe that this review will be beneficial to the scientific community by presenting current information about the critical work in this area, the toxicity of well-modified materials emerging in healthcare, treatment and early detection applications.,

Table 1 Graphen derivates Toxicity in Aquatic organism (modified by Malthora et al. 2020)

Model Organism	Negative Result	Dose Concentration	Ref
<i>Crassostrea virginica</i>	Go in oysters exposed gills and remaining in the digestive gland tissue increased lipid peroxidation and glutathione S-transferase (GST) was observed changes in activity. Stress signal was observed, leading to negative effects at the level of oxidative damage and cellular damage.	2.5 and 5 mg/L 14 days	Khan et al., 2019
<i>Crassostrea virginica</i>	Short-term GO exposures can cause oxidative stress, epithelial inflammation and adversely affect overall <i>Crassostrea virginica</i> health.	1 and 10 mg/L 72 h static regeneration.	Khan et al., 2019
<i>Diopatra neapolitana</i>	GO <i>Diopatra neapolitana</i> in regenerative adverse effects on capacity, particularly in response to changing energy associated with a decrease in glycogen content and metabolism, cause cellular damage has been.	0.01, 0.10 and 1.00 mg/L 28 days	De Marchi et al., 2017
<i>Daphnia magna</i>	GO <i>Daphnia magna</i> important for toxicity reasons was. 21 days LC50 chronic toxicity 3.3 mg L ⁻¹ . Reduced GO toxicity in the presence of HA has been attributed to attenuation of oxidative damage by HA.	50.0, 65.0, 84.5, 110.0 and 143.0 mg/L 21 days	Zhang et al., 2019
<i>Daphnia magna</i>	¹⁴ C-labeled graphene accumulated 1% of the organism's dry mass. Excretion of stationary phase graphene in cleaning. The addition of algae and humic acid to the water during the depuration period resulted in a significant portion (~90%) of the accumulated graphene remaining in the organism. The graphene accumulated in adult <i>Daphnia</i> was probably passed on to the newborns.	250, 100, 50 and 25 µg/L 48 hours Depuration 24 hours	Guo et al., 2013
<i>Ceriodaphnia dubia</i>	GO triggered lethality, inhibition of reproduction, generation of ROS, decreased feeding rates, and accumulation in the intestinal tract. There was a shift in energy available for self-care rather than feeding or reproductive activities.	Acute exposure: 0.1; 0.2; 0.4; 0.8; 1.6 and 3.2 mg/L, 48 h Chronic exposure: 0.05; 0.1; 0.2; 0.4 and 0.8 mg/L 7 days	Souza et al., 2018
<i>Palaemon pandaliformis</i>	GO did not show acute ecotoxicity at concentrations up to 5.0 mg/L. 96 hours associated with GO Cd LC50, alone Cd 96-hour LC50 was less than 1.7 times and associated with GO Zn 96 hour LC50, alone Zn 96 hour LC50 of 1.8 times more were few. Co-exposure of GO with trace elements disrupted the routine metabolism of <i>Palaemon pandaliformis</i> .	GO - 0.1; 1.0; Co-exposure of 2.5 and 5.0 mg / L 96 hours GO 1.0 mg / L with trace elements Cd 1.0 mg / L and Zn 1.0 mg / L	De Melo et al., 2019
<i>Cyprinus carpio</i>	Significant decrease in RBC count. No significant effect on WBC, PCV and Hb.	0, 10, 20 mg/L, 10 days	Al-Rudainy et al., 2018
<i>Danio rerio</i>	Delayed hatching of zebrafish embryos at a high dose of 50 mg/L. Embryos exposed to GO exhibited significant cellular apoptosis only in the forehead and eye region, and no worsening of cellular apoptosis was observed with increasing GO concentration.	0, 3.4, 7.6, 12.5, 25 and 50 mg/L 96 hours after fertilization	Chen et al 2012
<i>Anabas testudineus</i>	GO induced oxidative stress in cell and mitochondria in fish	200 µL from 1 g/L 100 mg/L, 10 mg/L of GO in aqueous solution 24 h	Paital et al., 2019
<i>Palaemon pandaliformis</i>	GO did not present acute ecotoxicity at concentrations up to 5.0 mg/L. The 96 h LC50 of Cd associated with GO was 1.7 times less than the 96 h LC50 of Cd alone and the 96 h LC50 of Zn associated with GO was 1.8 times less than the 96 h LC50 of Zn alone.	GO - 0.1; 1.0; 2.5 and 5.0 mg/L 96 h Co-exposure of GO 1.0 mg/L with trace elements Cd 1.0 mg/L and Zn 1.0 mg/L	De Melo vd., 2019
<i>Ceriodaphnia dubia</i>	GO induced lethality, reproduction inhibition, gut tract. Decreasing of the reproduction.	Acute exposure: 0.1; 0.2; 0.4; 0.8; 1.6 and 3.2 mg/L,	Souza et al 2018

Demand for carbon nanomaterial-based products in the commercial sector has increased in recent years; also, its production is expected to increase continuously (Zhao et al. 2014). Concentrations of graphene and its derivatives will be released into freshwater environments. Ecotoxicological studies should be given importance and increased as it will pose a potential risk on aquatic organisms. There are *in vitro* and *in vivo* studies on the toxic effects of NPs (Kunzmann et al., 2011). NPs can enter the organism in different ways, pass through various barriers in the body, enter the cell by disrupting the membrane structure, and affect the biomolecules in the cell (Chan et al., 2006).

It is necessary to know the biological responses of the designed nanomaterials in the living organism. In the future, biological tools, known as omics approaches, which examine changes in living organisms, can be monitored at the level of genes (genomics), gene transcripts (transcriptomics), proteins (proteomics), small biomolecules (metabolomics) and biological networks (bioinformatics) and can decompress (Sun et al., 2019). Currently, transcriptomic next-generation sequencing techniques are the most advanced omics approach used in nanotoxicology. Promising advances in obtaining many information from transcriptome information in next-generation sequencing may facilitate the identification of biological effects in risk assessment of NPs. However, difficulties such as the lack of standard protocols, analysis algorithms, and database management in nanobioinformatics should not be underestimated (Pikula. et al., 2020).

CONCLUSION

In this review, we mentioned that studies on aquatic organisms are limited. Research on the toxicity of graphene-based nanomaterials has been done gradually in the last decade. The interaction of graphene and GO, which is a new generation nanomaterial, which is frequently mentioned today with the term rising star, with the environment, aquatic organisms and other living systems *in vitro* and *in vivo*, potential risk analyzes for their safe use should be done more and this issue should be well clarified.

Current literature shows that graphene-based nanomaterials are cytotoxic. However, the specific mechanism for their toxicity has not yet been established, with ROS elevation, lipid peroxidation, nutrient/oxygen depletion, and inflammation being the most widely accepted mechanisms. Graphene-based nanomaterials toxicity in aquatic organisms Applications and uses of graphene and GO are popular in the fields of supercapacitors, sensors and building materials, and biomedicine.

Graphene-based nanomaterials interact with natural organic material (NOM), aggregates, adsorbs and colloids. May cause toxicity to aquatic organisms through body mechanism. Physiochemical properties of graphene and GO such as particle size, surface functional groups, and oxygen content/surface charges can affect toxicity upon interaction with aquatic organisms. There is clearly no concrete explanation for the toxicity criteria guidelines. The side effects of the practical applications of promising new graphene-based nanomaterials should be well known and knowledge gaps should be filled.

REFERENCES

1. Canli EG, Ila HB, Canli M., 2019. Responses of biomarkers belonging to different metabolic systems of rats following oral administration of aluminium nanoparticle. *Environ Toxicol Pharmacol.*, 69, 72-79.

2. Chan LL, Sit WH, Lam PKS, Hsieh DPH, Hodgkiss IJ, Wan JMF, Dudgeon D., 2006. Identification and characterization of a “biomarker of toxicity” from the proteome of the paralytic shellfish toxin-producing dinoflagellate *Alexandrium tamarense* (Dinophyceae). *Proteomics*, 6, 654-666.
3. Chen B, Liu M, Zhang L, Huang J, Yao J, Zhang Z., 2011. Polyethylenimine-functionalized graphene oxide as an efficient gene delivery vector. *J Mater Chem.*, 21, 7736–7741
4. Clemente Z, Castro VLSS, Moura MAM, Jonsson CM, Fraceto LF., 2014. Toxicity assessment of TiO₂ nanoparticles in zebrafish embryos under different exposure conditions. *Aqua toxicol.*, 147, 129-139.
5. De Marchi L, Neto V, Pretti C, Figueira E, Brambilla L, Rodriguez-Douton MJ, Rossella F, Tommasini M, Furtado C, Soares AM., 2017 Physiological and biochemical impacts of graphene oxide in polychaetes: The case of *Diopatra neapolitana*. *Comp Biochem Physiol Part C Toxicol Pharmacol.*, 193, 50–60
6. D'souza SF., 2001. Microbial biosensors. *Biosens Bioelec.*, 16, 337-353.
7. Fan JA, Wu C, Bao K, Bao J, Bardhan R, Halas NJ, Capasso F., 2010. Self-assembled plasmonic nanoparticle clusters. *Sci.*, 328, 1135-1138.
8. Guo X, Dong S, Petersen EJ, Gao S, Huang Q, Mao L., 2013. Biological uptake and depuration of radio-labeled graphene by *Daphnia magna*. *Environ Sci Technol.* 47, 12524–12531.
9. He Q, Zhou Y, Wang G, Zheng B, Qi M, Li X, Kong L., 2018. Effects of two nano-ZnO processing technologies on the properties of rubber. *Appl. Nanosci.*, 8, 2009-2020.
10. Jain M, Choi JI, Kim T, Bharadia D, Seth S, Srinivasan K. Sinha P., 2011. September). Practical, real-time, full duplex wireless. In *Proceedings of the 17th annual international conference on Mobile computing and networking* (pp. 301-312).
11. Khan B, Adeleye AS, Burgess RM, Smolowitz R, Russo SM, Ho KTA., 2019. 72-h exposure study with eastern oysters (*Crassostrea virginica*) and the nanomaterial graphene oxide. *Environ Toxicol Chem.*, 38, 820–830.
12. Kumbıçak Ü., 2013. Bakır-çinko alaşım nanopartiküllerinin in vitro sitotoksik ve genotoksik etkilerinin araştırılması.
13. Malhotra N, Ger TR, Uapipatanakul B, Huang JC, Chen KHC, Hsiao CD., 2020. Review of copper and copper nanoparticle toxicity in fish. *Nanomater.* 10, 1126.
14. Nogueira V, Lopes I, Rocha-Santos T, Goncalves F, Pereira R., 2015. Toxicity of solid residues resulting from wastewater treatment with nanomaterials. *Aquatic Toxicol.*, 165, 172-178.
15. Panzer MA, Goodson KE., 2008. Thermal resistance between low-dimensional nanostructures and semi-infinite media. *J Apply Phys.*, 103, 094301.
16. Pikula K, Mintcheva N, Kulinich SA, Zakharenko A, Markina Z, Golokhvast K., 2020. Aquatic toxicity and mode of action of CdS and ZnS nanoparticles in four microalgae species. *Environ. Res.*, 186, 109513.
17. Rowley-Neale SJ, Randviir EP, Dena ASA, Banks CE., 2018. An overview of recent applications of reduced graphene oxide as a basis of electroanalytical sensing platforms. *App Mater Today.*, 10, 218-226.

18. Scown TM, Santos EM, Johnston BD, Gaiser B, Baalousha M, Mitov S, Tyler CR., 2010. Effects of aqueous exposure to silver nanoparticles of different sizes in rainbow trout. *Toxicol Sci.*, 115, 521-534.
19. Sharma VK, Yngard RA, Lin Y., 2009. Silver nanoparticles: green synthesis and their antimicrobial activities. *Adv Electrochem Sci Eng.*, 145, 83-96.
20. Souza JP, Venturini FP, Santos F, Zucolotto V., 2018. Chronic toxicity in ceriodaphnia dubia induced by graphene oxide. *Chemosphere* ., 190, 218–224
21. Tan G, Sağlam S, Emül E, Erdönmez D, Sağlam N., 2016. Synthesis and characterization of silver nanoparticles integrated in polyvinyl alcohol nanofibers for bionanotechnological applications. *Turk J Biol.*, 40, 643-651.
22. Turan NB, Erkan HS, Engin GO, Bilgili MS., 2019. Nanoparticles in the aquatic environment: Usage, properties, transformation and toxicity—A review. *Process Saf Environ*, 130, 238-249.
23. Tüylek Z., 2017. Drug Delivery Systems and Nanotechnological Interaction. *Bozok Tıp Dergisi*, 7, 89-98.
24. Vardar DO, Aydın S, Hocaoglu I, Acar FHY, Basaran N., 2018. Effects of silver sulfide quantum dots coated with 2-mercaptopropionic acid on genotoxic and apoptotic pathways in vitro. *Chem Biol Interact.*, 291, 212-219.
25. Walters C, Pool E, Somerset V., 2016. Nanotoxicology: a review. *Toxicol.* 10, 5772-6475.
26. Yang X, Gondikas AP, Marinakos SM, Auffan M, Liu J, Hsu-Kim H, Meyer JN., 2012. Mechanism of silver nanoparticle toxicity is dependent on dissolved silver and surface coating in *Caenorhabditis elegans*. *Environ Sci Techn.*, 46, 1119-1127.
27. Yola ML, Eren T, Atar N., 2015. A sensitive molecular imprinted electrochemical sensor based on gold nanoparticles decorated graphene oxide: application to selective determination of tyrosine in milk. *Sensors Actuators B: Chemical*, 210, 149-157.
28. Zhang L, Li R, Tang B, Wang P., 2016. Solar-thermal conversion and thermal energy storage of graphene foam-based composites. *Nanoscale*, 8, 14600–14607.
29. Paital B, Guru D, Mohapatra P, Panda B, Parida N, Rath S, Kumar V, Saxena PS, Srivastava A., 2019 .Ecotoxic impact assessment of graphene oxide on lipid peroxidation at mitochondrial level and redox modulation in fresh water fish *anabas testudineus*. *Chemosphere*, 224, 796–804.
30. de Melo CB, Côa F, Alves OL, Martinez DST, Barbieri E., 2019. Co-exposure of graphene oxide with trace elements: Effects on acute ecotoxicity and routine metabolism in *palaemon pandaliformis* (shrimp). *Chemosphere* , 223, 157–164.

KIRSAL YAPILARIN SÜRDÜRÜLEBİLİRLİĞİNİN İNCELENMESİ: ÇANKIRI İLİ ÖRNEĞİ

INVESTIGATION OF THE SUSTAINABILITY OF RURAL BUILDINGS: THE CASE OF
CANKIRI

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ÖZET

Kırsal kalkınma; kırsal alanlarda yaşayan insanların sosyo-ekonomik ve kültürel açıdan yapısını değiştirecek biçimde üretim, gelir ve refah düzeylerinin geliştirilmesi, dengesizliklerin giderilmesi, kentsel alanlarda mevcut fiziksel ve toplumsal alt yapının kırsal alanlarda da oluşturulması, tarımsal ürünlerin daha iyi değerlendirilmesi yönündeki süreçleri, etkinlik ve örgütlenmeler üst düzeye çıkartılarak kırsal alanların mevcut doğal yaşam koşullarına uyacak şekilde modern ve konforlu yapılar entegre edilerek ekonomik hareketlilik sağlanırken insanların kendi topraklarında sürdürülebilir bir yaşama ulaşmalarının önünün açılması ile mümkün olabilir. Kırsal alanların tarımsal üretim ve diğer ticaret alanları hacmini ve dolayısıyla istihdam ve iş imkanlarını arttıracak sorunların çözülmesi oldukça önem arz etmektedir. Sürdürülebilirlik son yıllarda en çok üzerinde durulan konulardandır. Yeryüzünde bulunan kısıtlı kaynakların kullanımı ve verimli kaynak yönetimi yapılamamasından dolayı sorunlar yaşanmaktadır. Kaynakların verimli kullanılması adına sürdürülebilirliğin sağlanması gerekmektedir. Türkiye'deki kırsal yaşam alanları genellikle ekonomik ve sosyal açıdan az gelişmiş, alt yapı yetersizliği nedeniyle yatırım cazibesi olmayan bir yapı göstermektedir. Alt yapı sorunlarının çözülmesi, kırsal alanlardaki tarımsal üretim ve diğer ticari faaliyet hacminin geliştirilmesi ile istihdam ve iş imkanlarını arttıracak en önemli faktördür. Kırsal alanların altyapı önceliklerinin yanı sıra, temel ihtiyaçların başında gelen diğer önemli unsur da eğitim ve sağlık hizmetlerinin bu bölgelere ulaştırılmasıdır. Yapı –inşaat ve mimari ölçekte gelişim ve tasarım sürecinde oluşturulması gereken mekanlardan, kullanılması gereken yapı malzemelerine kadar çevresel verilerin göz önünde bulundurulması gerekmektedir. Çalışmanın amacı, kırsal alanlarda Avrupa birliği programı kapsamında kırsal alanlarda yapılaşma ile yerleşik hayata geçerek kentlere göç etme ihtiyacının azalması, yöre halkının kendi bildiği topraklarda kendi bildiği işleri yaparak ekonomik güçlerini kazanmaları sonucu kırsal alanlarda sürdürülebilirliğin sağlanabilirliğini değerlendirmek ve AB standartlarında çiftlik faaliyetleri kapsamında yan mesleklerin doğması, sosyo-kültürel mekanlara gereksinimlerin artması yönündeki istek ve etkilerin incelenmesidir.

Anahtar Kelimeler: Kırsal alan, Sürdürülebilirlik, Yaşam Standartları.

ABSTRACT

Rural development; The processes of improving the production, income and welfare levels of the people living in rural areas in a way that will change their socio-economic and cultural structure, eliminating the imbalances, creating the existing physical and social infrastructure in urban areas in rural areas, making better use of agricultural products, activities and organizations to a higher level. This can only be possible by paving the way for people to reach a sustainable life in their own lands while providing economic mobility by integrating modern and comfortable structures to suit the existing natural living conditions of rural areas.

It is very important to solve the problems that will increase the volume of agricultural production and other trade areas in rural areas and therefore employment and job opportunities. Sustainability is one of the most emphasized issues in recent years. Problems are experienced due to the use of limited resources on earth and the inability to manage efficient resources. Sustainability must be ensured in order to use resources efficiently. Rural living areas in Turkey are generally economically and socially underdeveloped and lack investment attractiveness due to insufficient infrastructure. Solving infrastructure problems is the most important factor that will increase employment and job opportunities by improving the volume of agricultural production and other commercial activities in rural areas. In addition to the infrastructure priorities of rural areas, another important element that comes first is the delivery of education and health services to these regions. Environmental data should be taken into consideration, from the spaces that need to be created during the development and design process at building-construction and architectural scale to the building materials that should be used. The aim of the study is to evaluate the sustainability of sustainability in rural areas as a result of the decrease in the need to migrate to the cities by settlement in rural areas within the scope of the European Union program in rural areas, the local people gaining their economic strength by doing their own work in the lands they know, and the emergence of subsidiary occupations within the scope of farm activities in EU standards, The aim of this study is to examine the demands and effects of increasing the needs for socio-cultural spaces.

Keywords: Rural area, Sustainability, Living standarts.

1. GİRİŞ

Kır ve kent arasında sosyal ve ekonomik bir etkileşim vardır. Kentsel ve kırsal alandaki gelişmenin dengeli bir biçimde olabilmesi için kırsal ve kentsel alan arasındaki ilişkilerin güçlendirilmesi gerekir. Bunun için de oluşturulacak kırsal planlama modelinde kıyı ve kenti bir bütün olarak ele alan bir yaklaşım izlenmelidir. (Kiper,2012)

Yerel kültürün bir sonraki nesillere aktarılması, kültürel mekânların korunması ve yaşatılmasıyla mümkündür. Kırsal yerleşimlerin gelişiminde etkili olan doğal ve kültürel faktörler aynı zamanda, kırsal mimarinin oluşumunda da büyük rol oynar. Doğal çevrenin değerlendirilmesinde, köy halkının geçmişi, geçim kaynağı, gelişmişlik düzeyleri etkili olup, yerleşim yerlerinin biçimlenişinde ise kültürel faktörler ön plana çıkmaktadır. (Usman, 2011)

Kentsel ve kırsal alanların kendilerine özgü olan karakteristik özelliklerini korumak için yapılacak planlamalarda; yerellik, sürdürülebilirlik ve doğallık yaklaşımları temel alınmalıdır. Yerellikten bahsedilen; genel anlamda kırsal ve kentsel peyzaja, yaşam biçimine, mimarisine, yapı malzemesine uygun yapılaşmanın sağlanması iken, sürdürülebilirlik; enerji etkin tasarım, iklim, eğitim ve yöne uygun yapılaşma, yenilenebilir enerji ve yenilenebilir kaynaklardan elde edilen malzeme kullanımı, doğallıktan kastedilen ise tamamen alan özgü doğal peyzaj değerlerinin göz önüne alınmasıdır. (Kiper,2013)

Kırsal mimari; kullanıcının genel ihtiyaçları doğrultusunda biçimlenen, gündelik hayatın getirdiği yeniliklerle gelişen, yerel malzemelerle geleneksel yapıım tekniğini oluşturan, aynı zamanda köy halkının tüm sosyal yaşamını etkileyen kültürel ve yerel bir olgudur. Kırsal yerleşimlerde bazı mekânlar bireysel yaşam alanını tanımlarken, bazıları da sosyal yaşamı belirlemektedir. Avlu, ambar, samanlık, ahır ve fırın kişiye ait konut birimini desteklerken; köy odası, köy kahvesi, çeşme, sakana ve değirmen sosyal yaşamın sınırlarını ortaya koymaktadır. (Usman,2011)

Kır konutu, şehir konutlarından farklı olarak yan birimleri ile bütün olarak ele alınmakta; konut çevresi kullanımı bölgenin ekonomik faaliyetlerine göre değişmekte ve bu faaliyetler kır

yaşamının genel yapısı hakkında bilgi vermektedir. Konut çevresindeki kullanım alanı ahır, samanlık, serander gibi yapıların yanında; yeşil doku, şev, çit gibi doğal ve yapay elemanlar ile sınırlanmaktadır. Bunların konuta olan mesafeleri topoğrafya ve alanın büyüklüğüne bağlı olarak köyden köye farklılık göstermesine rağmen, yerleşmiş bazı konumlar ve kullanımlar da söz konusudur. (Sonay ve Eminağaoğlu,2015)

2. ÇANKIRI İLİ VE İLÇELERİNDE KONUTLAR İÇİN MEVCUT DURUM TESPİTİ VE DEĞERLENDİRİLMESİ

İç Anadolu Bölgesi, Anadolu'nun orta kısmında yer alan, Türkiye'nin yedi coğrafi bölgesinden biridir. Türkiye'de gelişmiş bölgeler arasında yer alır. Bu konumu sebebiyle bu bölgeye "Orta Anadolu" da denir. İç Anadolu Bölgesi'nin yüz ölçümü 151.000 km² olup bu alan Türkiye topraklarının %21'ini kaplamaktadır. (Arıcı, 2019)

Çankırı İlinin ilçeleri incelendiğinde tarım ve hayvancılık faaliyetleri temel ekonomik hareketliliği oluşturmaktadır. İlçeler ve köyler genellikle kırsal alanlar dağlık alanlar içersinde yer almaktadır. Karasal iklim nedeni ile kış aylarında ki soğuk hava koşullarında yalıtım olmayan yapılarda zor şartlarda yaşamaktadırlar. Köylerde doğalgaz gibi altyapı gerektiren hizmetler bulunmamaktadır. Bu nedenlerden dolayı konutlarda ve iş yerlerinde soğuk hava şartlarında yaşam oldukça zordur. Yapılarda yalıtım yapılmamıştır. Söz konusu yapılarda uygun yapı malzemeleri ve doğru işçilik uygulanmamıştır. Tarım ve hayvancılık faaliyetleri de hava şartlarına uyum sağlayan yapılar bulunmadığı için özellikle kış aylarında sekteye uğramaktadır. Yöre halkı her mevsim aynı rahatlık ve konforla yaşamlarını ve ticari faaliyetlerini sürdürmeleri sonucu kırsal alanlarda sürdürülebilirlik sağlanacaktır.

3. MATERYAL VE YÖNTEM

Çalışma evreni olarak belirlenen alanlarda (Çankırı ilindeki Şabanözü ilçesi Kamış Köyü ve Ödekli Köyü, Kızılırmak ilçesi Karadibek Köyü, Merkez Aşağıyanlar Köyü ve Değim Köyü) mevcut konut tipleri mevcut ticari faaliyet türleri tespit edilerek ihtiyaçlarını karşılayıp karşılamadığı ve beklentileri belirlenmiştir. Daha sonra ise kentte mi yoksa kendi kırsal alanlarında köylerinde mi yaşamlarını sürdürmek istediklerini belirledik. Kırsal alanlarda halkın konutlarında ve iş yerlerinde yapılarda ki sorun ve sıkıntıların uygun olmayan yapı malzemelerinin kullanıldığını ve arz- taleplere yanıt veremeyen yapılaşma olduğunu belirledik. Söz konusu alanlarda ekonomik faaliyetlerin genellikle tarım ve hayvancılık ve bunlara dayalı işleme ve pazarlama işlemleri olduğunu belirledik. Söz konusu çalışma alanlarında AB standartlarına uygun refah alanlarına ve ergonomik kriterlere uygun yapı malzemeleri kullanılarak yapılan çiftlik ve konutlar incelenmiştir. Bu aşamadan sonra yörede ki değişimler göçlerde ki azalma ve hatta kentten kırsala gelerek kendi işlerini yapmak isteyen halkta nasıl bir değişim ve beklenti olduğu belirlendi.

Alan çalışması yöntemi ile elde edilen veriler, belirlenen yerleşim gruplarında, yerinde yapılan mimari ölçüm ve gözlemlere dayalı olarak tespit edilmiş, bunlar plan, kesit, görünüş gibi çizimlerle ifade edilerek, çevresel verilerle birlikte değerlendirilmiştir. Bölgede yapılan çalışmalar fotoğraf, kamera çekimleri gibi görsel araçlar ile desteklenmiştir. Çalışma alanında anket çalışması uygulanarak sorun ve beklentiler tespit edilmiştir.

4. BULGULAR

Araştırmanın evreni olarak, Çankırı ilindeki Şabanözü ilçesi Kamış Köyü ve Ödekli Köyü, Kızılırmak ilçesi Karadibek Köyü, Merkez Aşağıyanlar Köyü ve Değim Köyü dahilindeki semt pazarında çalışan esnaflar, öğrenciler, hane halkları, tarım ve hayvancılıkla uğraşan kişiler hedef kitle olarak belirlenmiştir.

Sorular hazırlanırken, ön görüşmeler ve teorik çerçeve dikkate alınmıştır. Anket bizzat hazırlayıcı tarafından semt pazarında çalışan esnaflar, öğrenciler ve hane halklarına uygulanmıştır. Toplam 180 kişiye anket uygulanmıştır. Ankette kullanılan soruların çoğunluğunun kapalı uçlu olması, elde edilen verilerin elektronik ortama aktarılmasında çok büyük kolaylık sağlamıştır. Bu da gerekli hız ve doğruluğu beraberinde getirmiştir.

Çalışmada elde edilen bulgular değerlendirilirken, istatistiksel analizler için SPSS 23.0 istatistik paket programı kullanılmıştır. Çalışma verileri değerlendirilirken tanımlayıcı istatistiksel metotların (Frekans, Yüzde, Ortalama, Standart Sapma) yanı sıra normal dağılımının da incelenmesi için güvenilirlik analizi kullanılmıştır.

Katılımcıların %40'ı kadın %60'ı erkeklerden oluşmaktadır. Yaş aralıkları açısından dağılımda, 20-29 yaş aralığı (% 26,87) ile 40-49 yaş aralığı(% 16,87), çoğunluk olarak göze çarpmaktadır. Araştırmaya katılanların yarısından fazlası (%64,37) evlilerden oluşmaktadır. Katılımcıların %35'i okuryazar, % 27,5'i ilköğretim, %36,25'i lise, % 1,25'i üniversite mezunlarından oluşmaktadır. Mesleklerine göre dağılımında; çiftçiler (%64,37), öğrenci (%13,12), işçi (%8,75), serbest meslek (%5,62), ev hanımı (%3,14), işsiz (%2,5) ve memur (% 2,5) seçeneklerinin ağırlığı göze çarpmaktadır. Katılımcıların %73,12'si 15 yıldan fazla süredir yaşadıkları bölgede ikamet ettiklerini ifade etmişlerdir. Demografik özellikler bölümünde katılımcıların ana gelir kaynaklarının çiftçilik ve hayvancılığa bağlantılı olup olmadığı sorulmuştur. Bu soruların yöneltilmesinin iki sebebi vardır, birincisi katılımcıların ne düzeyde çiftçilik ve hayvancılık faaliyetleriyle iç içe olduklarını görmek, ikincisi ise ilkel çiftlikler ile eski ve yetersiz yapılardan kurtularak, yeni, AB standartlarında donanımlı ve modern yapılar ile profesyonel çiftçilik ve hayvancılık faaliyetlerine olan ilgilerini araştırmaktır. Sonuçlar incelendiğinde, katılımcıların %78,75'inin ana gelir kaynağının çiftçilik ve hayvancılığa bağlı olduğu görülmektedir. Bu durum, yerel halkın önemli bir kısmının çiftçilik ve hayvancılık faaliyetleri ile iç içe olduğunu göstermektedir. Son olarak, katılımcıların %93,75'i, ilkel çiftlikler ile eski ve yetersiz yapılardan kurtularak, yeni, AB standartlarında donanımlı ve modern yapılar ile profesyonel çiftçilik ve hayvancılık faaliyetlerine dönüştürmeyi istediklerini ifade etmişlerdir.

Yöre halkının %88,75'i kırsal alanlardan kentsel alanlara göç eden bireylerin, bu kararı verirken yaşam yerlerini değiştirmenin kültürünü, topluluğunu ve belki ailesini terk etmesinden doğacak sakıncaları bastırarak kadar büyük bir düzelme sağlayacağını düşündükleri görülmektedir. Bölgede yapılan modern besi çiftliklerinde bulunan yapıların hayatlarını ve çalışma şartlarını kolaylaştıracağını düşünerek kendi çiftliklerine mahal eklemek isteyen %90,00'lık bir kesim olmasına rağmen, %6,25'i mevcut işletmelerinde değişiklik yapmak istememektedir ve %3,75'lik bir kesimin ise kararsız oldukları görülmektedir. Çiftçilik ve hayvancılık faaliyetlerini ikinci bir iş olarak yapmak yerine profesyonel bir meslek haline getirmek isteyenlerin oranı %92,50'dir. Kırsal alanlarda sürdürülebilirlik açısından bölgeye kazandırılan modern besi tesislerinin ekonomik hareketliliğe olumlu etkisinin olacağını düşünenlerin oranı %91,25'dir. Diğer yandan bölgede kurulan ve kurulacak olan söz konusu işletmeler ile halihazırda çiftçilik ve hayvancılık faaliyetlerini sürdüren kesimin ekonomik hareketlilik ve arz-talep durumundan dolayı gelirlerinin artacağını düşünenlerin oranı %90,00'dir. Söz konusu çiftliklerin bölge halkını kalkındıracağı konusunda %86,25'i olumlu düşünürken, %10,00'u ise kararsız olduklarını belirtmektedirler. Kırsal alanlarda

sürdürülebilirliğin sağlanmasına yönelik olarak, %88,75'lik bir oranın yörede olumlu değişikliklere (sosyo-ekonomik-kültürel) yol açacağını düşündüğü görülmektedir.

5. TARTIŞMA, SONUÇ VE ÖNERİLER

Araştırmaya katılan pazarcılarının eğitim durumları her ne kadar düşük olsa da, özellikle genç kuşakta eğitime karşı olumlu bir tavır mevcuttur. Anket uygulanan bütün pazarcılar çocuklarını okutmaktadır.

Bu çerçevede, ankete katılanların kırsal alanlarda sürdürülebilirliğin sağlanması gerektiği ulaşılan önemli bir sonuçtur.

Kırsal alanlardan kentsel alanlara göç eden kesim, kentlerin ekonomik bakımdan gelişmiş olması değil, kırların yetersiz kalmasıdır. İç göç alan yerlerde kent hayatına uyum sağlama sürecinde sıkıntı yaşamaktadırlar. Kırsal kesimdeki gençlerin çoğunluğu işsizdir veya eksik istihdam altındadır. Çok yetersiz bir gelire sahip kırsal kesim gençliği, sosyo-ekonomik yönden de gelişme imkanına pek sahip değildir; kentlere göç eden gençlerin büyük bir kısmını daha çok bu tür gençlerden oluşmaktadır.

Genel olarak, kırsal alanların itici ve kentsel alanların çekici şartlarına bağlı olarak gelişen iç göç hareketleri, gelinen yerlerin boşalmasının yanında, gidilen yerlerde başta işsizlik olmak üzere, konut sıkıntısı, gecekondulaşma, çevrenin ve tarihi yapının tahribatı, sosyal çatışmalar, kapkaç ve hırsızlık gibi birçok sosyo-ekonomik sorunu da beraberinde getirmiştir. Kırsal alanlarda sürdürülebilirlik sağlandığında dolaylı olarak kentsel alanlarda ki sorunların çözümüne yönelik adım atılmış olunacaktır.

Kentsel alanlara gelenlerin kendilerini salt maddesel olarak değil, aynı zamanda zihinsel olarak da kente ait görmeleri, en azından buna istekli olmaları önemlidir. Kırsal alanlarda kalarak kendi kültüründe ve toprağında yaşamlarını ve geçimlerini sağlayabilme imkanına sahip olacaklardır. Bu durumdan dolayı kentsel alanlarda kendilerini maddesel ve psikolojik olarak kötü hissetmeyeceklerdir.

Kırsal alanlarda oluşturulan projeler ile oluşan yapılaşmalarda kırsal alanlar incelendiğinde aslında eski kırsal dokusundan çok daha farklı bir kırsal alan anlayışı görülmektedir. Bir çok kırsal alanda ihtiyaç olan kamusal alanlara farkındalık sağlanacaktır. Kırsal alanlarda sürdürülebilir yapılaşma, sürdürülebilir ekonomi ve sosyal yaşam sonucu doğacak olan ihtiyaçların başında rekreasyon alanları, parklar, gelişmiş alt yapı başta olmak üzere sürdürülebilirlik ekolojik bir ortamda taçlanacaktır.

Bir yüz yüze sosyalleşme alanı olan açık alanlar, geniş çok fonksiyonlu köy meydanlarının yerini daha kullanım aralığı kısıtlanmış daha dar meydanlara dönüştürmeden korunması ve canlandırılması sağlanmalıdır. Hatta birçok aktivite için kapalı alanlarda çözümlenme sağlanmalıdır.

Kırsal alanlarda sürdürülebilirlik için besi çiftlikleri, yöresel ürün işletmeleri, eko turizm gibi alternatifler ile hızlı bir gelişme gözlemlenmektedir. Ülkenin ekonomisine katkı sağlanmaya başlanmıştır. Ayrıca bu işletmelerin çevresel ve sosyo-kültürel etkileri, koruma kullanma dengesine olumlu katkıları ile de değerlendirilmiş ve hassas doğal ve kültürel çevrelere odaklı bir kültür olarak gelişmektedir.

Kırsal alanlarda bilinçli bir planlama ve uygulamayı beraberinde getiren sürdürülebilirlik çakışmaları ile çevre koruma ve sosyo-kültürel, ekonomik gelişme bir bütün olarak ele alınmalıdır. Kırsal alanlarda sürekliliğin sağlanmasında kırsal alanlarda ki doğal kimliğe uygun

yapılaşmaya dikkat edilmeli insan refahı ve konforuna ergonomi ilkelerine bağlı kalmak gerekmektedir.

Kırsal alanlarda eski ve ilkel besi çiftliklerinde gözlemlenen bilinçsiz ve plansız yapılan yapıların çevre değerlerinin bozulmasına ve yerel kültürün zarar görmesine neden olduğu görülmektedir. Bu olumsuzlukları önlemek için yörelerin potansiyellerinin doğru bir şekilde saptanması ve doğayla bütünlük sağlayan bilinçli ve konforlu yapıların planlanarak uygun yapı malzemeleri ile hayata geçirilmesi gerekmektedir.

Ayrıca, kırsal alanlarda sürdürülebilirliğin geliştirilmesi amacıyla yerel ve doğal alanlarda önemli değişiklikler yapılmaktadır. Yerel topluluklarda, insanlar topraklarından ve yüzlerce yıldır kullandıkları doğadan mahrum bırakılmaktadır. Geleneksel üretim faaliyetleri ortadan kaldırılmakta onun yerine daha az insan gücü ile daha fazla makine ve teknoloji ile modern çalışma hayatına dayanan bir kültür ve ticari bir ilişki biçimi kurulmaktadır. Böylece, bir kültür tümü ile ortadan kaldırılmak yerine modern yapılaşma ve modern teknoloji ile endüstrilerine fonksiyonel bir yapı kurulmaktadır.

Sonuç olarak; kırsal alanlarda bulunan konutların ve yeni yapılacak konutların geçmişin kültür izlerini taşıyarak bugünün şartlarını karşılayacak şekilde olması gerekmektedir. Ve söz konusu tasarımlar gelecek nesillere aktarılabilir şekilde olmalıdır. Kırsal alanlarda iç Anadolu bölgesinde özellikle örneklem olarak incelenen alanda ekonomik faaliyetlerin büyük bir kısmı hayvancılık ve tarım faaliyetlerine dayanmaktadır. Söz konusu faaliyetlerin konforlu ve verimli bir şekilde gerçekleştirilebileceği uygun tasarımlar bulunmadığı belirlenmiştir. Mevcutta faaliyette olan yapılarda ise gerekli refah alanları bulunmamaktadır. Ayrıca yapılarda uygun malzeme seçimi yapılmadığı için ve doğru işçilik kullanılmadığı için yaşam şartları daha da zor bir hal almaktadır. Yapılarda uygun tasarımlar yapılır, gerekli refah alanları hesaplanmalıdır. Ve uygun yalıtımlar ve yapı malzemeleri seçimleri yapılmalıdır. Bu durumların çözülmesi kırsal alanlarda ekonomik faaliyetleri daha güvenli ve konforlu yapmalarını sağlayacaktır. Bu faaliyetleri güvenli ve konforlu şekilde yapılması kentlere göç oranını düşürecektir. Kırsal alanlarda konforlu yapılarda konaklarken konforlu ve güvenli yapılarda çalışma imkanı sağlanacaktır.

KAYNAKLAR

1. (A. Arıcı, 2019) “Kırsal Yapıların Sürdürülebilirliğinin İncelenmesi: Çankırı İli Örneği” Doktora Tezi, İnşaat Mühendisliği Ve Mimarlık Fakültesi, Uluslararası Travnik Üniversitesi, Travnik.
2. Eminağaoğlu, Z., & Çevik, S. (2015) Yaşam Kültürü Olarak Kır Konutu Çevresi: Artvin Örneği. *International Periodical For The Languages, Literature And History Of Turkish Or Turkic* Volume 10/6 Spring 2015, P. 433-448 Doi Number: [Http://Dx.Doi.Org/10.7827/Turkishstudies.8285](http://dx.doi.org/10.7827/Turkishstudies.8285) Issn: 1308-2140, ANKARA-TURKEY
3. Kiper, T. (2013). Kentsel ve kırsal alanların planlanmasında kimliğin rolü. *Türk Bilimsel Derlemeler Dergisi*, (2), 69-73.
4. Hoggart, K. (1990). Let's Do Away With Rural, *Journal of Rural Studies*, 6, 3, 245-257.
5. Labrianidis, L., (2006). Human Capital as the Critical Factor for the Development of Europe's Rural Peripheral Areas in Eds. Teresa de Noronha Vaz, Eleanor J. Morgan and Peter Nijkamp, *The New European Rurality: Strategies for Small Firms*, Ashgate, England.

6. Usman, E. Emre (2011). Kırsal Yerleşimlerin Biçimlenmesinde Su Etkisi ve Eskişehir Örneği, Çevre Tasarım Kongresi Bildiri Kitabı, ed. Tönük, S., Biket, A. Pınar, Sağıroğlu, M. Pınar, Yıldız Teknik Üniversitesi Yayınları, İstanbul, 57-66.

EFFECT OF FIBER TYPE AND UTILIZATION RATE ON PERMEABILITY PROPERTIES AND FREEZE-THAW RESISTANCE OF MORTAR MIXTURES

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ABSTRACT

In addition to the use of mineral and chemical additives, fibers are widely used to improve the mechanical, physical and durability properties of cementitious systems. In this study, the effect of fiber type and utilization rate on the water absorption capacity and freeze-thaw resistance of mortar mixtures was investigated. For this purpose, three different types of fibers (polypropylene, polyamide and basalt) having a length of 12 mm were used. It was aimed to produce 13 mortar mixes in total by adding different types of fiber instead of aggregate at the rate of 0.25, 0.50, 0.75 and 1% of the total volume to the control mixture containing no fiber. However, since the target flow value could not be achieved in the mixtures containing fiber beyond 0.50%, 8 different mortar mixtures could be produced. In all mixtures, water / binder ratio, sand / binder ratio and flow value were kept constant as 0.485, 2.75 and 200 ± 20 mm, respectively. In order to provide the desired flow value, a single type of polycarboxylate-ether based high range water reducing admixture was added to the mixture in different dosages. For the preparation of the mortar mixtures, CEM I 42.5 R type cement and crushed limestone aggregate having a maximum grain size of 4 mm were used. According to the results, irrespective of the fiber type, the permeability of the mixtures was negatively affected by the presence of fiber in the system, but their freeze-thaw resistance was positively affected. The mixture containing 0.5% polypropylene fiber showed the best performance in terms of freeze-thaw resistance.

Keywords: Polypropylene fiber, Polyamide fiber, Basalt fiber, Freeze-thaw resistance, Water absorption capacity

INTRODUCTION

The presence of fiber in the cementitious systems positively affects drying shrinkage behavior [1] and resistance of mixture to sulfate [2], acids [3], high temperature [4], alkali-silica reaction [5] and freezing-thawing actions [6]. As a result of the formation of change in length in cementitious systems due to the mentioned negative conditions, harmful tensile stress occurs in the system. In the case that this tensile stress exceeds the tensile strength of cementitious systems, the crack formation becomes inevitable [7]. The presence of fiber in the matrix prevents the progress of these cracks [8]. Thus, it increases the resistance of the system against negative factors such as freezing-thawing. Also, according to Richardson et al. [9], addition of the fiber to the mixture can cause the formation of independent air voids in the matrix. It was emphasized by the authors that this situation can minimize the expansion due to the 9% volume increase caused by the freezing of water. In addition, it was stated that the freeze-thaw resistance of cementitious systems depends on the pore structure of the matrix, the properties of the aggregates and the environmental conditions [10]. It was declared that there is a very strong relationship between the freeze-thaw resistance and permeability of cementitious systems [11]. However, it was stated that this relationship is much more complex in fibrous systems [12]. It was emphasized that the presence of the fiber in the system increases the freeze-thaw resistance by preventing the progress of the cracks, and its effect on permeability is variable depending on the type, rate and amount of fiber used. The results of some studies about the subject are summarized below:

In a similar study, Niu et al. declared that adding 0.05%, 0.1% and 0.15% by volume of basalt fiber to concrete mixtures decreased the water absorption capacity of the mixtures by 20.98%, 3.39% and 2.67%, respectively. However, presence of 0.2% basalt fiber in the mixture increased the water absorption capacity by 18.83% [13]. The addition of a high amount of fiber to the mixture causes an increase in the void volume in the cement matrix. It was reported that this is due to the fact that the fibers are not distributed homogeneously as a result of flocculation formation [14]. In another study by Huang [15], it was observed that the permeability of the mixture increased with the addition of 1 w.t. % of polypropylene fiber to the mortar mixture.

The effect of different fiber types on the freeze-thaw performance of concrete mixtures was investigated by Richardson [16]. For this purpose, different concrete mixtures were prepared by using monofilament polypropylene fiber having a length of 6.5, 19 mm and fibrillated polypropylene fiber with a length of 38 mm. It was reported that the freeze-thaw resistance increases with the addition of fiber to the mixture, irrespective of fiber type and length. However, it was emphasized that concrete mixtures containing monofilament-type fibers showed superior performance in terms of freeze-thaw resistance.

The effect of polypropylene fiber utilization on freeze-thaw resistance of the concrete mixtures containing fly ash and silica fume was examined by Zhang et al. [12]. The freeze-thaw performance of the mixture was positively affected by fiber utilization up to 0.08 w.t % of the total binder. However, the mentioned positive effect decreased by adding the fiber to the mixture beyond the above ratio.

It was reported that with the addition of 0.20% polypropylene fiber to the concrete mixture, the water absorption capacity and freeze-thaw resistance of the mixture increased by 28% and 27%, respectively [7].

According to the literature, it was found that various studies were conducted about the effect of polypropylene fiber utilization on the durability properties of cementitious systems. However, a limited number of studies were conducted on the freeze-thaw resistance of mixtures containing polyamide and basalt fiber in the literature. Besides, it was understood

that there is no definite conclusion about the effect of using different fiber types on the permeability properties of cementitious systems. In particular, different results were reported by various researchers regarding the comparison of polypropylene and basalt fibers in terms of permeability performance. In this study, the effect of fiber type and usage rate on permeability and freeze-thaw performance of mortar mixtures was investigated. For this purpose, different fibrous mortar mixtures were prepared by addition of polypropylene, polyamide and basalt fibers to the fiber-free control mixture in the 3 different proportions.

2. MATERIALS AND METHODS

2.1 Materials

In this study, CEM I 42.5 R type cement was used as a binder. The chemical composition, physical and mechanical properties of the cement supplied by their manufacturer are given in Table 1.

Table 1. Chemical composition, physical and mechanical properties of cement

Item	(%)	Physical properties	
SiO ₂	18.86	Specific gravity	3.15
Al ₂ O ₃	5.71	Mechanical properties	
Fe ₂ O ₃	3.09	Compressive Strength (MPa)	1-day 14.7
CaO	62.70		2-day 26.80
MgO	1.16		7-day 49.80
SO ₃	2.39		28-day 58.5
Na ₂ O+0.658 K ₂ O	0.92	Fineness	
Cl ⁻	0.01	Blaine specific surface (cm ² /g)	3530
Insoluble residue	0.32	Residual on 0.045 mm sieve (%)	7.6
Loss on ignition (LOI)	3.20		
Free CaO	1.26		

The crushed limestone aggregate having a maximum grain size of 4 mm was used. The water absorption capacity and specific gravity of aggregate were determined as 2.03 and 2.6%, respectively, according to TS EN 1097-6 Standard. The gradation curve of the aggregate and the ASTM C33 Standard limits are shown in Figure 1.

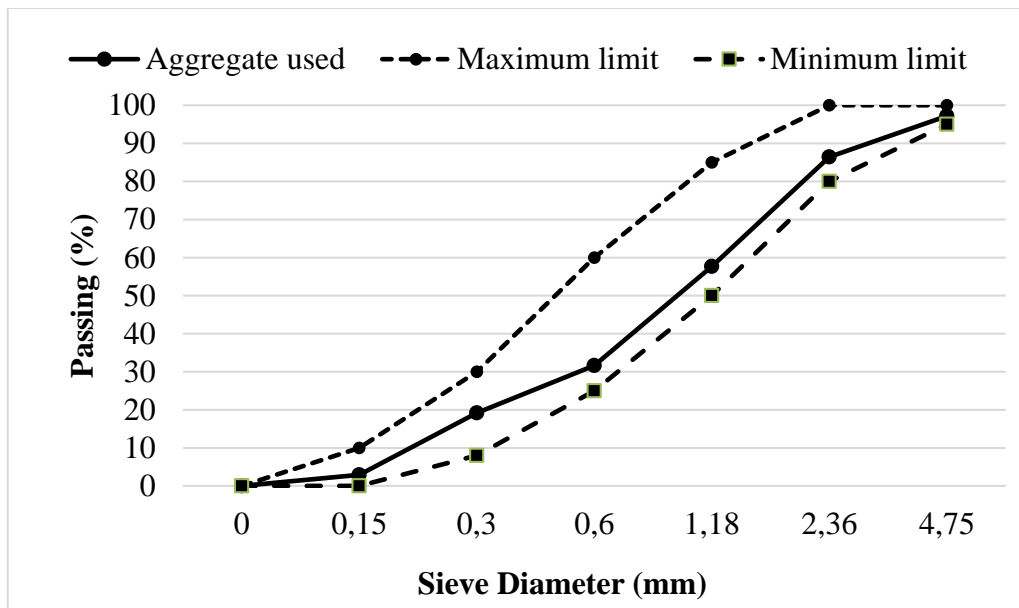


Fig. 1. Gradation curve of aggregate and ASTM C33 standard limits.

In order to the desired flow value a single type of polycarboxylate-ether based high range water reducing admixture (HRWRA) was used. Some properties of the water reducing admixture provided by its manufacturer are given in Table 2.

Table 2. Some properties of water reducing admixture

Type	Density (g/cm ³)	Solid Content (%)	pH	Chloride content (%)	Alkali (%) Na ₂ O	ratio
Polycarboxylate ether-based HRWRA*	1.097	36.35	3.82	<0.1	<10	

*High range water reducing admixture

Three different types of fibers (polypropylene (PP), polyamide and basalt) having a length of 12 mm were used in the study. The mechanical and physical properties of the fibers provided by the manufacturer are summarized in Table 3.

Table 3. Physical and mechanical properties of fibers

Type	Density (g/cm ³)	Length (mm)	Tensile Strength (N/mm ²)	Modulus of Elasticity (N/mm ²)	Melting point (°C)
Polypropylene	0.91	12	450-700	3000-3500	162
Polyamide	1.14	12	900	3000-3500	260
Basalt	2.70	12	4840	89000	1450

2.2 Preparation of Mixtures

In all of the mortar mixtures, water / binder ratio, sand / binder ratio and flow value were kept constant as 0.485, 2.75 and 200 ± 20 mm, respectively. It was aimed to produce 13 different mortar mixes by adding polypropylene, polyamide and basalt fibers in proportions of 0.25%, 0.50%, 0.75% and 1% of the total volume to the fiber-free control mixture. However, since 200 ± 20 mm slump-flow value could not be achieved in mixtures with polyamide and basalt fiber at 0.75% and above and mixtures containing 1% PP fiber, the production of these mixtures could not be realized. Therefore, 8 different mortar mixtures were produced within the scope of the study. The mixtures were designated according to the fiber type and usage rate, e.g. the mixture containing 0.25% polypropylene fiber is designated as PP25, while the mixture containing 0.50% basalt fiber is denoted B50. The material amounts for 1 dm³ mixtures are given in Table 4.

Table 4. Amount of materials used for 1 dm³ mortar mixture production (g/dm³)

Mix	Cement	Water	Sand	HRWRA*	Fiber	Flow (mm)
C	550	266.75	1512.50	1.276	-	182
PP25	550	266.75	1505.78	1.805	2.275	205
PP50	550	266.75	1499.05	2.013	4.550	181
PP75	550	266.75	1492.33	2.794	6.825	180
PA25	550	266.75	1505.78	1.805	2.850	212
PA50	550	266.75	1499.05	2.035	5.700	182
B25	550	266.75	1505.78	1.805	6.750	180
B50	550	266.75	1499.05	2.607	13.50	180

* High range water reducing admixture

2.3 Experimental procedures

The 90-day water absorption capacity and freeze-thaw resistance of the mixtures were determined on 50 mm cube specimens in accordance with ASTM C 642-97 and ASTM C666/C666M Standards, respectively.

3. RESULTS AND DISCUSSION

As it can be seen from Table 4, irrespective of fiber type, the admixture demand to provide 200 ± 20 mm target flow value increased by the presence of the fiber in the matrix. This effect was more pronounced by increasing fiber utilization rate. This phenomenon may be due to the fact that the mixture became more cohesive with the addition of fiber.

3.1. Water absorption

The water absorption capacity of 90-day mortar mixtures are shown in Figure 2. Each value represents the average of three measurements. Irrespective of the fiber type and its utilization rate, the water absorption capacity of the mixtures increased with the addition of fiber to the mixture. This effect was more pronounced by the increase in fiber usage rate.

It is thought that this situation is caused by the increase in the volume of voids in the mixture as a result of the increase in the fiber usage ratio and the inability of the fibers to agglomerate and distribute homogeneously in the matrix. Similar results were reported by Abdullah M. Zeyad et al. [17]. In the mentioned study, polypropylene fiber was used in the ratios of 0.20, 0.35 and 0.50% of the total volume. In another study [7], it was found that the water absorption capacity of the mixtures containing 0.05%, 0.10% and 0.20% of polypropylene fiber as the total volume increased by 6%, 18% and 28%, respectively.

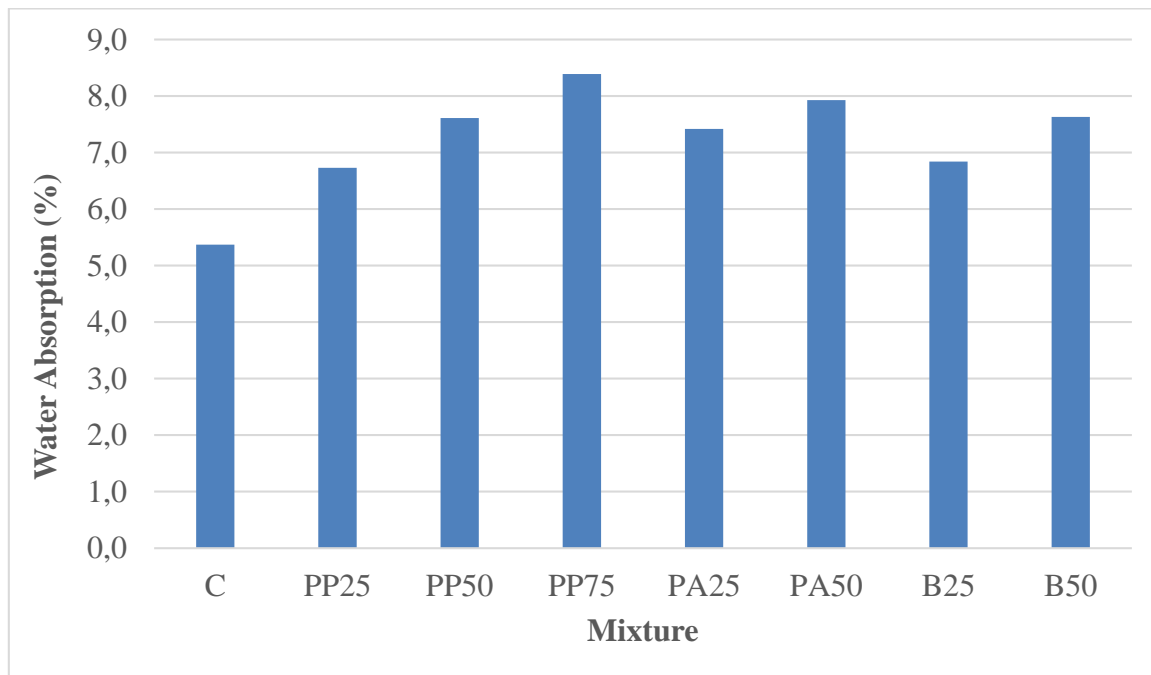


Figure 2. Water absorption rate of 90-day samples

3.2. Freeze - Thaw Resistance

In this study, the freeze-thaw resistance of the mixtures was monitored as the loss of strength due to freeze-thaw. The compressive strength losses of the 90-day mortar samples after 300 freeze-thaw cycles are given in Figure 3. Each value represents the average of three measurements. In addition, the appearance of the samples in every 100 cycles after being exposed to freeze-thaw is shown in Figure 4.

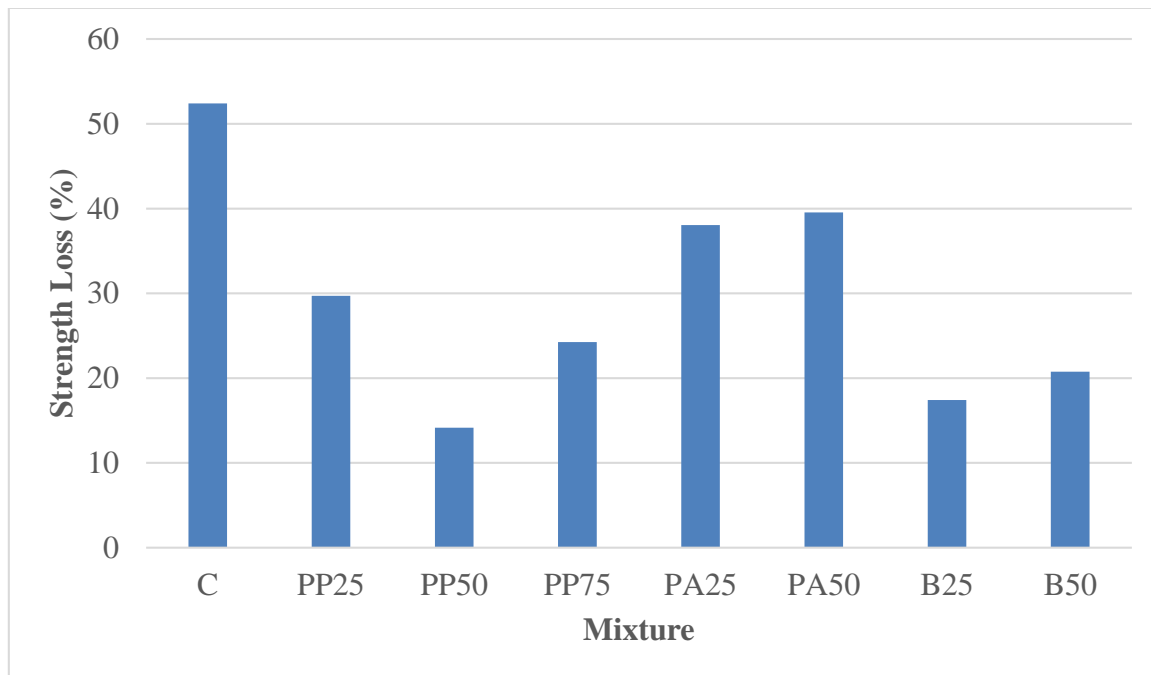


Figure 3. Compressive strength loss of mortar mixtures at the end of exposed to 300 freeze-thaw cycles

It is also understood from Figure 3 that the loss of compressive strength due to freeze-thaw cycles decreased with the addition of fiber to the mixture, regardless of the fiber type and usage rate. At the end of 300 freeze-thaw, a 52% strength loss was observed in the fiber-free control mixture, while this ratio was found to be 39% in the polyamide fiber containing mixtures, 19% in the basalt fiber mixtures and 20% in the polypropylene fiber mixtures. In general, it is known that the increase in the water absorption capacity of the mixtures in cement systems negatively affects the resistance of the mixture against freezing-thawing. However, reverse behavior was observed in this study. It was emphasized earlier that the water absorption capacity values of the mortar mixtures increased with the addition of fiber to the mixture. It is thought that the superior performance of fibrous concretes in terms of freeze-thaw resistance compared to the control mixture is due to the bridging effect of the fiber preventing the progress of the cracks that occur due to the increase in water volume during freezing. Similar statements were expressed by Sanjuán et al. [18,19]. In addition, it was emphasized that the addition of fiber to the mixture increases the cohesiveness and causes more air voids in the matrix during the mixing process [20]. These voids are thought to behave similarly to voids created by the use of air-entraining admixtures during freezing.

Except for polypropylene fiber mortar mixtures, it was observed that strength loss due to freeze-thaw increases with the increase in fiber usage ratio in other fiber mixtures. The superior performance of basalt fiber containing mixtures in terms of freeze-thaw resistance compared to polyamide fiber mixtures is thought to be due to the fact that the basalt fiber forms a better adherence to the matrix as a result of its rough surface. It is understood from Figure 2 that basalt fiber and polyamide fiber mortar mixtures exhibit almost the same performance in terms of water absorption. Compared to the control mixture, it was found that there was a 40% improvement in the freeze-thaw resistance of the mixture with the increase in the usage rate of polypropylene fiber up to 0.5%. This situation, as described above, is thought to result from the formation of individual voids with the addition of fibers, in addition to the increase in tensile strength. However, with the addition of fiber above this ratio, the

freeze-thaw resistance of the mixture was adversely affected. This is thought to be due to the increase in void volume due to the excessive amount of fiber in the system. It is also understood from Figure 2 that PP75 mixture exhibits the lowest performance in terms of permeability.



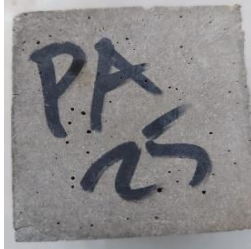







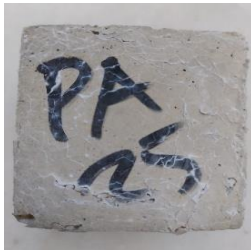





Control	Polypropylene Fiber	Polyamide Fiber	Basalt Fiber	Number of Cycle
				0
				100
				200
				300

Figure 4. Damage in samples after freeze-thaw cycle

4. CONCLUSION

For the materials used and test methods applied the following conclusions can be drawn:

- Irrespective of fiber type and utilization rate, the water absorption capacity of the mortar mixture increased between 25% and 56% with the addition of fiber to the mixture. This effect was become more pronounced with the increase in fiber presence in the matrix.

- Irrespective of fiber type and utilization rate, the freeze-thaw resistance of mortar mixtures increased by the addition of fiber to the mixture.
- At the end of exposure to 300 freeze-thaw cycles, it was determined that the highest strength loss was measured in the control mixture with 52%. In this context, the strength loss of basalt fiber-containing mortar mixtures was lower compared to polyamide fibrous one. The mixture containing 0.5% polypropylene fiber showed the highest performance in terms of freeze-thaw resistance with a strength loss of 14%.

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REFERENCES

- [1] Zhang, P., & Li, Q. F. (2013). Effect of polypropylene fiber on durability of concrete composite containing fly ash and silica fume. *Composites Part B: Engineering*, 45(1), 1587-1594.
- [2] Afroz, M., Patnaikuni, I., & Venkatesan, S. (2017). Chemical durability and performance of modified basalt fiber in concrete medium. *Construction and building materials*, 154, 191-203.
- [3] Talikoti, R. S., & Kandekar, S. B. (2019). Strength and durability study of concrete structures using aramid-fiber-reinforced polymer. *Fibers*, 7(2), 11.
- [4] Bayraktar, O. Y., Kaplan, G., Gencil, O., Benli, A., & Sutcu, M. (2021). Physico-mechanical, durability and thermal properties of basalt fiber reinforced foamed concrete containing waste marble powder and slag. *Construction and Building Materials*, 288, 123128.
- [5] Wang, J., Dai, Q., Si, R., & Guo, S. (2019). Mechanical, durability, and microstructural properties of macro synthetic polypropylene (PP) fiber-reinforced rubber concrete. *Journal of Cleaner Production*, 234, 1351-1364.
- [6] Nassiri, S., AlShareedah, O., Rodin, H., & Englund, K. (2021). Mechanical and durability characteristics of pervious concrete reinforced with mechanically recycled carbon fiber composite materials. *Materials and Structures*, 54(3), 1-18.
- [7] Karahan, O., & Atiş, C. D. (2011). The durability properties of polypropylene fiber reinforced fly ash concrete. *Materials & Design*, 32(2), 1044-1049
- [8] Ebrahimi, K., Daiezadeh, M. J., Zakertabrizi, M., Zahmatkesh, F., & Korayem, A. H. (2018). A review of the impact of micro-and nanoparticles on freeze-thaw durability of hardened concrete: Mechanism perspective. *Construction and Building Materials*, 186, 1105-1113.
- [9] Richardson, A. E., Coventry, K. A., & Wilkinson, S. (2012). Freeze/thaw durability of concrete with synthetic fibre additions. *Cold regions science and technology*, 83, 49-56.
- [10] Neville AM, Brooks JJ. *Concrete technology*. Second ed. UK: Longman (2010).

- [11] Tuyan, M., Mardani-Aghabaglou, A., & Ramyar, K. (2014). Freeze–thaw resistance, mechanical and transport properties of self-consolidating concrete incorporating coarse recycled concrete aggregate. *Materials & Design*, 53, 983-991.
- [12] Zhang, P., & Li, Q. F. (2013). Effect of polypropylene fiber on durability of concrete composite containing fly ash and silica fume. *Composites Part B: Engineering*, 45(1), 1587-1594.
- [13] Niu, D., Su, L., Luo, Y., Huang, D., & Luo, D. (2020). Experimental study on mechanical properties and durability of basalt fiber reinforced coral aggregate concrete. *Construction and Building Materials*, 237, 117628.
- [14] Aulia, T. B. (2002). Effects of polypropylene fibers on the properties of high-strength concretes. *Institutes for Massivbau and Baustofftechnologie, University Leipzig, Lacer*, 7.
- [15] Huang, W. H. (2001). Improving the properties of cement–fly ash grout using fiber and superplasticizer. *Cement and Concrete Research*, 31(7), 1033-1041.
- [16] Richardson, A. E. (2003). Freeze/thaw durability in concrete with fibre additions. *Structural Survey*.
- [17] Zeyad, A. M., Khan, A. H., & Tayeh, B. A. (2020). Durability and strength characteristics of high-strength concrete incorporated with volcanic pumice powder and polypropylene fibers. *Journal of Materials Research and Technology*, 9(1), 806-818.
- [18] Sanjuán, M. A., & Moragues, A. (1997). Polypropylene-fibre-reinforced mortar mixes: optimization to control plastic shrinkage. *Composites Science and Technology*, 57(6), 655-660.
- [19] Toutanji, H. A. (1999). Properties of polypropylene fiber reinforced silica fume expansive-cement concrete. *Construction and Building Materials*, 13(4), 171-177.
- [20] Yap, S. P., Goh, Y., Goh, W. X., Mo, K. H., Liu, M. Y. J., & Ibrahim, H. A. (2020). Relationship between microstructure and performance of polypropylene fibre reinforced cement composites subjected to elevated temperature. *European Journal of Environmental and Civil Engineering*, 1-15.

EFFECT OF SHRINKAGE-REDUCING ADMIXTURE UTILIZATION ON FLOWABILITY AND SHRINKAGE BEHAVIOUR OF KHORASAN MORTAR MIXTURES

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ABSTRACT

Khorasan mortar is a type of mortar and plaster obtained by lime as a binder, river sand and baked clay materials such as ground brick and tile as aggregate. Due to its water resistance, Khorasan mortar was preferred in structures that are exposed to water during the Byzantine, Seljuk and Ottoman periods. Today, Khorasan mortar is used in order to be compatible with the original material during the restoration works of these structures. Although there are studies aiming to improve the mechanical and durability properties of other lime-based repair mortars with the use of chemical admixtures, there is no study in this direction has been found about Khorasan mortar. In this study, reducing the shrinkage cracks, which negatively affect the mechanical and durability properties of Khorasan mortar, by using a shrinkage reducing admixture (SRA) was investigated. For this purpose, in addition to the control mixture without admixture, a total of 4 different mixtures by using SRA 0.05, 0.10 and 0.15 wt. % of the binder weight were prepared. According to the results, it was understood that the use of SRA did not have a significant effect on the flow value of the mixtures. It was determined that the shrinkage amount of the mortar samples decreased with the addition of SRA, regardless of the admixture dosage. At the end of 28-day measurements, it was observed that the shrinkage amounts of the mortar mixtures containing 0.05, 0.10, 0.15% SRA were 39, 18, 11% less than the control mixture. In this context, it has been determined that the admixture dosage in Khorasan mortar mixtures is more than 0.05%, which negatively affects the drying shrinkage values.

Keywords: Khorasan Mortar, Drying Shrinkage, Shrinkage- Reducing Admixture, Flow Value

1. INTRODUCTION

It is known that lime-based mortars were commonly used as masonry mortar and plaster in buildings before the widespread use of cement. Depending on the technology of the period, the mechanical and durability properties of these mortars were improved. For example, various pozzolans were added to the mixture to increase the strength and decrease the permeability of the lime-based mortar. In addition, it is aimed to improve the mechanical and durability properties of mortars by adding organic additives such as eggs, sugar, ruit juice and fibers such as horsehair and straw to the mixture [1,2].

Khorasan mortar, which contains slaked lime as a binder and, river sand and baked clay as aggregate, was frequently preferred in Ottoman period buildings because it is aesthetic and durable [3]. Since its water resistance, it has been widely used in structures exposed to water, especially after the 15th century [4]. This mortar is also called by different names such as Cocciopesto, Korassani, Surkhi, hHomra in different countries [3,5].

It was declared that the durability performances of plaster and masonry mortars used in historical buildings decrease due to various effects. One of these negative effects is that the structure is exposed to drying shrinkage. As a result of drying shrinkage developed by the rapid evaporation of the mixing water, cracks occur in the mortars. It was reported that this situation is stronger in air-lime mortars and shrinkage cracks appear from the beginning of hardening [6]. The formation of these cracks increases the permeability of structures. Thus, it causes the entering of harmful substances into the structure more easily with water. In addition, it was emphasized that the formation of cracks in the plaster protecting the structural element can negatively affect the structure's service life [6-9]. For this reason, it is essential to prevent or reduce the formation of cracks caused by drying shrinkage. It was understood that various fibers are added to lime-based mixtures to reduce these cracks [10]. Studies using chemical admixtures to improve various properties of lime-based mortars have been found in the literature [11-15]. However, no study has been found to improve the drying shrinkage behaviour of Khorasan mortar by using chemical admixtures. This study aims to reduce and prevent cracks in Khorasan mortar due to drying shrinkage using a shrinkage-reducing admixture (SRA). For this purpose, the effect of the admixture usage on the shrinkage behaviour was investigated by adding 4 different ratios of SRA to the mixture.

2. MATERIALS AND METHOD

2.1. MATERIALS

In addition to the control mixture without SRA, 3 more Khorasan mortar mixtures were prepared by using glycol ether-based SRA at the ratios of 0.05, 0.10 and 0.15% by weight of the total binder. Binder/aggregate ratio and target flow values of all mixtures were kept constant as 1/3 and 200±20 mm, respectively. 80 % of the total binder weight is composed of natural hydraulic lime with a specific gravity of 2.76 and 20% is composed of pozzolanic brick powder having a specific gravity of 555. The aggregate mass was 70% crushed brick and 30% river sand. The maximum grain size is 4 mm for each type of aggregate. The gradation curve of river sand and brick aggregate is shown in Figure 1. The naming of the mixtures was carried out according to the SRA dosage. For example, the control mix is denoted by C. The mixture containing 0.15% SRA was named C15. The amounts of materials used in the production of Khorasan mortar mixtures are given in Table 1.

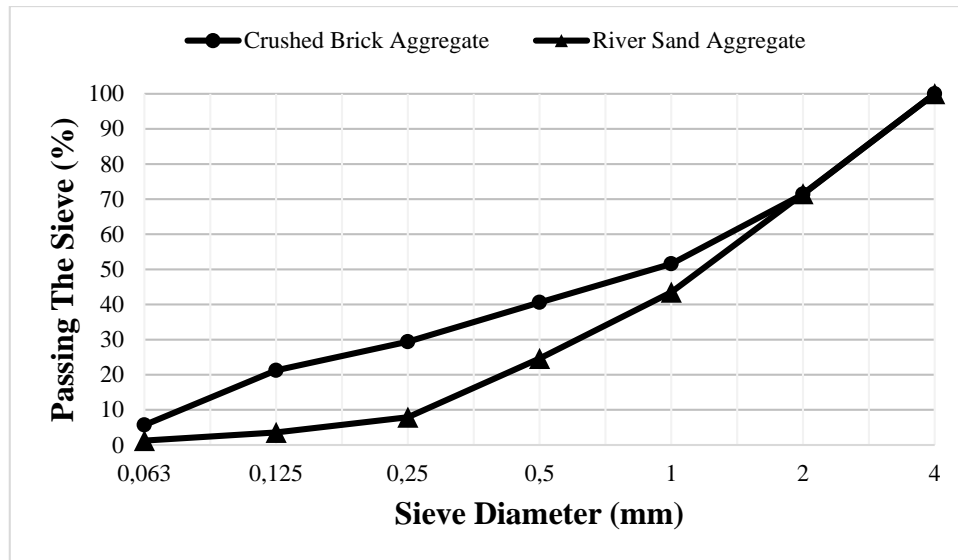


Figure. 1. Gradation curve of Crushed Brick and River Sand Aggregate

Table 1. Amount of materials used for Khorasan mortar mixture

Mix	Lime (gr)	Brick Powder (gr)	Crushed Brick (gr)	River Sand (gr)	Water (gr)	SRA (%)*
C	280	70	735	315	357	0
C5	280	70	735	315	357	0.05
C10	280	70	735	315	357	0.10
C15	280	70	735	315	357	0.15

*by total binder weight

2.2. METHOD

Flow values of mortar mixes were measured according to ASTM C1437 Standard. Length variation of the mixtures due to drying shrinkage was calculated according to ASTM C596 and ASTM C157 standards. For each mixture, 4 specimens of 25x25x285 mm were produced. These specimens were cured in the mold at 20±2°C and 95% relative humidity for the first 7 days. Then, during the shrinkage measurements, they were kept at 20±2°C and 55±5% relative humidity. The length changes of the specimens due to drying shrinkage were calculated according to Equation 1. Each data represents the average of 4 measurements.

$$S = \frac{L_1 - L}{L_0} \times 100 \tag{1}$$

In this equation, S is the percentage of change in length as a result of drying shrinkage of the specimens, L₁ is the initial length of the specimen, L is the instantaneous measurement value, L₀ is the effective measurement length (250 mm).

3. RESULTS AND DISCUSSION

Flow values of the mixtures are given in Table 2. It was determined from the results that the use of SRA does not have a serious effect on the workability of Khorasan mortar.

Table 2. Flow values of Khorasan mortar mixtures

	Mixture			
	C	C5	C10	C15
Flow value (mm)	209	214	207	211

The length changes of the prepared specimens due to drying shrinkage measured for 28 days are shown in Figure 2. Shrinkage-induced length change was observed in all mixtures regardless of the SRA dosage. It was understood that the drying shrinkage of the specimen was much more severe at the beginning and decreased with time. Compared to the control mixture, the drying shrinkage values of all specimens containing SRA were lower. Similar behaviour was observed in cementitious systems [16]. Shrinkage values of C5, C10 and C15 specimens after 28 days decreased by 39, 18 and 11%, respectively, compared to the control mixture. In terms of shrinkage behaviour, the C5 specimens showed the best performance. The addition of SRA beyond 0.05% adversely affected the shrinkage performance of the mixtures. As it is known, the reason for the drying shrinkage in mortar mixtures is the water loss in the specimens over time. It was emphasized that due to the low viscosity of the SRA, they prevent the outflow of water by reducing the surface tension of the kneading water [16,17].

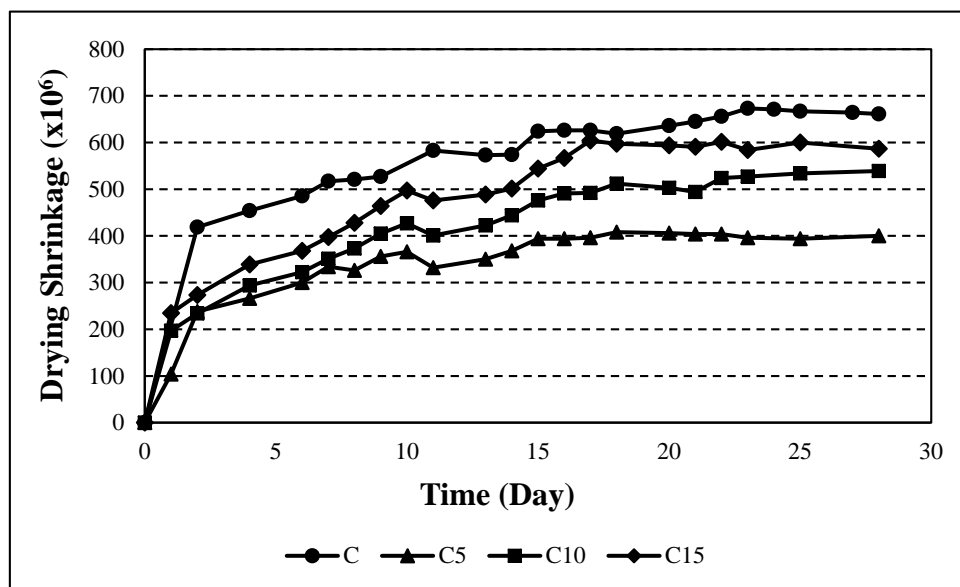


Figure 2. Drying shrinkage of Khorasan mortar mixtures during 28 days

4. CONCLUSION

The results obtained in this study, in which the effect of the using SRA on the drying-shrinkage behaviour of Khorasan mortar mixtures was examined, are given below:

- SRA utilization had no significant effect on the flow value of Khorasan mortar.
- The shrinkage values of Khorasan mortar specimens containing SRA decreased compared to the control mixture.
- In terms of shrinkage behaviour, the optimum utilization rate of SRA was determined as 0.05%. The use of admixture beyond this ratio increased the shrinkage values of the specimens.

5. ACKNOWLEDGMENTS

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REFERENCES

1. Tekin, Ç. ve Kurugöl, S. (2012). Çeşitli Organik Katkıların Kirecin Karbonizasyonu Üzerindeki Etkisi. *Journal of the Faculty of Engineering and Architecture of Gazi University*, 27(4), 717–728.
2. Brandt, A. M. (2008). Fibre reinforced cement-based (FRC) composites after over 40 years of development in building and civil engineering. *Composite Structures*.
3. Akman, M., Güner, A., Aksoy, İ., (1986), “The history and properties of khorasan mortar and concrete”, In: *Turkish and Islamic Science and Technology in the 16th Century*, ITU Research Centre of History of Science and Technology (1), İstanbul, Turkey, pp. 101-112.
4. Mavioğlu, Ü. A. (2011). Farklı Puzolanik Katkılar İle Hazırlanan Horasan Harçlarının Değişen Parametrelerinin İncelenmesi (Doctoral dissertation, Fen Bilimleri Enstitüsü).
5. Böke, H., Akkurt, S., İpekoğlu, B. (2004), “Tarihi yapılarda kullanılan horasan harcı ve sıvalarının özellikleri”, (The properties of khorasan mortar and plasters used in historical buildings), *Yapı Magazine*, 269, pp. 90-95.
6. Veiga, R. (2017). Air lime mortars: What else do we need to know to apply them in conservation and rehabilitation interventions? A review. *Construction and Building Materials*, 157, 132-140.
7. Pozo-Antonio, J. S. (2015). Evolution of mechanical properties and drying shrinkage in lime-based and lime cement-based mortars with pure limestone aggregate. *Construction and Building Materials*, 77, 472-478.
8. Anna, A., & Giuseppe, C. (2014). The water transfer properties and drying shrinkage of aerial lime-based mortars: An assessment of their quality as repair rendering materials. *Environmental Earth Sciences*, 71(4), 1699–1710. <https://doi.org/10.1007/s12665-013-2574-x>
9. Benavente, D., Cañaveras, J. C., Cuezva, S., Laiz, L., & Sanchez-Moral, S. (2009). Experimental definition of microclimatic conditions based on water transfer and porous

- media properties for the conservation of prehistoric constructions: Cueva Pintada at Galdar, Gran Canaria, Spain. *Environmental geology*, 56(8), 1495.
10. Izaguirre, A., Lanas, J., & Alvarez, J. I. (2011). Effect of a polypropylene fibre on the behaviour of aerial lime-based mortars. *Construction and Building Materials*, 25(2), 992-1000.
 11. Gonzalez-Sanchez, J. F., Fernández, J. M., Navarro-Blasco, Í., & Alvarez, J. I. (2021). Improving lime-based rendering mortars with admixtures. *Construction and Building Materials*, 271, 121887.
 12. Silva, B. A., Pinto, A. F., Gomes, A., & Candeias, A. (2020). Suitability of different surfactants as air-entraining admixtures for lime mortars. *Construction and Building Materials*, 256, 118986.
 13. Silva, B., Pinto, A. P. F., Gomes, A., & Candeias, A. (2021). Admixtures potential role on the improvement of the freeze-thaw resistance of lime mortars. *Journal of Building Engineering*, 35, 101977.
 14. Izaguirre, A., Lanas, J., & Alvarez, J. I. (2009). Effect of water-repellent admixtures on the behaviour of aerial lime-based mortars. *Cement and concrete research*, 39(11), 1095-1104.
 15. Izaguirre, A., Lanas, J., & Alvarez, J. I. (2010). Ageing of lime mortars with admixtures: Durability and strength assessment. *Cement and Concrete Research*, 40(7), 1081-1095.
 16. Mardani-Aghabaglou, A., & İlhan, M. (2018). Büzülme engelleyici katkıların su azaltıcı katkı varlığında harç karışımlarının basınç dayanımına, su emmesine ve kuruma-büzülmesine etkisi. *Sakarya Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 22(2), 417-426.
 17. Kadıoğlu, T. (2007). Rötire Azaltıcı Katkı Maddeleri (Doctoral dissertation, Fen Bilimleri Enstitüsü).

EXAMINATION OF THE EFFECTS OF BLOCKAGE POSITIONS ON MASS DISTRIBUTIONS IN PEM FUEL CELL

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ÖZET

Alternatif enerji kaynaklarının çeşitlendiği ve önem kazandığı günümüzde, temiz, yenilenebilir ve verimli enerji kaynaklarından olan hidrojen enerjisi dikkat çekmektedir. Proton değişim membranlı yakıt pilleri (PEMFC) elektrokimyasal reaksiyonlar sonucunda elektrik üreten bir cihazdır. Bu elektrokimyasal reaksiyonların gerçekleşme durumlarına göre yakıt hücresinin ürettiği akım yoğunluğu değerleri farklılık göstermektedir. Yakıt pillerinde, reaktanların membran ve katalizör yüzeylerine yayılmasını sağlayan, bipolar plakaların üzerindeki kanal yapılarıdır. Farklı kanal tasarımı hem anot hem de katot bölgesinde farklı reaktan dağılımına neden olmaktadır. Bu durum ise katalizör ve membran yüzeyinde gerçekleşen reaksiyon bölgelerinin yoğunlaşmasına veya ölü (reaksiyon oranı düşük) bölgelerin oluşmasına neden olabilmektedir. Akış kanalları üzerine yerleştirilen engellerin, şekil, ölçü ve konumlarına göre yakıt hücresinin reaktan dağılımlarını ve elektriksel performansını iyileştirme potansiyeli mevcuttur. Kanal üzerine yerleştirilen engellerin konumlandırılan bölgedeki reaktanın basınç, hız ve doğrultusunu değiştirerek, bölgesel olarak ihtiyaç duyulan fiziksel varyasyonlar sağlanabilmektedir. Bu çalışmada, anot ve katot bölgelerinde konumlandırılan engellerin hücre yapısındaki reaktan ve su (H₂O) kütle dağılımları üzerindeki etkileri nümerik olarak incelenmiştir. Bu amaçla, sabit bir engel tipi (sabit şekil, sabit sıklık, sabit ölçü) belirlenmiş ve üç farklı durumda yakıt hücresinde konumlandırılmıştır. Engeller önce sadece anot akış alanında kullanılmıştır (durum 1), daha sonra sadece katot tarafında kullanılmıştır (durum 2), son olarak hem anot hem de katot akış alanlarında beraber kullanılmıştır (durum 3). Farklı durumların etkilerinin karşılaştırılması amacıyla aynı fiziksel ölçülere ve çalışma koşullarına sahip herhangi bir engel bulunmayan yakıt hücresi değerleri kullanılmıştır. Analizler, ANSYS Fluent paket programı kullanılarak hesaplamalı akışkanlar dinamiği (CFD) yöntemiyle gerçekleştirilmiştir. Çalışmada, 50 cm² aktif alana sahip, üç boyutlu, tek hücreli bir yakıt pili modellenmiştir. Analizler, reaktanların ideal gaz kabul edildiği ve sıvı su fazının mevcut olmadığı koşullarda gerçekleştirilmiştir. Anot tarafında, hidrojen (H₂) kütle dağılımı, katot tarafında oksijen (O₂) ve H₂O kütle dağılımları dikkate alınmıştır. Sonuçlar, engel konumlarının kütle dağılımları üzerinde etkili olduğunu göstermiştir. Buna ek olarak, gas difüzyon tabakasındaki reaktanların kütle miktarları da değişkenlik göstermiştir.

Anahtar Kelimeler: PEMFC, CFD, Akış alanı, Kütle dağılımı.

ABSTRACT

Hydrogen energy, which is one of the clean, renewable and efficient energy sources, draws attention today, where alternative energy sources are diversifying and gaining importance. Proton exchange membrane fuel cells (PEMFC) are devices that generate electricity as a result of electrochemical reactions. The current density values produced by the fuel cell vary according to the realization of these electrochemical reactions. In fuel cells, it is the channel structures on the bipolar plates that allow the reactants to spread to the membrane and catalyst surfaces. Different channel design causes different reactant distribution in both anode and cathode regions. This situation may cause the concentration of the reaction zones occurring on the catalyst and membrane surface or the formation of dead (low reaction rate) zones. The blockages placed on the flow channels have the potential to improve the reactant distributions and electrical performance of the fuel cell, depending on their shape, size and location. By changing the pressure, velocity and direction of the reactant in the region where the blockages placed on the channel are located, physical variations required locally can be achieved. In this study, the effects of blockages located in the anode and cathode regions on the mass distribution of reactant and water (H_2O) in the cell structure were investigated numerically. For this purpose, a fixed blockage type (fixed shape, fixed frequency, fixed size) was determined and positioned in the fuel cell in three different situations. Blockages were first used only in the anode flow field (case 1), then only on the cathode side (case 2), and finally in both the anode and cathode flow fields together (case 3). In order to compare the effects of different situations, fuel cell values with the same physical dimensions and operating conditions without any blockages were used. Analyzes were performed using the ANSYS Fluent package program using the computational fluid dynamics (CFD) method. In the study, a three-dimensional, single-cell fuel cell with an active area of 50 cm^2 was modeled. Analyzes were performed under conditions where the reactants were considered ideal gases and no liquid water phase was present. On the anode side, the hydrogen (H_2) mass distribution, on the cathode side, the oxygen (O_2) and H_2O mass distributions are taken into account. The results showed that obstacle locations have an effect on mass distributions. In addition, the mass fractions of the reactants in the gas diffusion layer also varied.

Keywords: PEMFC, CFD, Flow field, Mass fractions.

INTRODUCTION

The fact that the welfare levels of developed societies are at such a high level are directly related to their maximum use of energy. It can often be said that these energy sources originate from fossil fuels. In recent years, mankind has turned to more affordable energy sources [1]. The main reasons for this can be explained by depleted fossil fuel reserves, the less efficiency of fossil fuels and the fatal damage that such fuels cause to nature and man. They spread greenhouse gases to the environment, such as carbon dioxide (CO_2), causing global climate change. Scientists have done a lot of work in this field to find greener and cleaner energy

sources. These can be classified as renewable natural energy sources (wind energy, solar energy, wave, hydroelectricity, isothermal hydrogen, etc.) [2]. Such edible energy sources are preferred because they are both more efficient and less harmful to the environment [3]. Hydrogen energy, which is among the edible energy sources, is the simplest and most present element and has attracted the attention of scientists because it is colorless, odorless and light. It has a very high energy per unit volume. We can't use hydrogen directly as energy. There are many different types of fuel cell (Alkaline fuel cell (AFC), Phosphoric acid fuel cell (PAFC), Solid oxide fuel cell (SOFC) and proton exchange membrane fuel cell (PEMFC) [4] which is the subject of this study. PEMFs operate at low temperatures and have a high power density, allowing such fuel cells to be used in different areas. The PEMFC fuel cell consists of 4 elements. The electrolyte membrane allows proton transmission, preventing the completion of the cycle and electron transmission, allowing electrons to be transmitted by external cycle. Another element is the gas diffusion layer involved in ensuring gas transmission and thermal contact [5]. There is a catalyst as the 3rd element. Another element consists of the anode and cathode part of the conductive plates, which are bipolar plates (BP). Both surfaces have flow channels. These channels ensure proper distribution of fuel and oxygen and prevent mixing. Some scientists have seen different parameters change by blocking these flow channels [6,7]. Other factors affecting these parameters are the shape, position, frequency, etc. of the obstacle. This has disadvantages such as dead zones and pressure irregularities when a good optimization is not performed. The aim is to keep the pressure at a constant value and minimize dead zones. Pemfc fuel cell has many uses. In this study, the effects of obstacles in different positions placed on the serpentine channel design, which is accepted as standard in the literature, on the mass distributions in the cell were examined.

MODELING AND SIMULATION

Differences are formed with the obstacle structures placed in PEMFC flow channels and the channel structure of the empty serpentine. In this study, the positions of the obstacle structures put in the PEMFC flow channel were examined for their effect on the react and mass distributions. For this purpose, a fixed obstacle structure (fixed shape, constant temperature, constant measure) is determined and modeled on the CATIA package program. The modeled obstacle structure has been examined in three cases. The modeled obstacle structure is placed only in the anode flow channel in the drawn bipolar plate section (I.case) Then it is placed only in the cathode flow channel in the bipolar plate part (case II) and finally it is placed in both the anode flow channel and the cathode flow channel and its effects are examined (III.status)²⁵ cm² active flow area is modeled in the study. The channel width dimensions are determined as 1.5 mm. The dimensions of the cell components made in Table 1 are given.

Table 1. Geometric properties of design parameters

parameter	value
Active surface area	25 mm ²
Channel depth	1.5 mm
Channel width	1.5 mm
Membrane thickness	0.05 mm
Catalyst layer thickness	0.025 mm
Gas diffusion layer thickness	0.365 mm
Bipolar plate base thickness	3 mm

Analysis of pemfc fuel cell drawn in CATIA package program was carried out in ANSYS Fluent package program. The computational fluid dynamics (CFD) method is used in the ANSYS fluent Package program. Analysis for PEMFCs consists of model setup, geometry identification, mesh throwing and results. First, inlet, outlet and wall definitions were made in the fluid channel in the geometry identification part of our model. Then, the mesh section was switched to provide the same element value for all models. The element was selected for you 0.5 and operated in 20000 iterations. the mesh process was smooth in all volumes.A four-layer network structure with a number of elements of 170,000 elements was created. Figure 1 shows the image of this network structure.

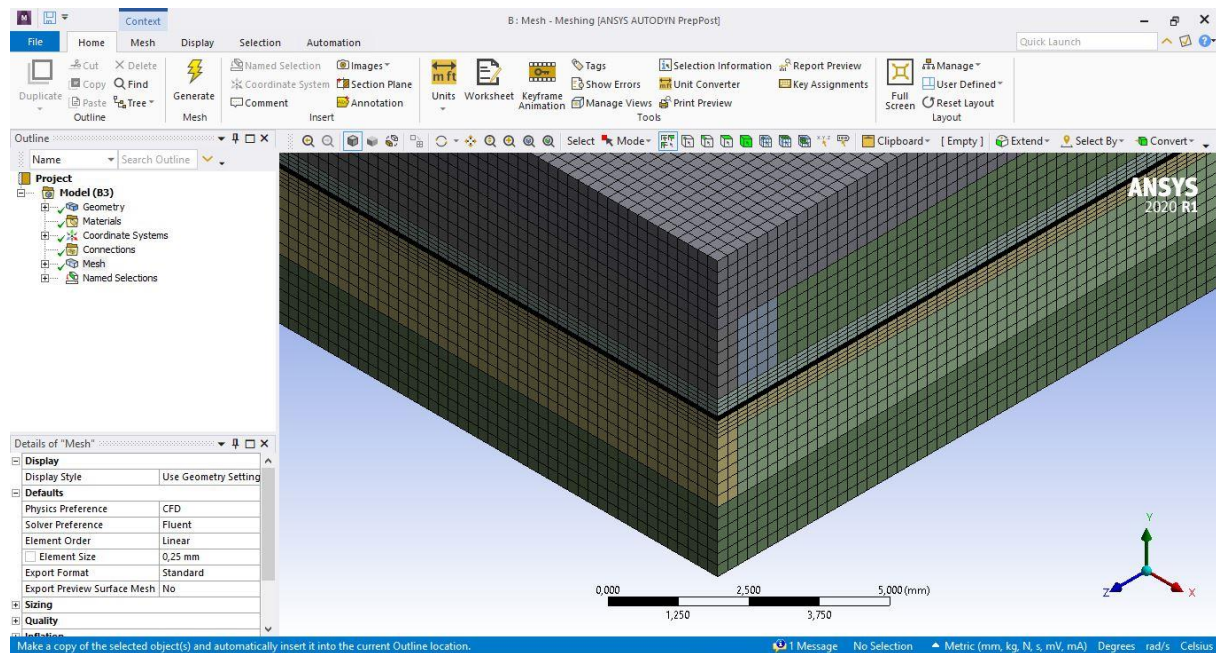


Figure 1. Mesh image for designed flow area model

All prepared models have entered the same parameter values on the PEMFC model. Inlet outlet and wall value of open circuit voltage catalyst and Gas Diffusion layers is defined. Analysis parameters are shown in Table 2.

Table 2. Defined properties for model parameters

parameter	value
Open circuit voltage	0.98 V
Anode reference current density	1x10 ⁴ A/m ²
Cathode reference current density	20 A/m ²
Anode concentration base	0.5
Cathode concentration base	1
Reference mole concentration	1 kmol/m ³
Conversion coefficient	0.7
Membrane equivalent weight	1100 kg/kmol
Membrane protonic transmission coefficient and transmission base	1
Membrane density	1968 kg/m ³
Catalyst and gas diffusion layer porosity	0.6
Bipolar plate electrical conductivity	8000 S/m
Reassurance output pressure	101325 Pa
Reassurance inlet temperature	338.15 K
Anode input flow	1.045x10 ⁻⁶ kg/s
Cathode input flow	3.19x10 ⁻⁵ kg/s
Anod and cathode stonometric	2, 2,5
Anod and cathode moisturizing	0.5, 0.3

20000 is run as iteration for analysis solution. Three-dimensional flow and heat transfer were applied taking into account the CFD method of computational fluid dynamics cfd containing mass and Momentum expressed in the Naiver Stokes Equations below.

$$\frac{\partial}{\partial t} \int \rho \phi dV + \oint \rho \phi V \cdot dA + \oint \Gamma_{\phi} \nabla_{\phi} \cdot dA = \int S_{\phi} dV$$

The equations solved in the PEMFC model are specified in table 3.

Table 3. Equations solved in PEMFC [8]

Electron transport	$\nabla \cdot (\sigma_{sol} \nabla \phi_{sol}) + R_{sol} = 0$ $R_{sol} = \begin{cases} -R_{an} = (\zeta_{an} j_{an}^{ref}) \left(\frac{[H_2]}{[H_2]_{ref}} \right)^{\gamma_{an}} (e^{\alpha_{an} F \eta_{an} / RT}) \\ R_{cat} = (\zeta_{cat} j_{cat}^{ref}) \left(\frac{[O_2]}{[O_2]_{ref}} \right)^{\gamma_{cat}} (e^{-\alpha_{cat} F \eta_{cat} / RT}) \end{cases}$
Protonic transport	

$$\nabla \cdot (\sigma_{mem} \nabla \phi_{mem}) + R_{mem} = 0$$

$$R_{mem} = \begin{cases} R_{an} = (\zeta_{an} j_{an}^{ref}) \left(\frac{[H_2]}{[H_2]_{ref}} \right)^{\gamma_{an}} (e^{\alpha_{an} F \eta_{an} / RT}) \\ -R_{cat} = (\zeta_{cat} j_{cat}^{ref}) \left(\frac{[O_2]}{[O_2]_{ref}} \right)^{\gamma_{cat}} (e^{-\alpha_{cat} F \eta_{cat} / RT}) \end{cases}$$

Loss of local surface activation

$$\eta_{an} = \phi_{sol} - \phi_{mem}$$

$$\eta_{cat} = \phi_{sol} - \phi_{mem} - V_{OC}$$

Volumetric resource terms of species

$$S_{H_2} = -\frac{M_{w,H_2}}{2F} R_{an} < 0$$

$$S_{O_2} = -\frac{M_{w,O_2}}{4F} R_{cat} < 0$$

$$S_{H_2O} = \frac{M_{w,H_2O}}{2F} R_{cat} > 0$$

Protection of the current

$$\int_{anode} R_{an} dV = \int_{cathode} R_{cat} dV$$

Thermal energy solution

$$S_h = h_{react} - R_{an,ctl} \eta_{an,ctl} + I^2 R_{ohm} + h_L$$

Volumetric ratio of liquid water

$$\frac{\partial(\varepsilon \rho_l s)}{\partial t} + \nabla \cdot (\rho_l \vec{V}_l s) = r_w$$

$$r_w = c_r \max \left(\left[(1-s) \frac{P_{wv} - P_{sat}}{RT} M_{w,H_2O} \right], [-s \rho_l] \right)$$

$$\frac{\partial(\varepsilon \rho_l s)}{\partial t} + \nabla \cdot \left[\rho_l \frac{K s^3}{\mu_l} \frac{d p_c}{ds} \nabla s \right] = r_w$$

Kapiler rust

$$p_c = \begin{cases} \frac{\sigma \cos \theta_c}{\left(\frac{K}{\varepsilon}\right)^{0.5}} (1.417(1-s) - 2.12(1-s)^2 + 1.263(1-s)^3) & \theta_c < 90^\circ \\ \frac{\sigma \cos \theta_c}{\left(\frac{K}{\varepsilon}\right)^{0.5}} (1.417s - 2.12s^2 + 1.263s^3) & \theta_c > 90^\circ \end{cases}$$

Diffusivity of gas phase species

$$D_i = \varepsilon^{1.5} (1-s)^{r_s} D_i^0 \left(\frac{p_0}{p} \right)^{\gamma_p} \left(\frac{T}{T_0} \right)^{\gamma_t}$$

$$D_{eff}^j = \varepsilon^{1.5} D_i^j$$

Electrolyte conductivity

$$\sigma_{mem} = \beta (0.514 \lambda - 0.326)^\omega e^{1268 \left(\frac{1}{303} - \frac{1}{T} \right)}$$

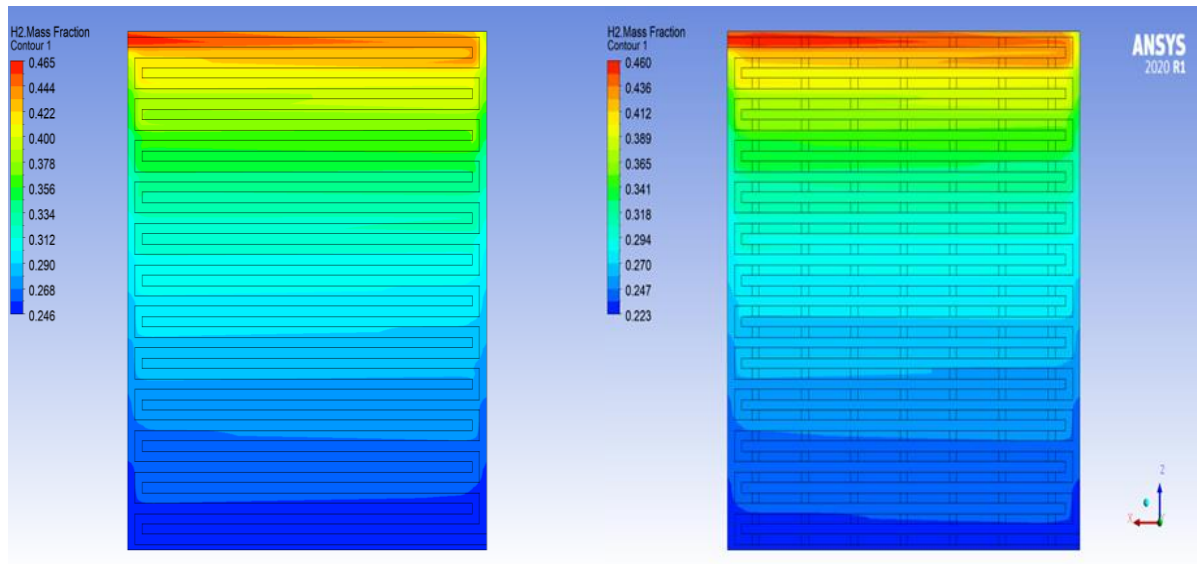
Osmotic drag coefficient

$$n_d = 2.5 \frac{\lambda}{22}$$

Back diffusion flux	$J_w^{diff} = -\frac{\rho_m}{M_m} M_{H_2O} D_l \nabla \lambda$
Membrane water diffusivity	$D_l = f(\lambda) e^{\left(\frac{1}{303} - \frac{1}{T}\right)}$
Water content	$\lambda = 0.043 + 17.18\alpha - 39.85\alpha^2 + 36\alpha^3 \quad (\alpha < 1)$ $\lambda = 14 + 1.4(\alpha - 1) \quad (\alpha > 1)$ $\alpha = \frac{P_{wv}}{P_{sat}} + 2s$
Water vapor pressure	$P_{wv} = x_{H_2O} P$
Saturation pressure	$\log_{10} P_{sat} = -2.1794 + 0.02953(T - 273.17)$ $-9.1837 \times 10^{-5} (T - 273.17)^2 + 1.4454 \times 10^{-7} (T - 273.17)^3$

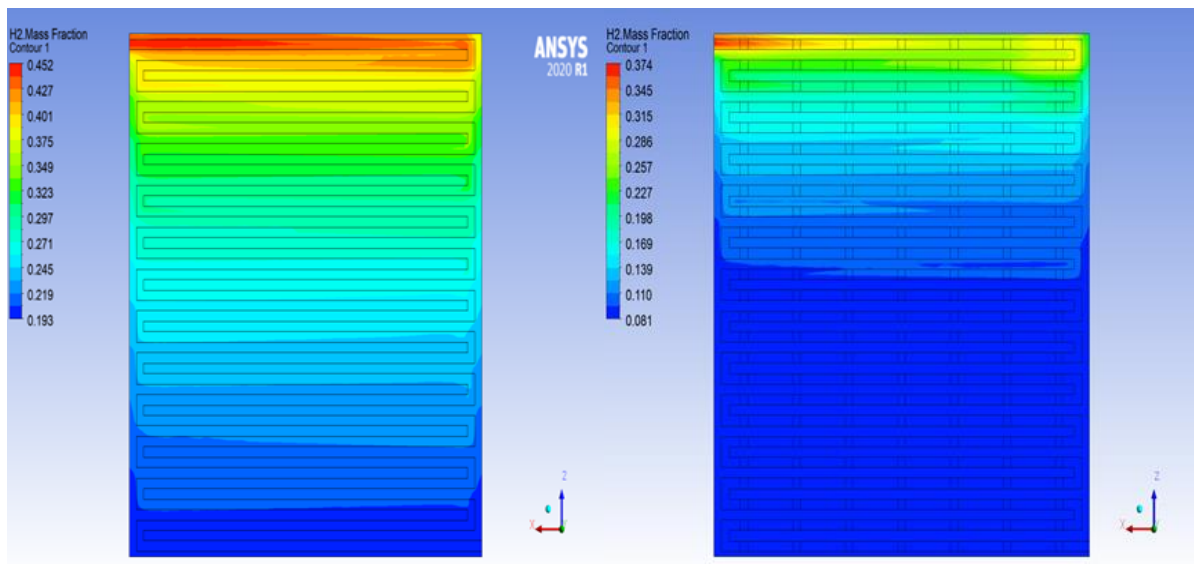
FINDINGS AND DISCUSSION

In this study, the effects of obstacles located in the anode and cathode regions on react and water (H₂O) mass distributions in cell structure were examined numerically. For this purpose, a fixed type of obstacle (fixed shape, constant frequency, constant measure) is determined and positioned in the fuel cell in three different situations. The obstacles were first used only in the anode flow area (status 1), then only on the cathode side (case 2), and finally in both the anode and cathode flow areas together (status 3). Fuel cell values with the same physical dimensions and working conditions were used to compare the effects of different situations. The analyses were carried out using the ANSYS Fluent package program using computational fluid dynamics (CFDs). When the hydrogen mass distribution is examined according to the obstacle positions, it is seen that the mass distribution is similar to the classical serpentine design and the hydrogen mass distribution (Status -1) also worsens. (Figure 2).



Normal serpentin

Case-1

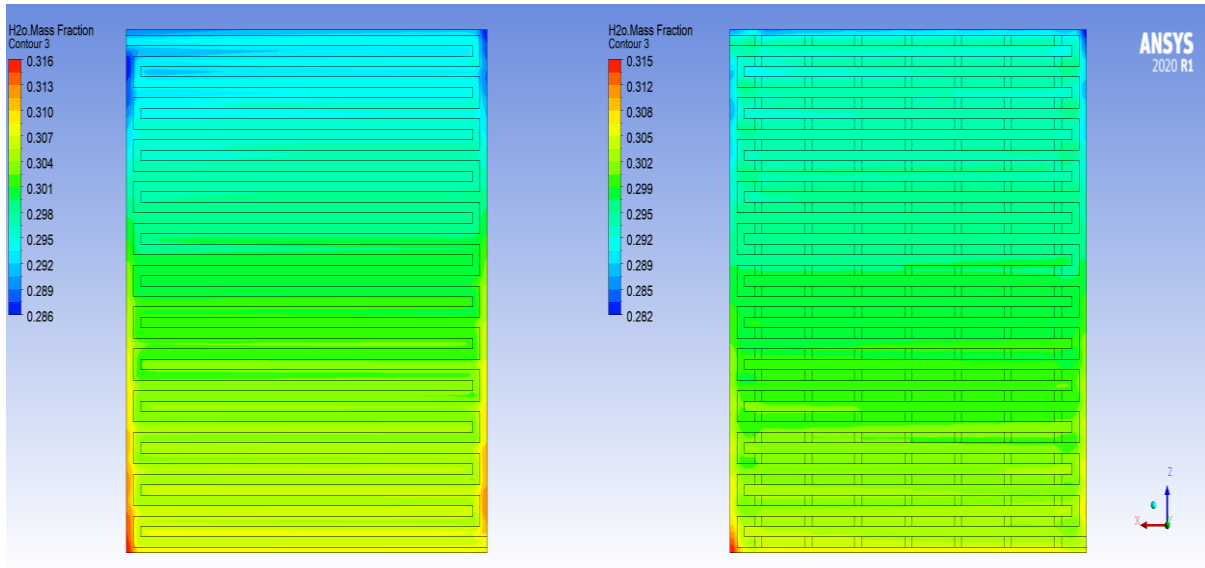


Case-2

Case-3

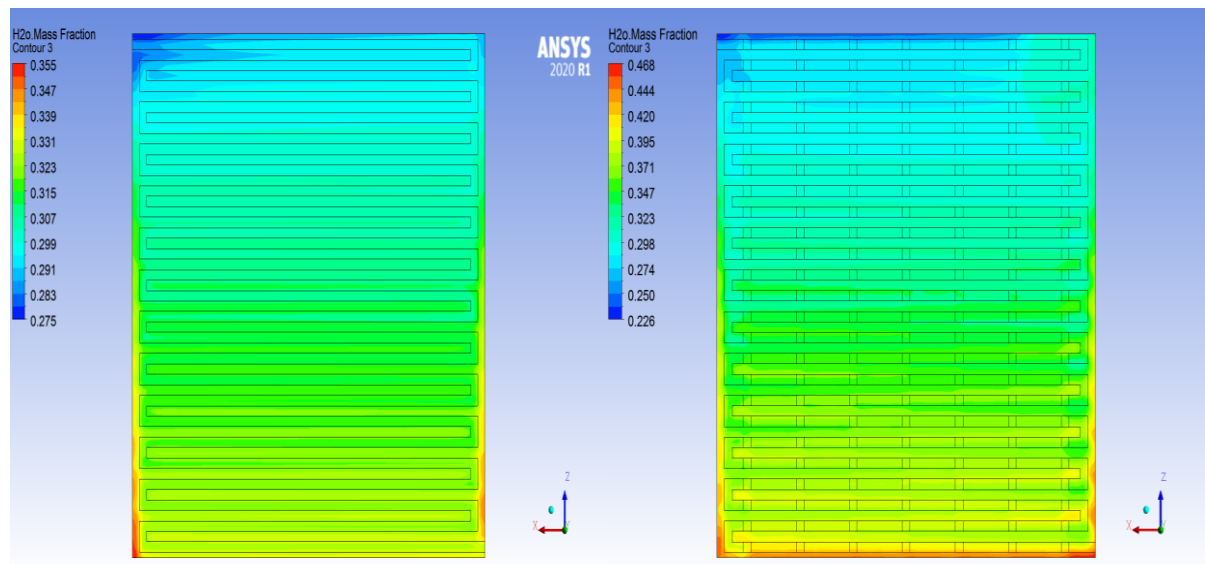
Figure 2. H₂ mass distributions (anode)

The presence of liquid water keeps the membrane moist, while blocking the gas diffusion pass, reducing the diffusion rate and the surface area that reacts effectively, and therefore cell performance. When H₂O mass distribution is examined in disabled structures, it is seen as in other distributions. It is seen that there are obstacles in both plates (situation-4) It is seen that it shows a more homogeneous fluid distribution. (Figure 3).



Normal serpentin

Case-1



Case-2

Case-3

Figure 3. H₂O mass distributions (cathode)

It is thought that oxygen leads to the transport of more oxygen in lower areas of oxygen in cells that are blocked on the cathode side. This is illustrated in figure 3.

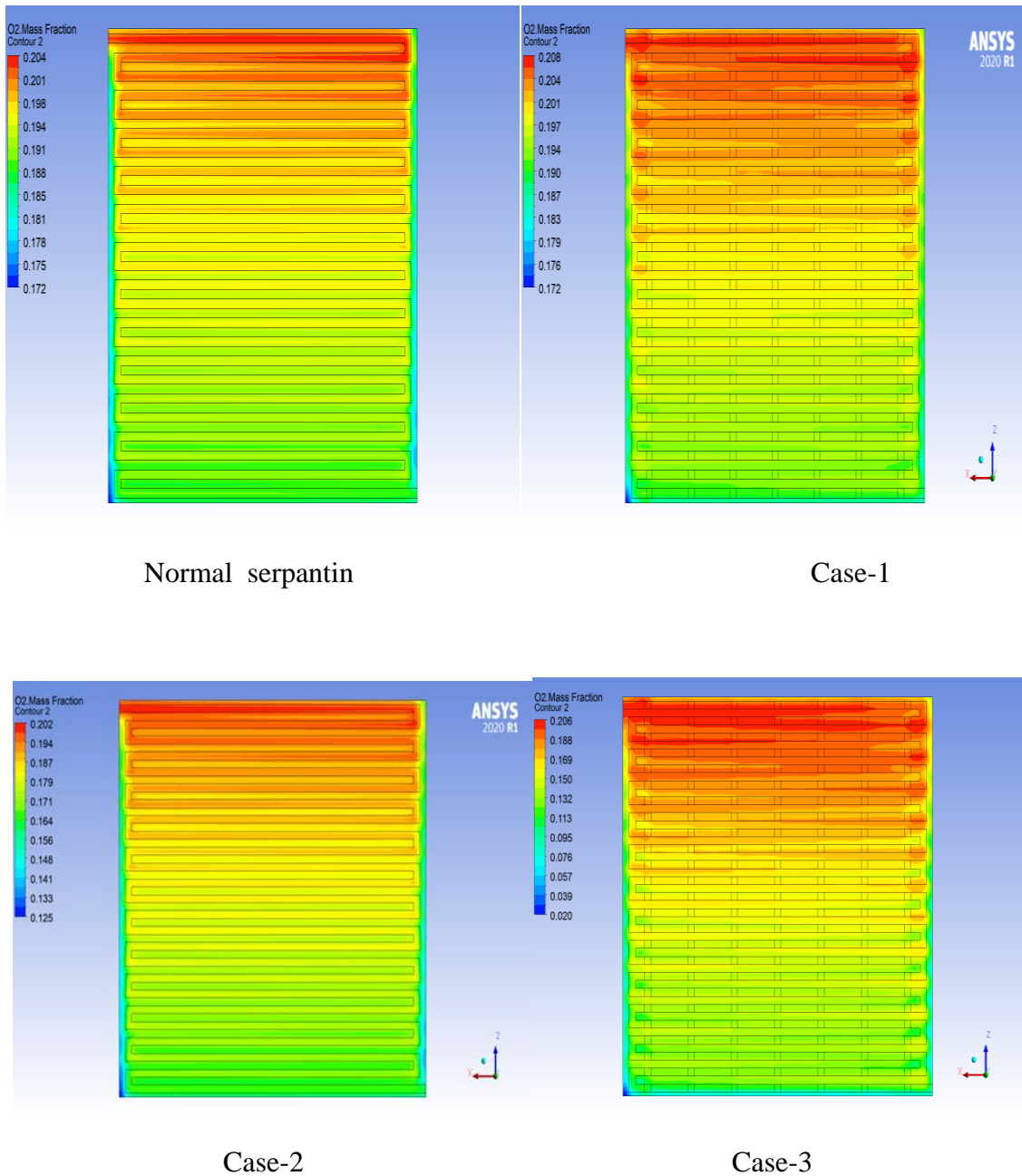


Figure 4. O₂ mass distributions (cathode)

RESULTS AND RECOMMENDATIONS

In this study, different obstacle designs were placed in the flow area within PEMFCs and comparisons were made with empty serpentine. Flow areas were examined by computational fluid dynamics (CFD) method. Oxygen, hydrogen and water images were taken in the anode and cathode section. These images obtained have been examined and interpreted in 3 different cases. The performance effects of the values found have been examined. Within the scope of this study, the analyses were compared at a temperature of 65 degrees and a pressure of 1

atm. However, it is thought that different factors such as channel sizes and obstacle measurements may change pemfc fuel cell performance.

REFERENCES

- [1] Sevinc H, Caspian H. Determining the effects of 2-ethylhexyl nitrate blend on isolated diesel engine attributes using the experimental and ANN approaches. *Energy Sources, Part A Recover Util Environ Eff* 2019. doi:10.1080/15567036.2019.1651791.
- [2] Edwards PP, Kuznetsov VL, David WIF, Brandon NP. Hydrogen and fuel cells: Towards a sustainable energy future. *Energy Policy* 2008;36:4356–62. doi:10.1016/j.enpol.2008.09.036.
- [3] Abe JO, Popoola API, Ajenifuja E, Popoola OM. Hydrogen energy, economy and storage: Review and recommendation. *Int J Hydrogen Energy* 2019;44:15072–86. doi:10.1016/j.ijhydene.2019.04.068.
- [4] Mahapatra MK, Singh P. *Fuel Cells*. *Futur. Energy*, Elsevier; 2014, p. 511–47. doi:10.1016/B978-0-08-099424-6.00024-7.
- [5] Park S, Lee J-W, Popov BN. A review of gas diffusion layer in PEM fuel cells: Materials and designs. *Int J Hydrogen Energy* 2012;37:5850–65. doi:10.1016/j.ijhydene.2011.12.148.
- [6] Asri NF, Husaini T, Sulong AB, Majlan EH, Daud WRW. Coating of stainless steel and titanium bipolar plates for anticorrosion in PEMFC: A review. *Int J Hydrogen Energy* 2017;42:9135–48. doi:10.1016/j.ijhydene.2016.06.241.
- [7] Heidary H, Kermani MJ, Advani SG, Prasad AK. Experimental investigation of in-line and staggered blockages in parallel flowfield channels of PEM fuel cells. *Int J Hydrogen Energy* 2016;41:6885–93. doi:10.1016/j.ijhydene.2016.03.028.
- [8] ANSYS Inc. *ANSYS Fluent Fuel Cell Modules Manual* 2013.

INVESTIGATION OF THE EFFECTS OF CHANNEL BLOCKAGE TYPES ON PERFORMANCE IN PEM FUEL CELL

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ÖZET

Artan insan nüfusu, azalan fosil yakıt kaynakları ve artış gösteren hava kirliliği insanoğlunu yeni ve temiz enerji kaynakları aramaya yöneltmiştir. Bu amaca yönelik olarak hidrojen enerjisi yüksek verimli, temiz ve yenilenebilir olma özellikleriyle dikkat çeken bir alternatif enerji kaynağı haline gelmiştir. Günümüzde ise hidrojenden elektrik üretmek için kullanılan yakıt pili teknolojisi küresel olarak kullanılabilir bir enerji aracı olarak görülmektedir. Yakıt pilleri arasında PEMFC'ler (Polimer elektrolit membranı yakıt hücresi) yüksek verim, düşük çalışma sıcaklığı ve mobil uygulamalarda kullanabilme kabiliyetiyle ön plana çıkmaktadır. PEMFC'ler günümüzde ticari olarak kullanılmaya başlanmış olmasına rağmen, tasarım, dayanıklılık/ömür, maliyet, güvenlik ve verim gibi konularda gelişmeye ihtiyaç duymaktadır. Yakıt pillerinde reaktanların katalizör ve membran yüzeyine dağılımını ve yönlendirilmesini sağlayan, hücre ve yığın yapısına mekanik destek sağlayan, sıcaklık ve elektrik iletme görevlerine sahip bipolar plakaların tasarımsal olarak geliştirilmesi yakıt pillerinin elektriksel performansını doğrudan etkilemektedir. Akış alanı desen tasarımının yapılması, akış alanı üzerinde delik, engel ve oyukların yerleştirilmesi yapılan tasarımsal iyileştirme konularından bazılarıdır. Kanal üzerine çeşitli ölçü ve geometrilerde engellerin yerleştirilmesi ile reaktanların daha fazla gas difüzyon tabakasına yönlendirilmesi sağlanmaktadır. Bu çalışmada, bipolar plakalardaki akış alanlarına farklı şekillerde engeller yerleştirilerek yakıt hücresinin performansına olan etkileri nümerik olarak incelenmiştir. Bu amaçla ANSYS Fluent paket programı kullanılarak hesaplamalı akışkanlar dinamiği (CFD) yöntemiyle modellenen farklı akış alanları simüle edilmiştir. Üç farklı engel şekline sahip üç farklı akış alanı tasarlanmıştır. Tasarlanan engelli akış alanları literatürde standart olarak kabul gören serpentin akış alanı tipi ile kıyaslanmıştır. Bu çalışmada, üç boyutlu olarak tasarlanan ve 50 cm² aktif alana sahip tek bir yakıt hücresi modellenmiştir. Analizler, reaktanların ideal gaz kabul edildiği ve sıvı su fazının mevcut olmadığı koşullarda gerçekleştirilmiştir. Yakıt hücresinin performansı değerlendirilirken akım-güç yoğunluğu (polarizasyon) grafiği, basınç ve sıcaklık dağılımları dikkate alınmıştır. Basınç ve sıcaklık dağılımları hücrenin maksimum güce ulaştığı 0,4V geriliminde incelenmiştir. Sonuçlar, akış kanalı boyunca engellerin yerleştirilmesinin, yakıt pilinin akım değerlerini olumlu yönde etkilediğini göstermiştir. Engel şekillerinin, akım-güç dağılımı ve bölgesel sıcaklık-basınç dağılımları üzerinde etkilere sahip olduğu görülmüştür.

Anahtar Kelimeler: PEMFC, CFD, Bipolar Plaka, Performans.

ABSTRACT

Increasing human population, decreasing fossil fuel resources and increasing air pollution have led human beings to seek new and clean energy sources. For this purpose, hydrogen energy has become a remarkable alternative energy source with its highly efficient, clean and renewable features. Today, fuel cell technology, which is used to generate electricity from hydrogen, is seen as an energy tool that can be used globally. Among fuel cells, PEMFCs (Polymer electrolyte membrane fuel cell) stand out with their high efficiency, low operating temperature

and ability to be used in mobile applications. Although PEMFCs have started to be used commercially today, they need improvement in terms of design, durability/lifetime, cost, safety and efficiency. The design development of bipolar plates, which provide the distribution and orientation of the reactants on the catalyst and membrane surface, provide mechanical support to the cell and bulk structure, and have temperature and electrical conduction functions in fuel cells, directly affects the electrical performance of fuel cells. Designing the flow area pattern, placing holes, blockage and cavities on the flow area are some of the design improvement issues. By placing blockages of various sizes and geometries on the channel, more of the reactants are directed to the gas diffusion layer. In this study, the effects of different shapes of blockages on the performance of the fuel cell were investigated numerically in the flow fields of the bipolar plates. For this purpose, different flow fields modeled by the computational fluid dynamics (CFD) method were simulated using the ANSYS Fluent package program. Three different flow areas with three different obstacle shapes were designed. The designed obstructed flow fields are compared with the serpentine flow field type accepted as a standard in the literature. In this study, a single fuel cell with an active area of 50 cm² is modeled in three dimensions. Analyzes were performed under conditions where the reactants were considered ideal gases and no liquid water phase was present. While evaluating the performance of the fuel cell, the current-power density (polarization) graph, pressure and temperature distributions were taken into account. Pressure and temperature distributions were investigated at a voltage of 0.4V, where the cell reached maximum power. The results showed that the placement of blockages along the flow channel positively affects the current values of the fuel cell. It has been observed that blockages shapes have effects on current-power distribution and regional temperature-pressure distributions.

Keywords: PEMFC, CFD, Bipolar Plates, Performance.

INTRODUCTION

Energy is one of the most important issues in order to survive. With the increasing world population every day, this issue has become more important [1]. Mankind has sought various energy sources for centuries. These energy sources have been examined in two types: clean energy source and dirty. Clean energy sources (solar wind energy, etc.) are energy sources that are friendly to the environment and health that can be recycled. Fossil fuels (coal, natural gas, etc.), which are sources of dirty energy, are composed of carbon monoxide, hydrocarbons and many other harmful pollutant gases that they produce when burning. The World Health Organization (WHO) stated that many people breathe dirty air, which causes people to end their lives due to air pollution [2]. Lung and respiratory diseases are the main causes of these deaths. Harmful emission gases given to nature cause us to drill the ozone layer, climate change and accumulate in the atmosphere, causing our world to warm in an unconsirical way. However, the inability to recycle the vast majority of energy in the combustion event and the efficient operation of a small number of them encouraged the search and use of clean energy sources. Fuel cell technology is an environmental energy conversion device that allows you to use hydrogen and oxygen efficiently. Different types of fuel cells are available. The most efficient and lightweight of these varieties is the Proton Exchange Membrane Fuel Cell (PEMFC). Fuel cell is used in many fields (automotive, aerospace, aerospace industry, etc.) [3,4]. PEMFC generally consists of five basic components, which consist of the membrane electrode group, gas diffusion layer, flow plates, current collection plates and the conta. The voltage output of the fuel cell ranges from 0.5 V to 1 V [5]. To achieve higher power, it is necessary to connect to each other in series [6]. The conditions of fuel and oxygen affect performance Bipolar plates (BP), one of the most important parts of the fuel cell, perform important tasks within the cell. It provides a lightweight structure, high thermal conductivity and mechanical support. Flow

channel designs inside bipolar plates affect the performance of the cell [7]. Incorrect designs in the flow area lead to irregular temperature and pressure drops. This suggests that the design in the field of flow is important. PEMFCs release water and moisturize the membrane while the system is running. However, the accumulation of liquid water in the flow channels is undesirable. In this case, it prevents the transport of oxygen and causes excessive compression of the cathode. The obstacles placed in the PEMFC Fuel Cell flow channel directly affect some parameters. These parameters are speed, water distribution, pressure and temperature. Obstacles in the PEMFC fuel cell flow channel can increase the pressure in places by accelerating the flow. Accordingly, performance values vary [8]. Another factor affecting performance is the shape, frequency, position and placement of the obstacle structure of the PEMFC fuel cell deployed in the flow channel. In addition, there are disadvantages to blockades. Adding obstacles to the flow channel above a certain number can have a turbulence effect and dead zones may occur within the channel due to this effect. Therefore, the placement of obstacles in the flow areas causes advantages/disadvantages and should be examined in detail [9]. In this study, the effects of obstacles with different geometric shapes on the electrical performance of a fuel cell and the distribution of pressure in the flow channels were examined. In addition, the temperature distribution caused by the reaction on the cathode membrane/catalyst surface was also compared.

MODELING AND SIMULATION

In this study, a flow plate with an active area of 25 mm^2 and channel depth dimensions of 1.5 mm is designed. The fuel cell consists of membrane, catalyst, gas diffusion layer and flow plate. The specifications of the fuel cell elements designed in Table 1 are given.

Table 1. Geometric properties of design parameters

parameter	value
Active surface area	25 cm^2
Channel depth	1.5 mm
Channel width	1 mm
Membrane thickness	0.05 mm
Catalyst layer thickness	0.025 mm
Gas diffusion layer thickness	0.365 mm
Bipolar plate base thickness	3 mm

Parts and fuel cells are modeled in 3D in the CATIA package program. In this study, blocking blockages were added to the traditional serpentine flow channel in three different geometries. These barriers were examined to see if the current and power densities in the fuel cell changed temperature and pressure. In the study, voltage values in the range of 0.9V – 0.2V were studied, where the aim is to create more reaction by directing the reactances to the catalyst layer. ANSYS fluent package program was used during the analysis phase. Models drawn through the CATIA program are transferred to the ANSYS analysis program. The process of

defining the transmitted geometry is performed. Mesh throwing and then model installation ends with the results section. Flow area designs prepared in geometry identification section are made inlet, outlet and wall definitions. Then, fixed values were entered for all models in the mesh section and the element size section was selected as 0.25 and mesh was performed for all volumes. Mesh images in Figure 2 with a number of 1,760,000 elements were obtained by entering the element value of 0.25.

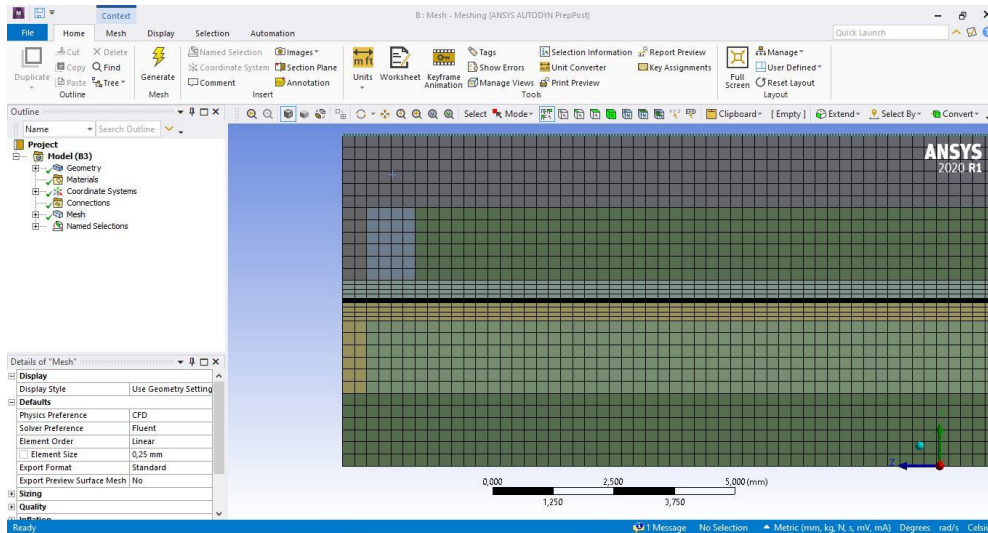


Figure 2. Mesh image for designed flow fields models

After the mesh process is finished, the model switches to the installation section and all designs are entered with the same value in an ANSYS fluent PEMFC mode. Reference current densities and open circuit voltage have been changed in the PEMFC model. Electrical conductivity of the bipolar plate and density values of the cell membrane were entered. In the Boundary Conditions Section, inlet and outlet values are defined. The analysis was run to have 10000 iterations. Table2 specified the values entered in the setup.

Table 2. Defined properties for model parameters

parameter	value
Open circuit voltage	0.98 V
Anode reference current density	$1 \times 10^4 \text{ A/m}^2$
Cathode reference current density	20 A/m^2
Anode concentration base	0.5
Cathode concentration base	1
Reference mole concentration	1 kmol/m^3

Conversion coefficient	0.7
Membrane equivalent weight	1100 kg/kmol
Membrane protonic transmission coefficient and transmission base	1
Membrane density	1968 kg/m ³
Catalyst and gas diffusion layer porosity	0.6
Bipolar plate electrical conductivity	8x10 ³ S/m
Reassurance output pressure	101325 Pa
Reassurance inlet temperature	338.15 K
Anode input flow	1.045x10 ⁻⁶ kg/s
Cathode input flow	3.19x10 ⁻⁵ kg/s
Anod and cathode stonometric	2, 2,5
Anod and cathode moisturizing	0.5, 0.3

The mass momentum carried into PEMFC is chemical species, thermal energy, electron distribution and ionic current. Some formulas are used in terms of accumulation and production/consumption ratio to define the transportation of these sizes. The equations applied to the PEMFC fuel cell are shown in table 3.

Table 3. General management equations for PEM fuel cell models [10]

Applied protection equations	Component
Mass $\frac{\partial(\varepsilon\rho)}{\partial t} + \nabla \cdot (\varepsilon\rho\vec{V}) = S_m$	Gas flow channel , gas diffusion layer, catalyst layer
Momentum $\frac{\partial(\varepsilon\rho\vec{V})}{\partial t} + \nabla \cdot (\varepsilon\rho\vec{V}\vec{V}) = -\varepsilon\nabla P + \varepsilon\mu\nabla^2\vec{V} + S_M$	Gas flow channel , gas diffusion layer, catalyst layer
Types $\frac{\partial(\varepsilon\rho w_k)}{\partial t} + \nabla \cdot (\varepsilon\rho w_k\vec{V}) = -\nabla \cdot [D_k\nabla(\rho w_k)] + S_k$	Gas flow channel , gas diffusion layer, catalyst layer
Energy $\frac{\partial(\varepsilon\rho c_p T)}{\partial t} + \nabla \cdot (\varepsilon\rho c_p T\vec{V}) = \nabla \cdot (k\nabla T) + S_E$	All components
Electrical charges $-\nabla \cdot (\sigma_e\nabla\phi_e) = S_e$	All component except the gas flow channel
Ionic loads $-\nabla \cdot (\sigma_i\nabla\phi_i) = S_i$	Catalyst layer, membrane

FINDINGS AND DISCUSSION

In this study, the flow-impaired models placed inside the flow channel are shown in Figure 2.

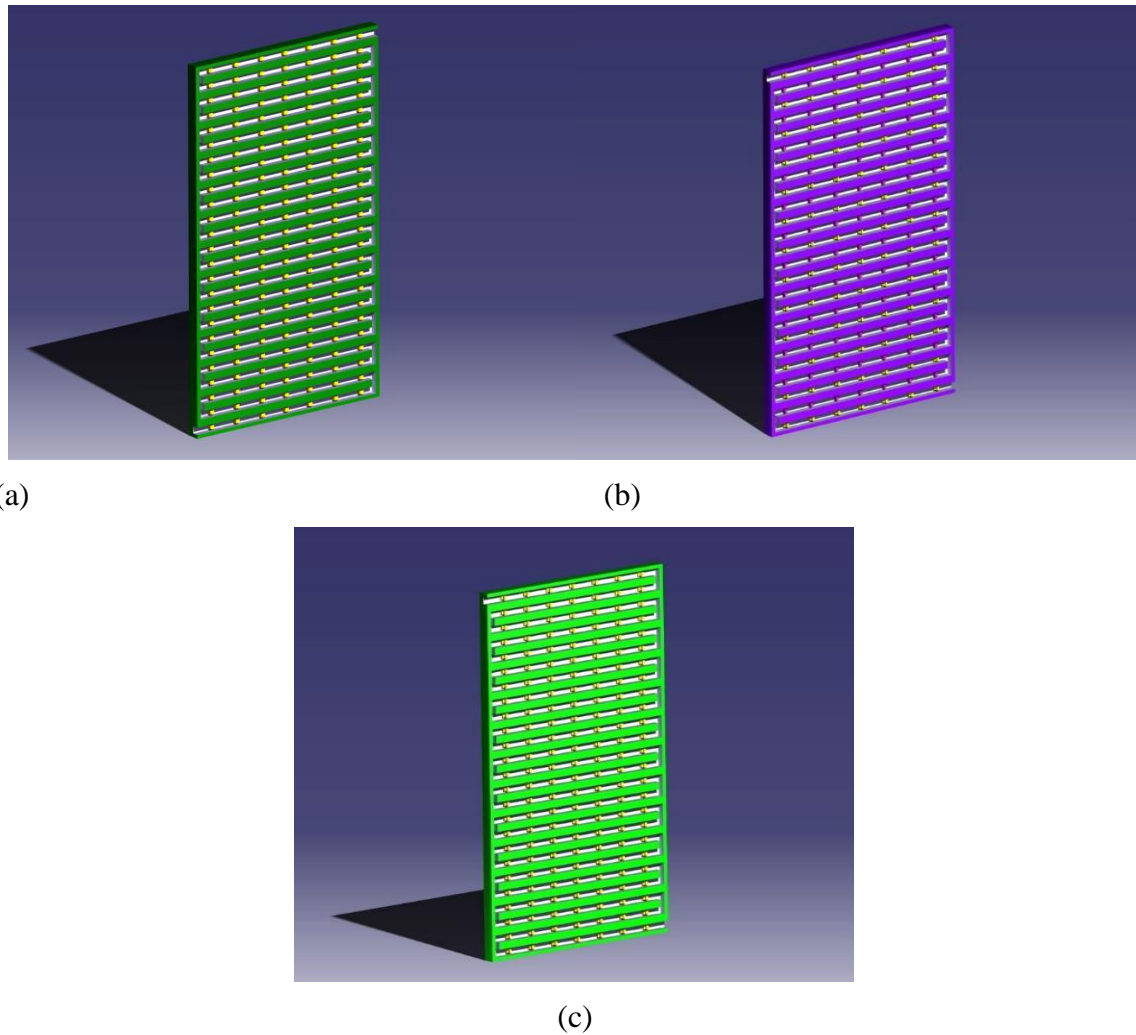


Figure 3. Blocked flow plates, (a) Type-1, (b) Type-2, (c) Type-3

One normal blank serpentine and 3 types of obstacle models are designed. The closer shape of obstacle designs is shown in figure 3.

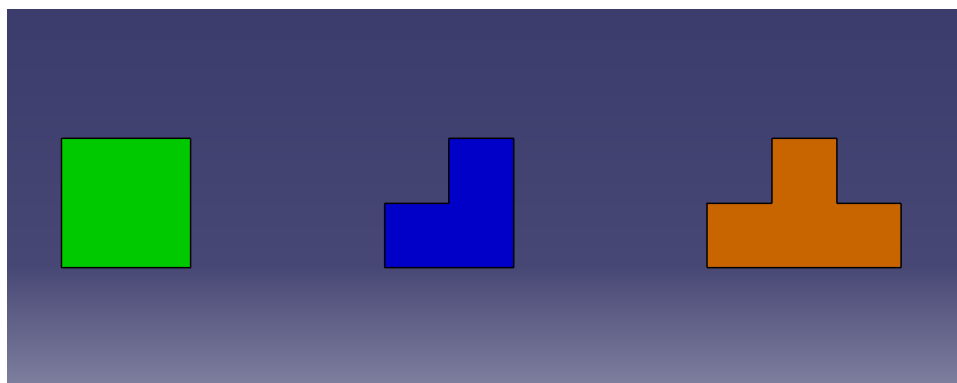


Figure 4. Obstacle models placed in flow areas

For each design, individual pressure distribution images are given. Anode pressure images in Figure 4 and cathode pressure images in figure 5 were given and their changes were examined.

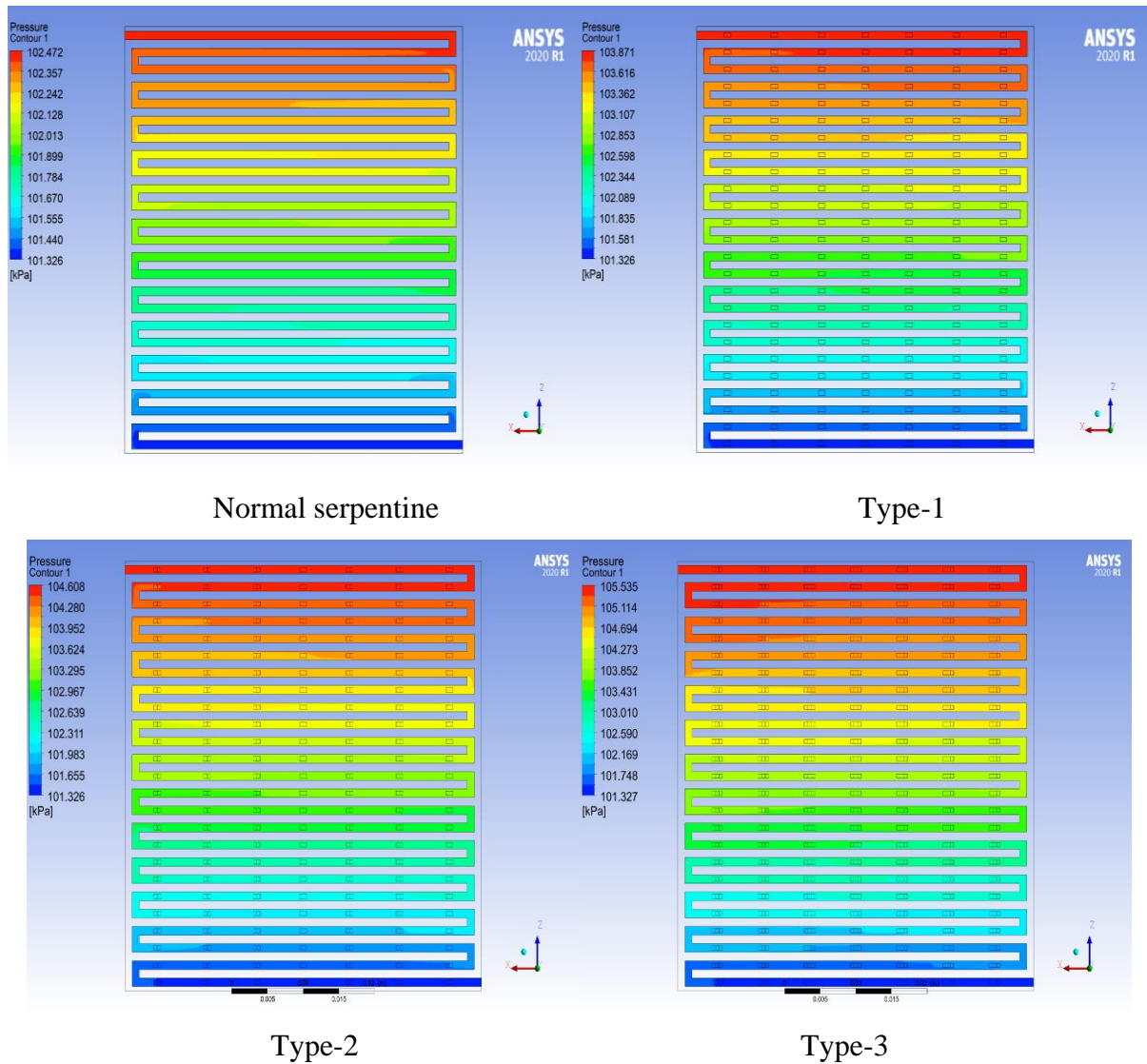


Figure 5. Anode pressure images

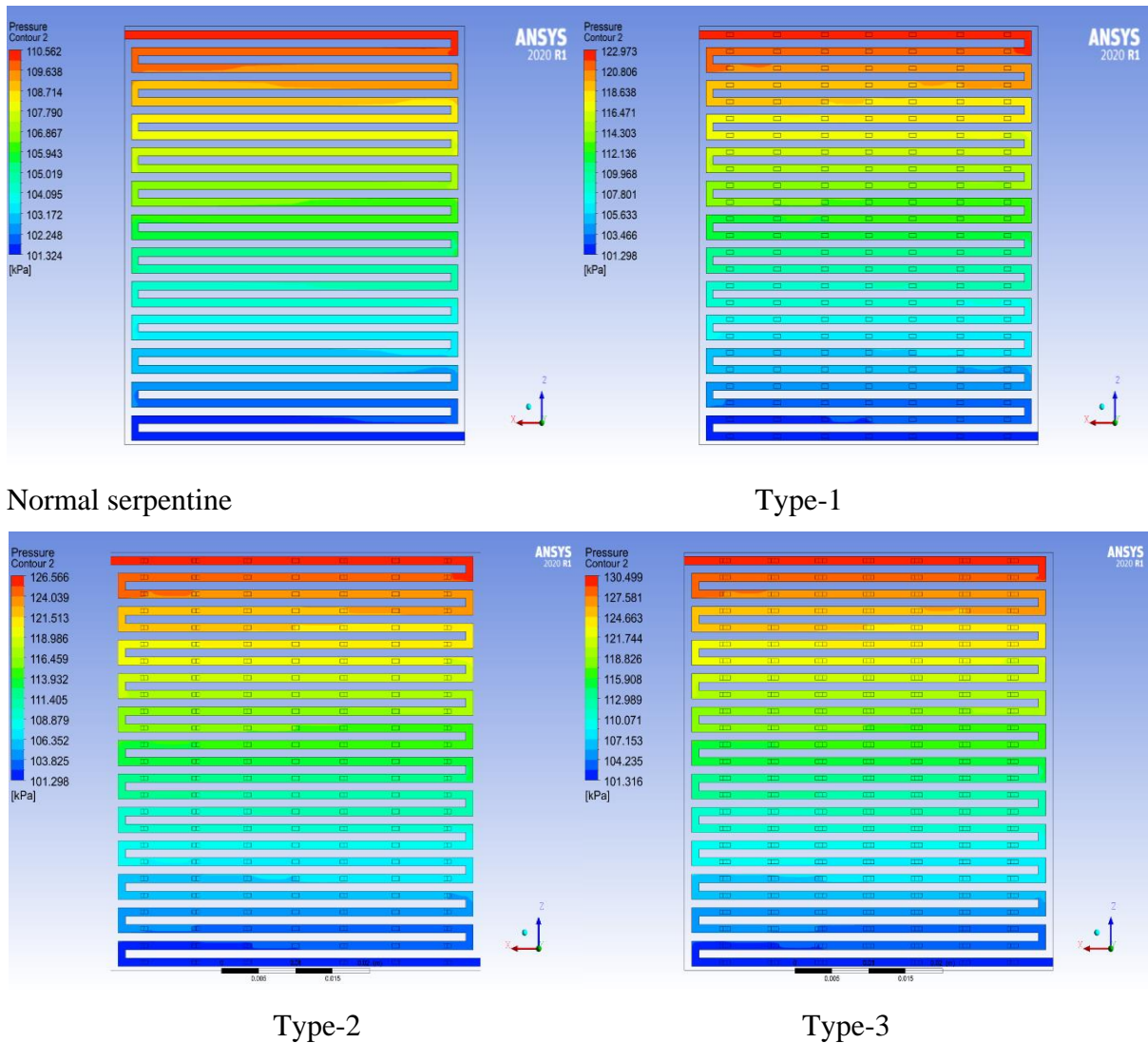
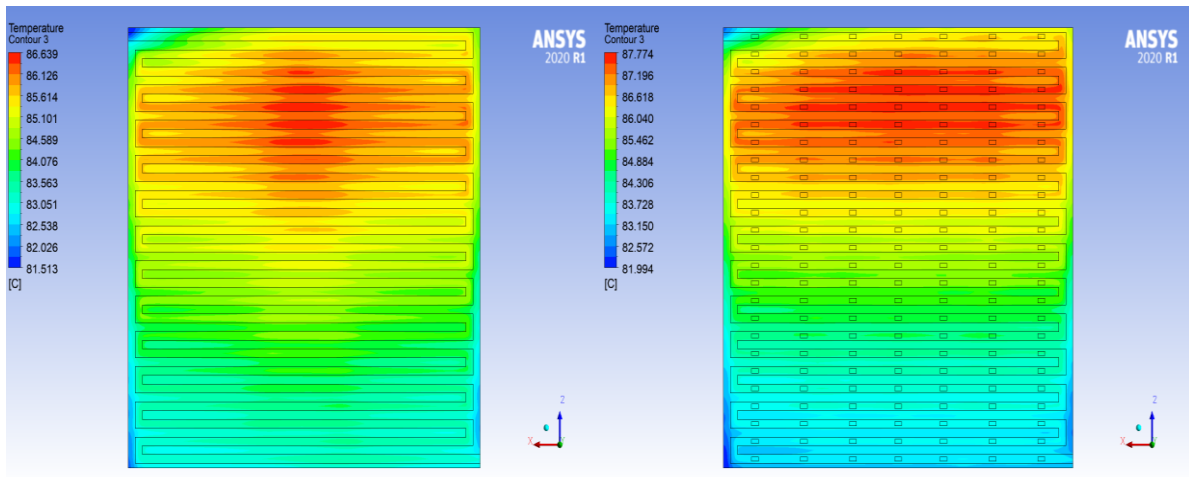


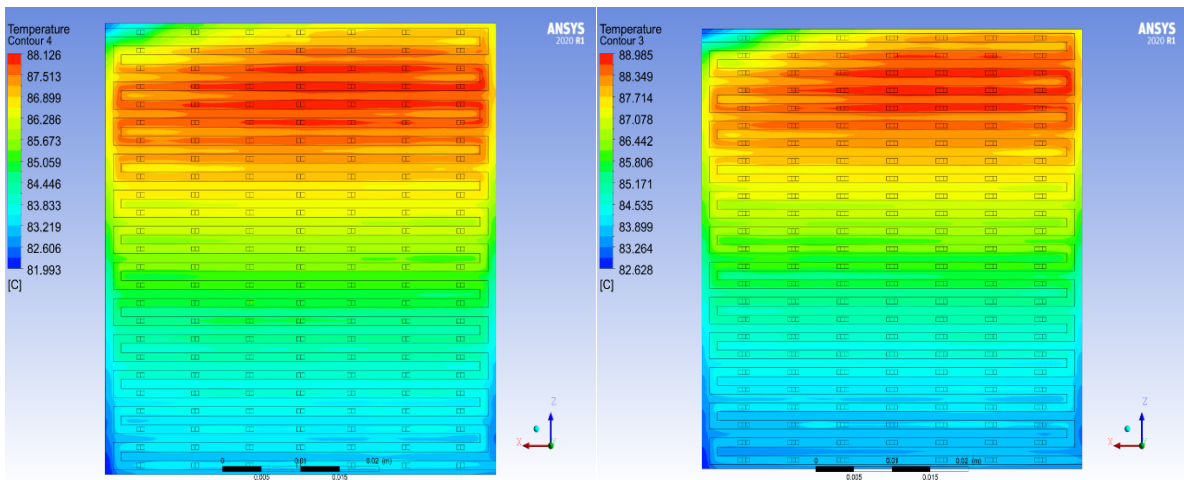
Figure 6. Cathode pressure images

Input values were found by performing numerical calculations of the flow channels with output values entered as 1 atm. The humidity values of the reacts at 65°C and 50% humidity in the anode and 30% humidity in the cathode are indicated. Hydrogen left the cell with a pressure difference of 1,146 kPa on the anode side, 2,545 kPa in Type-1, 3,282 in Type-2 and 4,208 kPa in Type-3. On the cathode side, pressure differences were seen as normal serpentine 9,238 kPa, Type-1 21,675 kPa, Type-2 25,268 kPa, Type-3 29,183 kPa. These pressure changes indicate the difference in pressure with the change of model structure. In the 1.5mm wide flow channels, both the anode and the cathode side showed the highest pressure difference of the Type-3. Temperature images of PEMFCs help to interpret the rate at which electrochemical reactions occur and in which regions. They also help to detect drying and moisture regions in the membrane. Temperature change images consisting of empty serpentine Type-1, Type-2, Type-3, Models were taken by the cathode. Shown in Figure 6.



Normal serpentine

Type-1



Type-2

Type-3

Figure 7. Cathode temperature images

Heat energy is released because the total reaction is an exothermic reaction. Therefore, the regions where the reaction is more experienced are the hot regions and the regions where the reaction is less experienced are the colder regions. In all models, it is seen that the recesses entering from the upper left region form warmer regions in the first regions depending on the obstacles and designs along the way. The current and power density values obtained at the end of the solution of the PEMFC Model are seen in the graph in Figure 7.

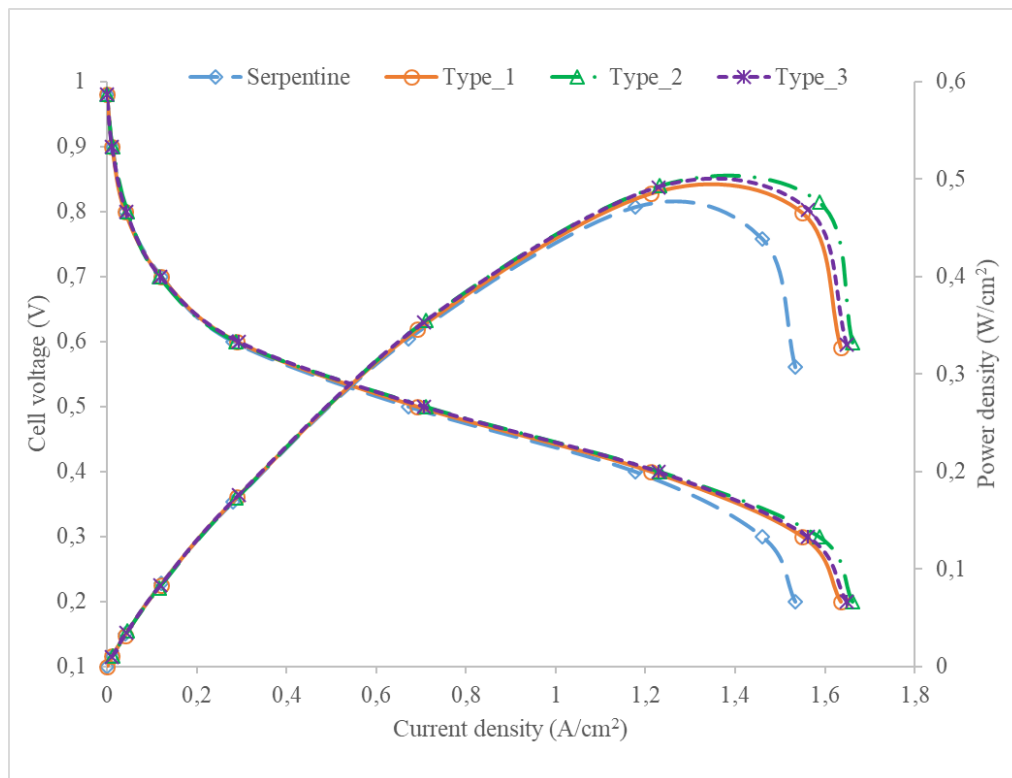


Figure 8. Current-power density graph

RESULTS AND RECOMMENDATIONS

In this study, different obstacle designs were placed in the flow area of PEMFCs and comparisons were made with empty serpentine. Flow areas were examined by computational fluid dynamics (CFD) method. In the anode and cathode section, pressure images were taken separately. Temperature images were taken from the cathode part and compared with empty serpentine and 3 different obstacle designs. The effects of the values found on strength and performance were examined. Within the scope of this study, the analyses were compared with a temperature of 65 °C and an atm pressure value of 1. However, it is thought that different factors such as duct sizes and obstacle measurements may change pemfc fuel cell performance.

REFERENCES

- [1] Veziroğlu TN, Şahi'n S. 21st Century's energy: Hydrogen energy system. *Energy Convers Manag* 2008;49:1820–31. doi:10.1016/j.enconman.2007.08.015.
- [2] World Health Organization (WHO). 9 out of 10 people worldwide breathe polluted air. 2018.
- [3] Baroutaji A, Wilberforce T, Ramadan M, Olabi AG. Comprehensive investigation on hydrogen and fuel cell technology in the aviation and aerospace sectors. *Renew Sustain Energy Rev* 2019;106:31–40. doi:10.1016/j.rser.2019.02.022.
- [4] Piffard M, Gerard M, Fonseca R Da, Massioni P, Bideaux E. Sliding mode observer for proton exchange membrane fuel cell: automotive application. *J Power Sources* 2018;388:71–7. doi:10.1016/j.jpowsour.2018.03.057.

- [5] Dong J, Xu X, Xu B. CFD analysis of a novel modular manifold with multi-stage channels for uniform air distribution in a fuel cell stack. *Appl Therm Eng* 2017;124:286–93. doi:10.1016/j.applthermaleng.2017.06.030.
- [6] Zeng YK, Fan P, Zhang X, Fu C, Li J, Li G. Sensitivity Analysis for a Planar SOFC: Size Effects of the Porous Gas Diffusion Layer Underneath the Channel Rib. *Fuel Cells* 2014;14:123–34. doi:10.1002/face.201300182.
- [7] Chowdhury MZ, Genc O, Toros S. Numerical optimization of channel to land width ratio for PEM fuel cell. *Int J Hydrogen Energy* 2018;43:10798–809. doi:10.1016/j.ijhydene.2017.12.149.
- [8] Shen J, Tu Z, Chan SH. Enhancement of mass transfer in a proton exchange membrane fuel cell with blockage in the flow channel. *Appl Therm Eng* 2019;149:1408–18. doi:10.1016/j.applthermaleng.2018.12.138.
- [9] Chen H, Guo H, Ye F, Ma CF. Forchheimer’s inertial effect on liquid water removal in proton exchange membrane fuel cells with baffled flow channels. *Int J Hydrogen Energy* 2021;46:2990–3007. doi:10.1016/j.ijhydene.2020.05.082.
- [10] Kone J-P, Zhang X, Yan Y, Hu G, Ahmadi G. Three-dimensional multiphase flow computational fluid dynamics models for proton exchange membrane fuel cell: A theoretical development. *J Comput Multiph Flows* 2017;9:3–25. doi:10.1177/1757482X17692341.

GÜMÜŞ NANOPARTİKÜLLERİN ÜRETİMİ, GIDA ALANINDA KULLANIMI VE TOKSİK ETKİLERİ

PRODUCTION, FOOD USE AND TOXIC EFFECTS OF NANO SILVER PARTICLES

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ÖZET

Nanoteknoloji, günümüzde tıp, gıda, kozmetik gibi birçok kullanım alanı bulmuştur. Bununla birlikte, son yıllarda tıbbi amaçlarla sadece birçok nanopartikül kullanılmaktadır. Bunların içinde en yaygın kullanılanlardan biri nano gümüş partikülleridir. Nano boyuttaki gümüş partiküller, oldukça sıra dışı fiziksel, kimyasal ve biyolojik özelliklere sahiptir. Bu özelliklerinden dolayı gümüş nanopartiküller (AgNP'ler) birçok uygulamada potansiyel kullanımlara sahip olmaktadır. Nano gümüş kaplamalar, güçlü antibakteriyel aktivitesi nedeniyle tekstil ve gıda alanı gibi farklı alanlarda kullanımı üzerine çalışmalar yapılmıştır. Ayrıca gümüş nanopartiküller, yaraların ve yanıkların tedavisi için kullanımının yanı sıra dezenfektan ve oda spreyi gibi ürünlerde de pazarlanma alanı bulduğu bilinmektedir. Bunların yanı sıra yapılan bilimsel araştırmalarda, gümüş nanopartiküllerin sağlığımız üzerine etkisinin yanında bağırsak mikrobiyotası üzerine olan etkileri de çalışılmış olup olumlu ve olumsuz etkiler gözlemlenmiştir. Birçok alanda kullanımı üzerine bugüne kadar yayınlanmış çok sayıda inceleme makalesi ve vaka çalışması olmasına rağmen, nanopartiküllerin eşikleri ve güvenli dozlarını açıkça tanımlayan güncel çalışmalar yeterli olmamaktadır. Bu nedenle, eşik limitleri, güvenli gümüş dozları ve bununla ilgili nano ölçekli formlar hakkındaki en son bulgulara ve insan, kara ve su yaşamlarının güvenliğini ve sağlığını korumak için daha kapsamlı çalışmalara ihtiyaç duyulmaktadır. Bunun nedeni gümüş nanopartiküllerin kullanımının giderek daha yaygın hale gelmesi akabinde artan bir maruziyetin oluşmasına neden olmasıdır. Bu durumda gümüş nanopartiküllerinin oluşturabileceği toksikolojik ve çevresel sorunların ele alınması kaçınılmaz olmuştur. Bu derleme ile gümüş nanopartiküllerin üretimi, gıda ve sağlık sektöründe kullanım alanları ile birlikte bu nanopartiküllerin faydalı ve toksik etkileri üzerine yapılmış mevcut çalışmalar bir araya getirilmiştir. Yapılan bu derlemenin amacı gümüş nano partiküllerin kullanım alanlarını ve toksik etkileri hakkında literatürdeki çalışmalarını bir araya getirerek mevcut durumu ortaya koymaktır.

Anahtar Kelimeler: Nanoteknoloji, Gümüş nanopartikül, Toksik Etki, Gıda

ABSTRACT

Nanotechnology has found many uses such as medicine, food and cosmetics. However, only many nanoparticles have been used for medical purposes in recent years. One of the most widely used of these are nanosilver particles. Nano-sized silver particles have very unusual physical, chemical and biological properties. Because of these properties, silver nanoparticles (AgNPs) have potential uses in many applications. Studies have been made on the use of nano-silver coatings in different areas such as textile and food due to its strong antibacterial activity. In addition, silver nanoparticles are known to be used for the treatment of wounds and burns, as well as being marketed in products such as disinfectants and air fresheners. In addition to these, the effects of silver nanoparticles on our health as well as on the intestinal microbiota have been studied in scientific researches, and positive and negative effects have been observed. Although there are many review articles and case studies published on its use in many fields, current studies that clearly define the thresholds and safe doses of nanoparticles are not sufficient. Therefore, the latest findings on threshold limits, safe doses of silver and related nanoscale forms, and more extensive studies are needed to protect the safety and health of human, terrestrial and aquatic life. This is because the use of silver nanoparticles is becoming more and more common, followed by an increased exposure. In this case, it has become inevitable to address the toxicological and environmental problems that can be caused by silver nanoparticles. With this review, the current studies on the production of silver nanoparticles, their use in the food and health sector, as well as the beneficial and toxic effects of these nanoparticles were brought together. The purpose of this review is to reveal the current situation by bringing together the studies in the literature on the usage areas and toxic effects of silver nanoparticles.

Keywords: Nanotechnology, Nanosilver, Toxic Effect, Food

1. GİRİŞ

Nanoteknoloji kavramı 1959 yılında fizikçi Richard Feynman'ın "There is plenty of room at the bottom," başlıklı bir konferansında ifade edilmiş ve atomik ölçekteki şeyleri manipüle etmenin ve kontrol edebilmenin önemi tartışılmıştır. Nanoteknoloji terimi ilk kez 1974 yılında Profesör Norio Taniguchi tarafından tanıtılmıştır ve Amerikalı mühendis Kim Eric Drexler, moleküler nanoteknoloji kavramını 1986 yılında *Engines of Creation; The Coming Era of Nanotechnology* isimli kitabında kullanarak yaygınlaştırmıştır. Bununla birlikte, ancak 1981'de yüzeyleri atomik seviyede görüntülemeyebilen, tarama mikroskobu ve bunu takiben atomik kuvvet mikroskobu gibi aletlerin icat edilmesinden sonra, nanoteknoloji büyüme sürecine girmiştir. Son yirmi yılda nanoteknoloji, tıp, terapötikler, ilaç geliştirme ve biyoteknoloji gibi alanlarda hızla kullanılmaya başlanmıştır (Ferdous and Nemmar, 2019).

Nano ölçekli malzemelerin çeşitli avantajlarına rağmen, kontrol edilemeyen kullanımları, doğaya geçmeleri ve potansiyel toksik etkileri nedeniyle sağlık üzerine olumsuz etkileri bulunabilmektedir. Bu nedenle nanotoksikoloji alanında, nanomateryallerin kullanımını daha rahat ve çevre dostu haline getirebilmek için yoğun araştırmalar yapılmaktadır (Bakand and Hayes, 2016). En yaygın olarak incelenen nanomateryallerden bazıları, fullerener, karbon nanotüpler (CNT'ler), gümüş nanopartiküller (AgNP'ler), altın nanopartiküller (AuNP'ler), titanyum oksit nanopartiküller (TiO₂), çinko oksit nanopartiküller, demir oksit (FeO) ve silika nanopartikülleridir. Bunlar arasında, AgNP'ler son yıllarda araştırmalar arasında güçlü bir popülerlik kazanmıştır (Vance et al., 2015).

AgNP'lerle ilgili ilk araştırmalar daha çok bu bileşiklerin kimyasal olarak sentezlenmesi ve karakterize edilmesine odaklanmıştır (Iravani et al., 2014). Bununla birlikte, güncel çalışmalar

biyolojik etkileri ve çeşitli amaçlarla uygulamaları üzerine daha fazla yoğunlaşmıştır. AgNP'lerin, yüzey plazmon rezonansı ve elektrik direnci açısından benzersiz özelliklere sahip olduğu bilinmektedir (Syafiuddin et. al., 2017). Bunlara dayanarak, yara sargılarındaki antimikrobiyal ajanlar, su dezenfektanları, elektronik cihazlar ve antikanser ajanlar gibi potansiyel uygulamalarını araştırmak için yoğun çalışmalar yapılmaktadır (Zhang et.al., 2016; Syafiuddin et. al., 2017).

2. GÜMÜŞ NANOPARTİKÜLLER

Ag olarak sembolize edilen gümüş, tüm metallerin en yüksek elektrik iletkenliğine sahip, elektrikli cihazlarda yaygın olarak kullanılan parlak, yumuşak, sünek ve dövülebilir bir metaldir. Bu değerli metal kimyasal olarak inaktif olup suda stabildir ve havada oksitlenmez, bu nedenle madeni para, süs eşyaları ve mücevher üretiminde kullanılmaktadır. Gümüş, saf yataklardan ve ayrıca boynuz gümüşü ve arjit gibi gümüş cevherlerinden elde edilebilir. Çoğu gümüş, altın, bakır ve kurşun içeren cevher yatakları ile birlikte bir yan ürün olarak elde edilmektedir (Robert, 1988). Her yıl yaklaşık 320 ton nanopartikül Ag formunun üretildiği ve nanomedikal görüntüleme, biyosensasyon ve gıda ürünlerinde kullanıldığı tahmin edilmektedir (Sharma et. al.,2019).

Gümüş nanopartiküllerin (AgNP'ler) çok çeşitli mikroorganizmalara karşı mükemmel bakterisidal özellikler gösterdiği bildirilmektedir. AgNP'leri ve bunların elektronik, kataliz, ilaçlardaki uygulamaları ve biyolojik sistemdeki mikroorganizma gelişimini kontrol etmeleri, onları bir açıdan çevre dostu yapmıştır (Husen and Siddiqi, 2014; Wei et. al., 2015; Lokina et. al., 2014).

AgNP'lerin biyojenik sentezi; bakteri, küf, maya, aktinomisetler ve bitki özleri ile gerçekleştirilebilmektedir (Siddiqi and Husen, 2016a; Husen and Siddiqi, 2016b; Shahverdi et. al., 2007; Lokina et. al., 2014; Shahverdi et.al., 2007). Son zamanlarda, altın ve gümüş nanoparçacıkların sentezi için, enzimlerin yanı sıra çiçek, yaprak ve meyveler gibi çeşitli bitkisel kaynaklarda kullanılmıştır (Husen and Siddiqi, 2014)

Nanopartiküllerin büyüklüğü, morfolojisi ve stabilitesi, hazırlama yöntemine, çözücünün yapısına ve konsantrasyona, indirgeyici ajanın gücüne ve sıcaklığa bağlı olmaktadır. Şimdiye kadar geliştirilen ve karakterize edilen tüm Ag NP'ler, doğal hareket özellikleri nedeniyle, katı halde bile bir antimikrobiyal ajan olarak büyük önem taşımaktadırlar. Önemi çok daha önce fark edilmiş olmasına rağmen, doğu tıbbında ve madeni paralarda kullanılması dışında daha geniş alanda kullanılmamıştır (Siddiqi et. al., 2018). Birçok metal tuzu ve metal nanopartiküllerinin, çoğu enfeksiyöz bakterinin büyümesini inhibe etmede etkili olduğu bulunmuştur. Bunlar arasında gümüş ve altın nanopartiküller, eskiden beri antimikrobiyal ajanlar olarak kullanılmaktadır. Özellikle gümüş tuzları, insan sistemindeki çeşitli bakterilerin büyümesini engellemek için kullanılmaktadır. Bunu bakterilerin sebep olduğu enfeksiyona karşı vücudu koruyarak gerçekleştirmektedirler. Kesik, yanık ve yara gibi durumlarda da derinin enfeksiyona karşı korunması için kullanılmaya başlanmıştır (Crabtree et al., 2003; Catauro et.al., 2004).

3. NANO GÜMÜŞ ÜRETİMİ

Geleneksel olarak nanomalzemeler, sol-jel yöntemi, misel, kimyasal çökeltilme, hidrotermal yöntem, piroliz ve kimyasal buhar biriktirmeyi içeren kimyasal veya fiziksel yöntemler kullanılarak sentezlenmektedir (Leela and Vivekanandan, 2008; Bai et. al., 2007; Jung et. al., 2006; Kruis et. al., 2000; Mafune et. al., 2000). Bu yöntemlerden bazıları kolaydır ve reaksiyon

ortamını eski haline getirerek kristal boyutu üzerinde kontrol sağlar. Ancak, ürünün genel kararlılığında ve ifade edilen yöntemlerin kullanılarak tek dağılımlı nano boyuta ulaşılmasında hala sorun olduğu belirtilmektedir (Kowshik et. al., 2002). Ayrıca, alışılmış tekniklerin birçoğunun çok zor olduğu, malzeme ve enerji kullanımında verimsiz olduğu bulunduğu bildirilmiştir. Bu yöntemlerle ilgili başka bir sorun, toksik maddelerin üzerlerine emilmesidir. Yeşil sentez yaklaşımları ile bu sınırlamaların üstesinden gelinebileceği düşünülmektedir (Abbasi et. al., 2016). Yeşil sentez çevre dostu ve biyo uyumlu bir süreçtir. Yeşil yöntemlerin artan popüleritesi, bakteriler, mantarlar, algler ve bitkiler gibi farklı kaynaklar kullanılarak AgNP'lerin sentezini tetikleyerek daha az kirlilikle büyük ölçekli üretimle sonuçlanmıştır (Ahmed et al., 2016; Ahmed et al., 2019). Gümüş nanopartiküllerin biyolojik olarak ilham veren yeşil sentezinin geliştirilmesi, tıp bilimi ve hastalık tedavisi konularında dünya çapında önemli ölçüde dikkat çekmiştir (Mousavi et al., 2018).

Fiziksel süreçlerde, metal nanopartiküller genellikle atmosferik basınçta bir tüp fırın kullanılarak gerçekleştirilebilen buharlaşma-yoğunlaştırma ile sentezlenmektedir. Fırında ortalanmış bir tekne içindeki temel malzeme bir taşıyıcı gaz ile buharlaştırılır. Ag, Au, PbS ve fulleren gibi çeşitli malzemelerin nanopartikülleri daha önce buharlaştırma/ yoğunlaştırma tekniği kullanılarak üretilmektedir (Gurav et.al., 1994; Magnusson et.al., 1999). Bununla birlikte, bir tüp fırın kullanılarak gümüş nanopartiküllerin (AgNP'ler) üretilmesinin birkaç dezavantajı vardır, çünkü bir tüp fırın büyük bir yer kaplamakta, kaynak malzemenin etrafındaki çevre sıcaklığını yükseltirken büyük miktarda enerji tüketmekte ve çok zaman gerektirmektedir. Tipik bir tüp fırın, sabit bir çalışma sıcaklığına ulaşmak için birkaç kilovattan fazla güç kullanan termal bir kararlılık ve bir ön ısıtma süresi gerektirttiği belirtilmektedir (Tsuji et.al., 2003; Sylvestre et.al., 2004).

Gümüş nanopartiküllerin sentezi için en yaygın yaklaşım, organik ve inorganik indirgeme ajanları ile kimyasal indirgeme olmaktadır. Genel olarak, indirgeme için gümüş iyonlarının (Ag⁺) sulu veya susuz çözeltilerinde sodyum sitrat, askorbat, sodyum borohidrit (NaBH₄), elementel hidrojen, poliöl işleme, Tollens reaktifi, N, N-dimetilformamid (DMF) ve poli (etilen glikol)-blok kopolimerler gibi farklı indirgeme ajanları kullanılmaktadır. Yukarıda bahsedilen indirgeme ajanları gümüş iyonlarını (Ag⁺) azaltır ve metalik gümüşün (Ag⁰) oluşumuna yol açar, bunu oligomerik kümeler halinde aglomerasyon izlemektedir. Bu kümeler sonunda metalik koloidal gümüş parçacıklarının oluşumunu sağlamaktadır (Evanoff and Chumanov, 2004; Wiley et.al., 2005). Parçacık yüzeyleri ile etkileşimler için işlevsellikler (örneğin tiyoller, aminler, asitler ve alkoller) içeren yüzey aktif maddelerin varlığı parçacık büyümesini stabilize edebilir ve parçacıkları tortulaşmadan, topaklaşmadan veya yüzey özelliklerini kaybetmekten koruyabilmektedir. Poli (vinil alkol), poli (vinilpirolidon), poli (etilen glikol), poli (metakrilik asit) ve polimetilmetakrilat gibi polimerik bileşiklerin, nanopartikülleri stabilize etmek için etkili koruyucu ajanlar olduğu bildirilmiştir (Valizadeh et al., 2012).

Literatürde, birkaç mikroorganizma, özellikle *Fusarium oxysporum* kullanılarak, gümüş nanopartiküllerin hücre ile ilişkili biosentezine ilişkin çok sayıda araştırma bulunmaktadır (Ahmad et al., 2003; Dura'n et al., 2005; Dura'n et al., 2007; Mukherjee et al., 2001). Doğal kaynak ortamları arasında, prokaryotik bakteriler en çok metalik nanopartiküllerin sentezi üzerinde araştırma yapılmıştır. Nanopartikül sentezi için bakterilerin tercih nedenlerinden biri, göreceli olarak işleyebilme kolaylığıdır. Son zamanlarda, kadmiyum sülfür, altın ve gümüş gibi metalik nanopartiküllerin sentezi için potansiyel biyoüretici olarak bazı mikroorganizmalar ile çalışılmıştır (Hussain et.al., 2003; Li et.al., 2008; Williams, 2008). Duran et.al. (2007), gümüş nanopartiküllerin (AgNP'ler), diğer benzer nanopartiküller gibi, çeşitli patojenik mikroorganizmalara karşı etkili bir antimikrobiyal ajan olduğunu göstermişlerdir. AgNP'lerin üretimi için çeşitli kimyasal ve biyokimyasal yöntemler araştırılsa da, mikroorganizmalar bu süreçte son derece etkilidir (Nanda and Saravanan, 2009). Nanopartiküllerin hem hücre içi hem

de hücre dışı sentezinde bakteri ve küfleri kullanan yeni enzimatik yaklaşımların, birçok geleneksel ve gelişmekte olan teknolojide anahtar bir role sahip olması beklenmektedir (Abbasi et.al., 2016).

4. GÜMÜŞ İYONLARI VE BAKTERİYEL DİRENÇ

Gümüş iyonlarına karşı bakteriyel direncin moleküler mekanizmaları, özellikle Gram-negatif bakterilerde iyi bilinmektedir (Silver, 2013; Randall et.al., 2015). Bakteriyel-gümüş direnci, ilk olarak 1975 yılında Massachusetts Genel Hastanesi'nin yanık bölümünde bir hastanın ölümüne neden olan gram negatif *Salmonella typhimurium*, gümüş iyonlarına bakteriyel direnç gösteren, spesifik bölgelere sahip 180 kb'lik bir yapı olan pMG101 plazmidinin belirlenmesiyle ortaya çıkmıştır (Silver et.al., 1999). Bu direnç türü Randall *et al.* (2015) tarafından “eksojen gümüş direnci” olarak adlandırılmıştır. Bu spesfik bölgelerin, her biri ayrı bir destekleyici tarafından kontrol edilen üç transkripsiyonel üniteden (silRS, silE ve silCFBAGP) oluşan toplamda dokuz sil genli bir bölgeyi oluşturmaktadır (Randall *et al.*, 2015).

Antibiyotiklere direnç, önemli ve gittikçe büyüyen bir halk sağlığı sorunudur. Avrupa'da her yıl yaklaşık 25.000 hastanın, antibiyotiklere dirençli bakteri suşlarının sebep olduğu enfeksiyonlar nedeniyle öldüğü tahmin edilmektedir (Hickey, 2017). Hem gram negatif hem de gram pozitif bakterilerin izolatlarının aynı anda birçok antibiyotiğe dirençli olduğu belirtilmektedir. “Çoklu direnç” (MR) terimi, enfeksiyon tedavisinde kullanılan birden fazla antibiyotiğe dirençli mikroorganizmaları ifade etmektedir. “Çok ilaca dirençli” (MDR) olarak tanımlanan bakteriler, 3 veya daha fazla farklı antibiyotiklere karşı bakteri direnci ile karakterize edilmektedir (Magiorakos et. al., 2012). MDR suşları, terapötik seçeneklerin sınırlı olmasından dolayı özellikle tehlikeli olan bir grup mikroorganizmadır (Kedziora et. al., 2020). Enfeksiyonların tedavisi bir veya iki antibiyotikle sınırlıdır (Nordmann and Poirel, 2014; Nordmann, 2014). Gümüş nanoformülasyonların ihtiyatlı kullanımı ve tüm sağlık sektörlerinde enfeksiyonların kontrol ve önlenmesi ilkelerinin yaygın olarak gözetilmesi, antibiyotiğe dirençli bakterilerin yayılmasını önlemek için etkili müdahalelerin temelini oluşturmaktadır (Klebens et al., 2007). Aksi takdirde, Avrupa'nın yakında Enterobacteriaceae'nin çoklu dirençle (yaygın olarak ilaca dirençli, XDR) neden olduğu salgın hastalıklarıyla karşı karşıya kalabileceği belirtilmiştir. Hatta uzun süreli maruziyetten sonra bakterilerin gümüş nano formülasyonlara karşı duyarlılığını kontrol etmek, gümüşün eksojen ve endojen direncini analiz etmek ve son olarak gram-pozitif ve gram-negatif bakteri suşlarının (gümüş nanoformülasyonlara tekrar tekrar maruz kaldıktan sonra duyarlılığı değişen mikroorganizma türleri ve varyantlar) antibiyotik duyarlılığını karşılaştırmak gerekeceği bildirilmiştir. (Kedziora et. al., 2020). Enterobacteriaceae'de karbapenemaz direncinin (CPE) hızlı yayılması, hastaların sağlığı ve güvenliği için en ciddi sorunlardan biridir (Klebens et. al., 2007).

5. NANO GÜMÜŞ VE GIDA

Son yüzyılda nano gümüş, çok sayıda üründe kullanılmıştır. AgNP'lerin bir sıvı içinde süspanse edildiği kolloidal gümüş, 20. yüzyılın başlarından beri sağlık ve tıbbi nedenlerle kullanılmakta olup şu anda besin takviyesi ve ikame ilaç olarak satılmaktadır (Seltenrich, 2013). Bununla birlikte, iyonik, nanopartikül ve toplu formlardaki gümüş çok farklı davranır. Metalik gümüşün boyutu nanometre ölçeğine küçültüldüğünde vücut hücrelerine girebilmekte ve sağlık üzerinde olumsuz etkilere neden olabilmektedir (Korani et.al., 2015).

Mikroorganizmalar tarafından gıda kontaminasyonu tüketiciler, üreticiler ve distribütörler için önemli bir sorundur. Uçucu yağlar (EO'lar) gibi doğal antimikrobiyal ajanlar, gıda korumaya etkili ve güvenli bir alternatif yaklaşım olarak son yıllarda artan ilgi görmüştür (Dehkordi et.

al., 2019). Gıda kaynaklı patojenler ve oksidasyon, gıda hazırlama ve saklama sırasında kalite özelliklerini etkileyen önemli iki etken faktördür (Chen and Park, 2016; Li et al., 2017). Özellikle oksidasyona duyarlı bazı gıdalar için yiyecekleri taze tutmayı ve saklama sürelerini uzatmayı amaçlayan fonksiyonel gıda ambalajlarına olan ilgi artmaktadır. Biyolojik olarak parçalanabilir filmler ve bir tür aktif gıda ambalajı olarak kaplamalar gerçek gıda koruma sistemlerine uygulanmaktadır (Umagiliyage et al., 2017). Bununla birlikte, kaplama formülasyonları için genel malzemeler, polisakkaritler (kitosan gibi) ve proteinlerdir. Böylece kaplamalarda kullanılan malzemeler antioksidan veya antimikrobiyal özelliklerden sadece bir özellik gösterir. Bu nedenle, her iki aktiviteye de sahip kompozit malzeme çalışmaları devam etmektedir (Wu, et al., 2019). Gümüş nanopartiküller (AgNP'ler), geniş spektrumlu mükemmel antimikrobiyal ajanlardır (Hartemann et al., 2015), ancak küçük boyutları ve kolay sızıntıları nedeniyle gıdalardaki uygulamaları sınırlıdır (Kaiser et al., 2017).

6. NANO GÜMÜŞ VE TOKSİSİTESİ

Gümüş toksisitesi üzerine yapılan çalışmalar absorpsiyon, inhalasyon ve ekskresyon; in-vivo toksisite; ve in vitro toksisite çalışmaları olmak üzere üç gruba ayrılabilir: bazı in vitro çalışmalar, gümüşün memeli hücreleri için toksik olduğunu göstermekte, ancak hücrelerin tepkisi hücre tipine ve onlarla temas halindeki gümüşün formuna göre farklı olabilmektedir (Fewtrell, 2014). ayrıca özellikle içme suyu kaynaklarında gümüş varlığı gümüşün etkilerine bakterilerden çok daha savunmasız olan belirli deniz canlılarını (örneğin karidesler, yengeçler, istakozlar ve kerevitler gibi kabuklular) tehlikeye atarak, potansiyel bir ekolojik zarara sebebiyet vermektedir (Rezvani et.al., 2019).

Gümüş nanopartiküllerin çeşitli bakteri türleri üzerindeki toksisitesi tartışılmaktadır. Bununla birlikte, kullanılan çeşitli sentez yöntemleri ve kaplama maddeleri doğrudan ve anlamlı karşılaştırmaları zorlaştırabilmektedir. Bu sebeple, farklı bakteri türlerinin yanı sıra aynı türden olsalar bile karşılaştırılma yapılması uygun olmayabilir (Varner et.al., 2010).

Wang *et.al.* (2010), gümüşün *Shewanella oneidensis*'in anaerobik kültürlerinin metabolizması üzerindeki etkisini araştırmış ve *S. oneidensis* MR-1'in çözeltideki toksik gümüş iyonlarını elementel nano gümüş parçacıklarına indirgelediğini bulmuşlardır, bu daha sonra X-ışını kırınım analizleri kullanılarak onaylanmıştır. Düşük gümüş iyon konsantrasyonlarının (1 ila 50 μM) büyüme üzerinde sınırlı bir etkiye sahipken, daha yüksek iyon konsantrasyonlarının (100 μM) hem bükme süresini hem de hücre verimini düşürdüğü bildirilmiştir. aynı çalışmada daha yüksek konsantrasyonda, gümüş nanopartiküllerin hücre içinde biriktiğini, daha düşük konsantrasyonlarda ise nanopartiküllerin hücre duvarının dışında özel olarak indirgenmiş ve çökelmiş olduğunu bildirmişlerdir. Tüm organizma metaboliti çeşitli gümüş konsantrasyonlarında büyütülen hücrelerin Fourier dönüşümü kızılötesi spektroskopi analizi yöntemini kullanarak, daha yüksek gümüş konsantrasyonlarında önemli fizyolojik değişiklikler olduğunu belirtmişlerdir (Wang *et.al.* (2010).

Gümüş nanopartiküllerin, çoklu etki mekanizmaları nedeniyle gram pozitif ve gram negatif bakterileri için oldukça toksik olduğu bildirilmiştir. Gümüş nanopartiküllerin küçük boyutları ve yüzey hacim oranlarının büyük olması, bu partiküllerin mikroorganizmalarla temas etmelerini kolaylaştırıp antimikrobiyal aktivite oluşturmaktadır (Pérez-Díaz et. al., 2016; Prabhu and Poulouse, 2012). Bu durumda, gümüş nanopartiküller hücresel zarlara saldırmakta ve zarar aktivitesini durdurmaktadır. Metal nanopartiküller ayrıca kükürt içeren proteinlerle etkileşime girerek DNA gibi fosfor içeren bileşiklere zarar vermektedir (Allahverdiyev et. al., 2011).

Lok *et.al.* (2006) son zamanlarda nanogümüşün *E. coli* üzerindeki etkisini proteomik kullanarak ve membran özelliklerini ölçerek belirledikleri çalışmada gümüşün etki mekanizmasının proton hareket kuvvetinin bozulması ve oksidatif fosforilasyonun ayrıştırılmasıyla sonuçlanan hücre içi ATP kaybına yol açtığı gözlemlenmiş ve nanogümüşün etkili konsantrasyonunun Ag^+ iyonlarından önemli ölçüde daha düşük olduğu bildirilmiştir.

Çevrede bulunma potansiyeline sahip tüm gümüş türleri arasında, literatürdeki toksikolojik verilerin çoğu yalnızca en yaygın iki biçimi için mevcuttur. Bunlardan birincisi temel gümüş (Ag^0) ve diğeri tek değerlikli gümüş iyonu (Ag^+)'dur. Gümüş, tıbbi, antibakteriyel ve antiviral özellikleri nedeniyle yüzlerce yıldır yaygın olarak kullanılmasına rağmen, literatürde toksisitesi hakkında nispeten sınırlı bilgi bulunmaktadır. Mevcut çevre ve insan çalışmaları, bazı gümüş biçimlerinin, özellikle de serbest gümüş iyonlarını (Ag) ayıran ve serbest bırakanların diğerlerinden daha toksik olduğunu göstermektedir. Birçok araştırmacı, gümüş içeren materyallerin toksik etkilerinin (özellikle akut) tek değerlikli gümüş iyonlarının salınım hızı ile doğru orantılı olduğunu öne sürmektedir (Varner *et.al.*, 2010).

Drake and Hazelwood (2005), metalik gümüşün sağlık için minimum risk oluşturduğunu, bunun aksine çözünür gümüş bileşiklerinin daha kolay emildiğini ve dolayısıyla olumsuz etkiler üretme potansiyeline sahip olduğunu göstermişlerdir. Bazı çalışmalar, 1 gramdan daha düşük gümüş konsantrasyonuna maruz kalan türlerde gümüş birikiminin büyüme üzerinde olumsuz etkilere yol açabileceğini göstermiştir (Eisler, 1996). Diğer araştırmalar, özellikle ortamdaki Ag^+ iyonlarının konsantrasyonlarının toksisiteye yol açamayacak kadar düşük olduğunu göstermiştir (WHO, 2002).

Farklı gümüş nanopartiküllerin özellikleri, toksisite seviyelerinde ve baskın etki mekanizmalarında önemli rol oynamaktadır. Genel olarak gümüş nanopartiküller, zebrafish embriyoları (*Danio rerio*) için gümüş iyonlarından daha az toksik olmaktadır. Polivinilpirolidon ile stabilize edilmiş gümüş nanopartiküllerine maruz bırakılmış zebra balığı embriyoları için 96 saatte LC_{50} değeri, 100 mg/L nin üzerinde olup uygulama grupları arasında çoğu ekspozisyonda farklılık olmazken larva çıkış oranlarında azalma belirlenmiştir (Caloudova *et al.*, 2018). Yine zebra balığı embriyolarında yapılan bir çalışmada gümüş nanopatiklere ($AgNP$ 'ler) maruz bırakılan embriyolarda Ca^{2+} sinyalinin aşağı regüle edildiği ve miyojenik lokusa özgü DNA metilasyonu yoluyla, miyofibril montaj ve sarkomer oluşumunda kusurlara neden olduğu daha sonra kalp atışında azalma ve davranış bozukluklarına neden olabileceğini bildirilmiştir (Xu *et al.*, 2018). Gümüş nanopartiküllerin yara iyileşmesi sürecindeki güvenliği henüz aydınlatılmamıştır; yine de biyolojik uyumluluk birincil husustur ve biyolojik olarak uyumlu gümüş nanopartiküllerin *in vivo* yara iyileşme sürecinde etkinliği belirlenmiştir (Parveen *et al.*, 2018). Seo *et al.*, (2017) yapmış olduğu çalışma, $AgNP$ 'lerin yara iyileşmesinin hızlanmasında etkili olduğunu belirtmişlerdir. Siçan trakeal epitel hücrelerinde (RTE) $AgNP$ 'lerin bariz sitotoksositeye, oksidatif strese ve apoptoza neden olduğunu, bu da sitokrom C ve pro-apoptotik proteinlerin kaspaz kademesini aktive etmek için sitoplazmaya salınmasını teşvik ettiğini ve sonunda apoptoza yol açtığını göstermiştir (Tang *et al.*, 2019).

Çok geniş ve kapsamlı bir alan olarak karşımıza çıkan nanoteknoloji, alanında hala oldukça büyük boşluklar bulunmaktadır. Bu alanda en çok dikkat çeken nano partiküller altın ve gümüş olmaktadır. Bu nano partiküller arasında gümüş, hem ekonomik açıdan hem de insan sağlığı üzerine etkinliği açısından daha çok kullanıldığı ve araştırıldığı görülmüştür. Gümüş nano partikülleri, gün geçtikçe çok fazla alanda farklı şekillerde sentezlenerek kullanılmaya başlanmıştır. Bu nanopartikülün insan sağlığı üzerine faydaları ve aynı zamanda toksik etkileri tam olarak belirlenememiştir. Yapılan çalışmalar incelendiğinde, gümüş nanopartiküllerin yararlı yönlerinin çok daha kapsamlı çalışmalar ile model canlılarda farklı fizyolojik süreçlerde (organ, doku ve hücre seviyesinde) incelenmesi gerektiği görülmüştür. Bu araştırma

kapsamının amacı, nanogümüş üzerine yapılan çalışmalarını bir araya getirerek daha ileri boyutlu in vitro, in vivo ve klinik araştırmalara katkı sağlamaktır.

KAYNAKLAR

1. Abbasi, E., Milani, M., Fekri Aval, S., Kouhi, M., Akbarzadeh, A., Tayefi Nasrabadi, H., Nikasa, P., Joo, S.J., Hanifehpour, Y., Nejati-Koshki, K., Samiei, M. (2016). Silver nanoparticles: synthesis methods, bio-applications and properties. *Critical reviews in microbiology*, 42(2), 173-180.
2. Ahmad, A., Mukherjee, P., Senapati, S., Mandal, D., Khan, M. I., Kumar, R., Sastry, M. (2003). Extracellular biosynthesis of silver nanoparticles using the fungus *Fusarium oxysporum*. *Colloids and surfaces B: Biointerfaces*, 28(4), 313-318.
3. Ahmad, S., Munir, S., Zeb, N., Ullah, A., Khan, B., Ali, J., Bilal, M., Ömer, M., Salman, S. M., Ali, S. (2019). Green nanotechnology: a review on green synthesis of silver nanoparticles—an ecofriendly approach. *International journal of nanomedicine*, 14, 5087.
4. Ahmed, S., Ahmad, M., Swami, B. L., Ikram, S. (2016). A review on plants extract mediated synthesis of silver nanoparticles for antimicrobial applications: a green expertise. *Journal of advanced research*, 7(1), 17-28.
5. Allahverdiyev, A. M., Kon, K. V., Abamor, E. S., Bagirova, M., Rafailovich, M. (2011). Coping with antibiotic resistance: combining nanoparticles with antibiotics and other antimicrobial agents. *Expert review of anti-infective therapy*, 9(11), 1035-1052.
6. Bai, J., Li, Y., Du, J., Wang, S., Zheng, J., Yang, Q., Chen, X. (2007). One-pot synthesis of polyacrylamide-gold nanocomposite. *Materials Chemistry and Physics*, 106(2-3), 412-415.
7. Bakand, S., Hayes, A. (2016). Toxicological considerations, toxicity assessment, and risk management of inhaled nanoparticles. *International journal of molecular sciences*, 17(6), 929.
8. Caloudova, H., Hodkovicova, N., Sehonova, P., Blahova, J., Marsalek, B., Panacek, A., Svobodova, Z. (2018). The effect of silver nanoparticles and silver ions on zebrafish embryos (*Danio rerio*). *Neuroendocrinology Letters*, 39(4).
9. Catauro, M., Raucci, M. G., De Gaetano, F., Marotta, A. (2004). Antibacterial and bioactive silver-containing $\text{Na}_2\text{O} \cdot \text{CaO} \cdot 2\text{SiO}_2$ glass prepared by sol-gel method. *Journal of Materials Science: Materials in Medicine*, 15(7), 831-837.
10. Chen, J., Park, B. (2016). Recent advancements in nanobioassays and nanobiosensors for foodborne pathogenic bacteria detection. *Journal of food protection*, 79(6), 1055-1069.
11. Crabtree, J. H., Burchette, R. J., Siddiqi, R. A., Huen, I. T., Hadnott, L. L., Fishman, A. (2003). The efficacy of silver-ion implanted catheters in reducing peritoneal dialysis-related infections. *Peritoneal Dialysis International*, 23(4), 368-374.
12. Dehkordi, N. H., Tajik, H., Moradi, M., Kousheh, S. A., Molaei, R. (2019). Antibacterial interactions of colloid nanosilver with eugenol and food ingredients. *Journal of food protection*, 82(10), 1783-1792.
13. Drake, P. L., Hazelwood, K. J. (2005). Exposure-related health effects of silver and silver compounds: a review. *The Annals of occupational hygiene*, 49(7), 575-585.

14. Durán, N., Marcato, P. D., Alves, O. L., De Souza, G. I., Esposito, E. (2005). Mechanistic aspects of biosynthesis of silver nanoparticles by several *Fusarium oxysporum* strains. *Journal of nanobiotechnology*, 3(1), 8.
15. Durán, N., Marcato, P. D., De Souza, G. I., Alves, O. L., Esposito, E. (2007). Antibacterial effect of silver nanoparticles produced by fungal process on textile fabrics and their effluent treatment. *Journal of biomedical nanotechnology*, 3(2), 203-208.
16. Eisler, R. (1996). *Silver hazards to fish, wildlife, and invertebrates: a synoptic review* (No. 32). US Department of the Interior, National Biological Service.
17. Evanoff, D. D., Chumanov, G. (2004). Size-controlled synthesis of nanoparticles. 2. Measurement of extinction, scattering, and absorption cross sections. *The Journal of Physical Chemistry B*, 108(37), 13957-13962.
18. Ferdous, Z., Nemmar, A. (2020). Health Impact of Silver Nanoparticles: A Review of the Biodistribution and Toxicity Following Various Routes of Exposure. *International Journal of Molecular Sciences*, 21(7), 2375.
19. Gurav, A. S., Kodas, T. T., Wang, L. M., Kauppinen, E. I., Joutsensaari, J. (1994). Gas-phase particle size distributions during vapor condensation of fullerenes. *Nanostructured materials*, 4(5), 491-496.
20. Hartemann, P., Hoet, P., Proykova, A., Fernandes, T., Baun, A., De Jong, Juliane Filser, Hensten, A., Kneuer, C., Maillard, J.Y., Norppa, H., Scheringer, M., Wijnhoven, S. (2015). Nanosilver: Safety, health and environmental effects and role in antimicrobial resistance. *Materials Today*, 18(3), 122-123.
21. Hickey, B. 2017. WHO GAP AMR Newsletter No. 20: Implementation of the global action plan on antimicrobial resistance.
22. Husen, A., Siddiqi, K. S. (2014). Phytosynthesis of nanoparticles: concept, controversy and application. *Nanoscale research letters*, 9(1), 229.
23. Hussain, I., Brust, M., Papworth, A. J., Cooper, A. I. (2003). Preparation of acrylate-stabilized gold and silver hydrosols and gold-polymer composite films. *Langmuir*, 19(11), 4831-4835.
24. Iravani, S., Korbekandi, H., Mirmohammadi, S. V., Zolfaghari, B. (2014). Synthesis of silver nanoparticles: chemical, physical and biological methods. *Research in pharmaceutical sciences*, 9(6), 385.
25. Jung, J. H., Oh, H. C., Noh, H. S., Ji, J. H., Kim, S. S. (2006). Metal nanoparticle generation using a small ceramic heater with a local heating area. *Journal of aerosol science*, 37(12), 1662-1670.
26. Kaiser, J. P., Roesslein, M., Diener, L., Wichser, A., Nowack, B., Wick, P. (2017). Cytotoxic effects of nanosilver are highly dependent on the chloride concentration and the presence of organic compounds in the cell culture media. *Journal of nanobiotechnology*, 15(1), 1-11.
27. Klevens, R. M., Morrison, M. A., Nadle, J., Petit, S., Gershman, K., Ray, S., Harrison, L.H. Lynfield, R., Dumyati, G., Townes, J.M., Craig, A.S., Zell, E.R., Fosheim, G.E., McDougal, L.K., Carey, R.B., Fridkin, S.K. 2007. Investigators for the Active Bacterial Core surveillance (ABCs) MRSA Investigators. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA*, 298, 1763-1771.

28. Korani, M., Ghazizadeh, E., Korani, S., Hami, Z., Mohammadi-Bardbori, A. (2015). Effects of silver nanoparticles on human health. *European Journal of Nanomedicine*, 7(1), 51-62.
29. Kowshik, M., Deshmukh, N., Vogel, W., Urban, J., Kulkarni, S. K., Paknikar, K. M. (2002). Microbial synthesis of semiconductor CdS nanoparticles, their characterization, and their use in the fabrication of an ideal diode. *Biotechnology and bioengineering*, 78(5), 583-588.
30. Kruis, F. E., Fissan, H., Rellinghaus, B. (2000). Sintering and evaporation characteristics of gas-phase synthesis of size-selected PbS nanoparticles. *Materials Science and Engineering: B*, 69, 329-334.
31. Leela, A., Vivekanandan, M. (2008). Tapping the unexploited plant resources for the synthesis of silver nanoparticles. *African Journal of Biotechnology*, 7(17).
32. Li, Q., Mahendra, S., Lyon, D. Y., Brunet, L., Liga, M. V., Li, D., Alvarez, P. J. (2008). Antimicrobial nanomaterials for water disinfection and microbial control: potential applications and implications. *Water research*, 42(18), 4591-4602.
33. Li, Y., Liu, H., Han, Q., Kong, B., Liu, Q. (2017). Cooperative antioxidative effects of zein hydrolysates with sage (*Salvia officinalis*) extract in a liposome system. *Food chemistry*, 222, 74-83.
34. Lok, C.-N., Ho, C.-M., Chen, R., He, Q.-Y., Yu, W.-Y., Sun, H., Tam, P.K.-H., Chiu, J.-F., Che, C.-M. 2006. Proteomic analysis of the mode of antibacterial action of silver nanoparticles. *J. Proteome Res.* 5, 916-924.
35. Lokina, S., Stephen, A., Kaviyaran, V., Arulvasu, C., Narayanan, V. (2014). Cytotoxicity and antimicrobial activities of green synthesized silver nanoparticles. *European journal of medicinal chemistry*, 76, 256-263.
36. Mafuné, F., Kohno, J. Y., Takeda, Y., Kondow, T., Sawabe, H. (2000). Formation and size control of silver nanoparticles by laser ablation in aqueous solution. *The Journal of Physical Chemistry B*, 104(39), 9111-9117.
37. Magiorakosa, A. P., Srinivasan, A., Carey, R. B., Carmeli, Y., Falagasde, M. E., Giskef, C.G., Harbarthg, S., Hindlerh, J.F., Kahlmeteri, G., Olsson-Liljequist, B., Patersonk, D.L., Ricel, L.B., Stellingm, J., Struelensa, M.J., Vatopoulosn, A., Weberb, J.T., Monneta, D.L., (2012). Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. *Clinical microbiology and infection*, 18(3), 268-281.
38. Magnusson, M. H., Deppert, K., Malm, J. O., Bovin, J. O., Samuelson, L. (1999). Gold nanoparticles: production, reshaping, and thermal charging. *Journal of Nanoparticle Research*, 1(2), 243-251.
39. Mousavi, S. M., Hashemi, S. A., Ghasemi, Y., Atapour, A., Amani, A. M., Savar Dashtaki, A., Babapoor, A., Arjmand, O. (2018). Green synthesis of silver nanoparticles toward bio and medical applications: review study. *Artificial cells, nanomedicine, and biotechnology*, 46(sup3), S855-S872.
40. Mukherjee, P., Ahmad, A., Mandal, D., Senapati, S., Sainkar, S. R., Khan, M. I., Parishcha, R., Ajaykumar, P. V., Alam, M., Kumar, R., Sastry, M. (2001). Fungus-mediated synthesis of silver nanoparticles and their immobilization in the mycelial matrix: a novel biological approach to nanoparticle synthesis. *Nano letters*, 1(10), 515-519.

41. Nanda, A., Saravanan, M. (2009). Biosynthesis of silver nanoparticles from *Staphylococcus aureus* and its antimicrobial activity against MRSA and MRSE. *Nanomedicine: Nanotechnology, Biology and Medicine*, 5(4), 452-456.
42. Nordmann, P. (2014). Carbapenemase-producing Enterobacteriaceae: overview of a major public health challenge. *Medecine et maladies infectieuses*, 44(2), 51-56.
43. Nordmann, P., Poirel, L. (2014). The difficult-to-control spread of carbapenemase producers among Enterobacteriaceae worldwide. *Clinical Microbiology and Infection*, 20(9), 821-830.
44. Parveen, A., Kulkarni, N., Yalagatti, M., Abbaraju, V., Deshpande, R. (2018). In vivo efficacy of biocompatible silver nanoparticles cream for empirical wound healing. *Journal of tissue viability*, 27(4), 257-261.
45. Pérez-Díaz, M., Alvarado-Gomez, E., Magaña-Aquino, M., Sánchez-Sánchez, R., Velasquillo, C., Gonzalez, C., Ganem-Rondero, A., Martínez-Castañón, G., Zavala-Alonso, N., Martínez-Gutierrez, F. (2016). Anti-biofilm activity of chitosan gels formulated with silver nanoparticles and their cytotoxic effect on human fibroblasts. *Materials Science and Engineering: C*, 60, 317-323.
46. Prabhu, S., Poulouse, E. K. (2012). Silver nanoparticles: mechanism of antimicrobial action, synthesis, medical applications, and toxicity effects. *International nano letters*, 2(1), 32.
47. Randall, C. P., Gupta, A., Jackson, N., Busse, D., O'Neill, A. J. (2015). Silver resistance in Gram-negative bacteria: a dissection of endogenous and exogenous mechanisms. *Journal of Antimicrobial Chemotherapy*, 70(4), 1037-1046.
48. Rezvani, E., Rafferty, A., McGuinness, C., Kennedy, J. (2019). Adverse effects of nanosilver on human health and the environment. *Acta Biomaterialia*, 94, 145-159.
49. Robert, W. (1988). *Handbook of chemistry and physics* (Vol. 540, No. W376h Ej. 1). CRC Press,.
50. Seltenrich, N. (2013). Nanosilver: weighing the risks and benefits.
51. Seo, S. B., Dananjaya, S. H. S., Nikapitiya, C., Park, B. K., Gooneratne, R., Kim, T. Y., Lee, J., Kim, C.H., De Zoysa, M. (2017). Silver nanoparticles enhance wound healing in zebrafish (*Danio rerio*). *Fish & shellfish immunology*, 68, 536-545.
52. Shahverdi, A. R., Minaeian, S., Shahverdi, H. R., Jamalifar, H., Nohi, A. A. (2007). Rapid synthesis of silver nanoparticles using culture supernatants of Enterobacteria: a novel biological approach. *Process Biochemistry*, 42(5), 919-923.
53. Sharma, V. K., Sayes, C. M., Guo, B., Pillai, S., Parsons, J. G., Wang, C., Yan, B., Ma, X. (2019). Interactions between silver nanoparticles and other metal nanoparticles under environmentally relevant conditions: A review. *Science of The Total Environment*, 653, 1042-1051.
54. Siddiqi, K. S., Husen, A. (2016)a. Fabrication of metal and metal oxide nanoparticles by algae and their toxic effects. *Nanoscale research letters*, 11(1), 363.
55. Siddiqi, K. S., Husen, A. (2016)b. Fabrication of metal nanoparticles from fungi and metal salts: scope and application. *Nanoscale research letters*, 11(1), 98.

56. Silver, S. (2003). Bacterial silver resistance: molecular biology and uses and misuses of silver compounds. *FEMS microbiology reviews*, 27(2-3), 341-353.
57. Silver, S., Gupta, A., Matsui, K., Lo, J. F. (1999). Resistance to Ag (I) cations in bacteria: environments, genes and proteins. *Metal-based drugs*, 6(4-5), 315-320.
58. Syafiuddin, A., Salim, M. R., Beng Hong Kueh, A., Hadibarata, T., Nur, H. (2017). A review of silver nanoparticles: Research trends, global consumption, synthesis, properties, and future challenges. *Journal of the Chinese Chemical Society*, 64(7), 732-756.
59. Sylvestre, J. P., Kabashin, A. V., Sacher, E., Meunier, M., Luong, J. H. (2004). Stabilization and size control of gold nanoparticles during laser ablation in aqueous cyclodextrins. *Journal of the American Chemical Society*, 126(23), 7176-7177.
60. Tang, J., Lu, X., Chen, B., Cai, E., Liu, W., Jiang, J., Chen, F., Shan, X., Zhang, H. (2019). Mechanisms of silver nanoparticles-induced cytotoxicity and apoptosis in rat tracheal epithelial cells. *The Journal of toxicological sciences*, 44(3), 155-165.
61. Tsuji, T., Kakita, T., Tsuji, M. (2003). Preparation of nano-size particles of silver with femtosecond laser ablation in water. *Applied Surface Science*, 206(1-4), 314-320.
62. Umagiliyage, A. L., Becerra-Mora, N., Kohli, P., Fisher, D. J., Choudhary, R. (2017). Antimicrobial efficacy of liposomes containing d-limonene and its effect on the storage life of blueberries. *Postharvest Biology and Technology*, 128, 130-137.
63. Valizadeh, H., Mohammadi, G., Ehyaei, R., Milani, M., Azhdarzadeh, M., Zakeri-Milani, P., Lotfipour, F. (2012). Antibacterial activity of clarithromycin loaded PLGA nanoparticles. *Die Pharmazie-An International Journal of Pharmaceutical Sciences*, 67(1), 63-68.
64. Vance, M. E., Kuiken, T., Vejerano, E. P., McGinnis, S. P., Hochella Jr, M. F., Rejeski, D., Hull, M. S. (2015). Nanotechnology in the real world: Redeveloping the nanomaterial consumer products inventory. *Beilstein journal of nanotechnology*, 6(1), 1769-1780.
65. Varner, K., Sanford, J., El-Badawy, A., Feldhake, D., Venkatapathy, R. (2010). State of the science literature review: everything nanosilver and more. *US Environmental Protection Agency, Washington DC*, 363. Fewtrell, L. (2014). Silver: water disinfection and toxicity. *Aberystwyth University, Aberystwyth*.
66. Wang, H., Law, N., Pearson, G., Van Dongen, B. E., Jarvis, R. M., Goodacre, R., Lloyd, J. R. (2010). Impact of silver (I) on the metabolism of *Shewanella oneidensis*. *Journal of bacteriology*, 192(4), 1143-1150.
67. Wei, L., Lu, J., Xu, H., Patel, A., Chen, Z. S., Chen, G. (2015). Silver nanoparticles: synthesis, properties, and therapeutic applications. *Drug discovery today*, 20(5), 595-601.
68. Who. World Health Organization. (2002). *Silver and silver compounds: environmental aspects*. World Health Organization.
69. Wiley, B., Sun, Y., Mayers, B., Xia, Y. (2005). Shape-controlled synthesis of metal nanostructures: the case of silver. *Chemistry—A European Journal*, 11(2), 454-463.
70. Williams, D. (2008). The relationship between biomaterials and nanotechnology. *Biomaterials*, 29(12), 1737.

71. Wu, Z., Zhou, W., Pang, C., Deng, W., Xu, C., Wang, X. (2019). Multifunctional chitosan-based coating with liposomes containing laurel essential oils and nanosilver for pork preservation. *Food chemistry*, 295, 16-25.
72. Xu, Q. H., Guan, P., Zhang, T., Lu, C., Li, G., Liu, J. X. (2018). Silver nanoparticles impair zebrafish skeletal and cardiac myofibrillogenesis and sarcomere formation. *Aquatic Toxicology*, 200, 102-113.
73. Zhang, X. F., Liu, Z. G., Shen, W., Gurunathan, S. (2016). Silver nanoparticles: synthesis, characterization, properties, applications, and therapeutic approaches. *International journal of molecular sciences*, 17(9), 1534.

THE EFFECTS AND MANAGEMENT OF ENVIRONMENTAL POLLUTION ORIGINATING FROM ELECTROMAGNETIC FIELDS

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ABSTRACT

Industrial production activities, which are accelerated and becoming prevalent worldwide due to industrialization, also bring about several problems associated with environmental pollution. With the disruption in natural balances, humanity is constantly encountering various forms of environmental pollution that constitute a threat to living beings and the continuation of life. In recent years, electromagnetic pollution, which is considered to be among new-generation environmental pollution forms, has started to be viewed as one of the most significant environmental problems especially regarding its potential effects, the prevalence of its sources and the place of these sources in our lives.

An electromagnetic field, which is also accepted to be electromagnetic pollution with the extent it has reached today, is a reality in our lives which consists of an electric field and a magnetic field and is in place in generally every environment involving electricity. Besides all these issues, the fact that the Earth has a substantial magnetic field and the release of electromagnetic radiation from the Sun in the form of heat and light show that electromagnetic fields are a part of the life within the balance of nature. Nevertheless, this situation has reached the level of pollution with the inclusion of artificial sources of electromagnetic fields developed by people in the daily lives of the people of our era. In general, all types of electric and electronic devices from cell phones to computers and from televisions to ovens that we use, large-scale power distribution lines, telecommunication lines and similar sources produce electromagnetic fields, and the artificial radiation that is produced by these sources has surrounded us in the form of a complex and dense web. The effects of electromagnetic pollution on living beings and health problems that will be caused by the prolonged exposure of people to this pollution cannot be completely explained yet. However, albeit not exactly proven, the fact that devices affect each other while working in a way that we can notice, and malfunctions originating from electromagnetic interference occur in aeronautic, medical and military systems are the most significant indicator that electromagnetic pollution could also have strong effects on biological systems.

Keywords: Electromagnetic field, Electromagnetic shielding, Interference, Pollution.

1. INTRODUCTION

Mankind, like all other living beings on earth, has been in a constant struggle. For quite a long time, the primary goal of this struggle has been to survive healthfully and preserve continuity. However, especially with the development of industrial production, it is apparent that the goals and methods have changed greatly. The main reason for this is the concept of need, which changes and expands over time depending on production. The basic approaches that now dominate the perspective on nature and life all over the world progress with the focus on needs and production. However, environmental health and the natural balances that are constantly ignored in this approach cause problems that grow and become more complex with each passing

day. Therewith, mankind is exposed to various types of pollution that threaten his health and the continuity of his daily life. Some of these are pollution resulting from activities that have been going on for a very long time. Depending on the time, both researches and the accumulation of knowledge about the results, or the fact that their effects occur easily or in a short time, make it easier to understand and accept these types of pollution. Furthermore, it can be seen that, in changing living conditions depending on the constantly developing science and the knowledge produced, various types of pollution also arise, the effects of which are not easy to understand in a short time. Electromagnetic pollution, accepted in recent years as a new generation pollution, has begun to be considered as one of the most important environmental problems, especially with its potential effects, prevalence of sources and place in our lives. One of the most important and distinguishing features of this new generation pollution to which we are constantly exposed in our daily lives is that it cannot be perceived consciously. Electrical electronic devices, equipment and tools, which have become an indispensable part of today's comfortable life, are a source of electromagnetic pollution, depending on the electromagnetic field they generate. This is an obvious sign that the pollution in question is a consequence of the level of technology that has been achieved, and that the technology that makes life easier for humanity will also be the source of many problems that need to be addressed.

Given the widespread of electromagnetic pollution and the point it has reached; it becomes necessary to address the problem with an international management approach. This approach fundamentally requires a detailed assessment of electromagnetic energy, especially its properties, sources, effects, levels of influence and methods of protection. It should be known that all parties, including authorities/managers, producers and consumers, have responsibilities in handling and solving the problem. It is precisely in this process, in which technological development and production are taking place faster than ever, that it is a great necessity to reflect on the safety of technology. It turns out that an effective fight will only happen with device user awareness and demands for safer or green technology. Because in the current situation, it is believed that the main requirements of the information society are to build a communication infrastructure that can provide high-speed data transmission, reliable and numerous wireless connections. It should not be forgotten, however, that people have the right to live in a healthy environment, as well as the responsibility to create that healthy environment (McLean 2011, Lin *et al.* 2017). From this point on, what needs to be done in the short term includes the fact that everyone needs to be sensitive, and a general framework should be set to avoid unnecessary exposure, at least through individual efforts and national and international safeguards for the side of the problem that goes beyond the individual. Later on, accelerating the studies to determine the exposure limits and developing effective standards against wide-ranging and long-term exposures by establishing the relevant legal infrastructure are of great importance. Later, the acceleration of studies to determine exposure limits and the development of effective standards against widespread and long-term exposures through the creation of the appropriate legal infrastructure are of great importance. It must be remembered that, and only in this way, can magnetic pollution be struggled and a safe technological development approach adopted.

2. ELECTROMAGNETIC FIELD AND ITS EFFECTS

The electromagnetic field is a fact consisting of an electric and magnetic field to which people are not consciously aware of being exposed but react biologically, and which is thought to have an effect on living life like gravity. The origin of all assessments about the electromagnetic field is the fact that the earth has a large magnetic field and the sun emits electromagnetic radiation as heat and light. So it is indeed another fact that the electromagnetic field, which is a part of

life in natural equilibrium, is a threat to human and environmental health under present conditions and has the potential to increase problems. The main reason for this situation is that most of the devices that use, transmit, process and distribute electricity are artificial sources of electromagnetic fields and they now become too widespread for biological systems to tolerate.

In a general sense, the electromagnetic field is created by the activation of the electric field when devices are connected to a power source and the activation of the magnetic field when devices are operated (with the passing of electric current). As indicated in the individual preventive measures, the strength of both fields decreases with increasing distance from the source or vice versa. While the electric field can be easily blocked by most materials, strongly penetrating magnetic fields are difficult to block (Balmori 2009, McLean 2011, Pandey *et al.* 2019, Rea and Patel 2019). The electromagnetic field and its effects are discussed in relation to the properties of electromagnetic waves. The range of frequencies and wavelengths for electromagnetic waves, which have interrelated physical properties such as frequency, wavelength, and photon energy, allow us to categorize electromagnetic waves and position them on the electromagnetic spectrum. As shown in Figure 1, the electromagnetic spectrum is divided into regions with different names, depending on the frequency band. The radiation regions on the spectrum are ordered according to their high or low of the frequencies and energies, which vary inversely with wavelength. A longer wavelength means a lower frequency and energy, and a shorter wavelength means a higher frequency and energy. In addition, on the spectrum radio waves, microwaves, infrared, visible light, and some part of ultraviolet rays constitute the region of non-ionizing radiation, while high-energy ultraviolet, X-ray, and gamma rays constitute the region of ionizing radiation. The sources of artificial electromagnetic waves to which we are much exposed in our daily life, such as mobile phones, household electrical appliances, Wi-Fi, base stations, wireless power transmission systems, radio, television, security systems, 5G technology, microwave ovens, satellites, etc. are located in the region up to 300 GHz frequency band (Albini *et al.* 2003, McLean 2011, Calabro 2018, Pandey *et al.* 2019, Rea and Patel 2019, Surducan *et al.* 2020, Wongkasem 2021). In this non-ionizing zone, the radiation does not carry enough energy to remove electrons. However, this does not mean that the radiation in the area in question is harmless. Although it is known that they can affect the structures they come across in various ways, the effects of the pollution they cause on living things and the future health problems caused by years of human exposure are not yet fully explained.

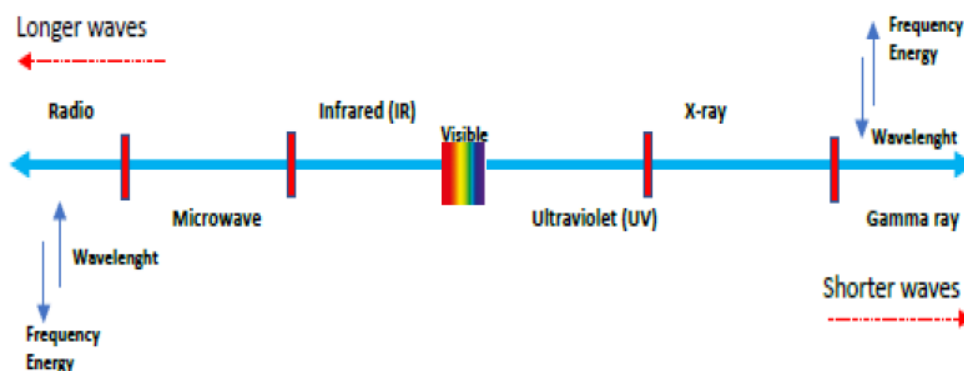


Figure 1. Electromagnetic spectrum

Research intensifying in parallel with the proliferation of artificial electromagnetic field sources is being carried out in a versatile way, from studies with animals and volunteers in laboratories

to epidemiological studies with large populations (McLean 2011, Ionut 2014, Lin *et al.* 2017, Rea and Patel 2019). There are also studies in the literature, albeit few, that examine its effects on wildlife and plants. In these studies, it is stated that the nervous, immune, cardiovascular and reproductive systems may be affected depending on the wavelength, exposure time and dose, especially in chronic exposures to wireless telecommunication systems (Balmori 2009, Dhama 2012, Lin *et al.* 2017). Although not fully proven, the fact that devices affect each other in operation, as we can also notice, and the malfunctions caused by electromagnetic interference on aeronautical, medical and military systems are the main indicators that they can have strong effects on biological systems (Yuan *et al.* 2014, Kulkarni *et al.* 2019, Wang *et al.* 2019, Wang *et al.* 2021).

3. MANAGEMENT OF ELECTROMAGNETIC POLLUTION

Today, all biological systems on Earth are surrounded by artificial radiation generated by countless devices, systems, and equipment, such as cell phones, computers, base stations, large power distribution lines, power cables, motors, electrical generators, magnetic resonance imaging equipments, security systems, GPS equipments, radios, radars, radio TV broadcast systems, satellites, automated environmental control systems, wireless telecommunications systems, personal electronics, and electrical appliances, etc. (Albini *et al.* 2003, Eovaldi and Eovaldi 2019, Wang *et al.* 2019, Wang *et al.* 2021). It is well known that the potential effects of these sources on living things will vary depending on the level of risk. However, although studies have shown that there are significant statistical relationships between diseases and exposures, these cannot yet be definitively explained (Dhama 2012, Calabro 2018). As a current environmental problem with many uncertainties, its management is therefore based on the precautionary principle. Multidimensional studies are needed to solve it, such as determining the effects and hazard levels on living beings through measurements and taking protective measures to minimize exposure.

The standards developed by the International Commission for Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE) are mostly effective in studies all over the world to determine limits. In particular, the exposure limits in different frequency bands established by ICNIRP and accepted by the World Health Organization (WHO) are form the basis for the national standards of many countries, including Turkey, England, Germany and Japan. Although the studies conducted by the two organizations are fundamentally similar, it is noted that the US and Canada are largely influenced by IEEE standards (McLean 2011, Galan-Jimenez and Chiaraviglio 2021).

Electromagnetic pollution requires a serious fight with determination and effort at national and international levels, as well as individual action to avoid unnecessary exposure. Exposure to intense electromagnetic fields, which is considered pollution because of its effects on the environment and human health, is also the cause of another problem, as electromagnetic interference. Manifesting itself as the effect of devices on each other while operating and the cause of interference and failures, this situation is viewed from a different angle due to sensitive equipment used in strategic areas such as aviation and the military (Kulkarni *et al.* 2019, Wang *et al.* 2019). This is the main reason for focusing on the development of protective materials against electromagnetic pollution. Reducing electromagnetic interference or problems by developing suitable and effective materials is also very important and a must from an industrial point of view. Electromagnetic shielding is based on the principle of reducing the penetration of radiation into certain areas by absorption or reflection (Mishra *et al.* 2013, Yuan *et al.* 2014, Kumar and Kaur 2018, Wang *et al.* 2021). For this purpose, metallic materials are usually used, which protect by reflection. However, the main disadvantages of metals such as high density,

susceptibility to corrosion, cost of production, poor mechanical flexibility, as well as secondary pollution caused by reflected electromagnetic waves, limit their use. Studies to develop materials that are efficient, lightweight, thin, flexible, low cost, easy to process, effective in a wide band, and capable of providing strong absorption in the high frequency region, therefore, attract great interest (Kulkarni *et al.* 2019, Wang *et al.* 2019, Wang *et al.* 2021).

4. CONCLUSION

Given the characteristics, sources and effects of electromagnetic pollution, which is recognised as a new generation pollution, it seen that it has great potential. The fact that daily life in modern societies depend on the sources of pollution in question, and that this dependence is increasing day by day, is an indicator of the difficulties that are or will be encountered in controlling and managing pollution too. All this also requires that the problem be addressed with an international management approach that involves all parties. Depending on the characteristics and distribution of pollution, authorities/managers, producers and consumers are considered as the responsible parties in managing this process. The fact that electromagnetic pollution is a current technology-based environmental problem also brings with it much uncertainty. This situation means that the process of management requires a much more serious and determined fight based on the precautionary principle. It is expected to be effective in designing the management process, minimizing the risks and accelerating the steps to solve the problem with balanced technological requirements, especially due to the increasing awareness and sensitivity of device users.

REFERENCES

1. Albin L, Burrascano P, Fiori S., 2003. A feasibility study for electromagnetic pollution monitoring by electromagnetic-source localization via neural independent component analysis. *Neurocomputing*, 55, 451-468.
2. Balmori A., 2009. Electromagnetic pollution from phone masts. Effects on wildlife. *Pathophysiology*, 16, 191-199.
3. Calabro E., 2018. Introduction to the Special Issue “Electromagnetic Waves Pollution” *Sustainability*, 10, 3326.
4. Dhama AK., 2012. Study of electromagnetic radiation pollution in an Indian city. *Environ Monit Assess.*, 184, 6507–6512.
5. Eovaldi BJ, Eovaldi Rj., 2019. Facile synthesis of coral cauliflower-like polypyrrole hemispheres toward screening electromagnetic interference pollution. *Environ. Pollut.*, 246, 122-123.
6. Galan-Jimenez J. Chiaraviglio L., 2021. Measuring the impact of ICNIRP vs. stricter-than-ICNIRP exposure limits on QoS and EMF from cellular networks. *Comput. Networks*, 187, 107824.
7. Ionut N., 2014. Electromagnetic pollution in urban areas. *International Conference and Exposition on Electrical and Power Engineering (EPE 2014)*, 16-18 October, Iasi, Romania.
8. Kulkarni G, Kandesar P, Velhal N, Kim H, Puri V., 2021. Facile synthesis of coral cauliflower-like polypyrrole hemispheres toward screening electromagnetic interference pollution. *J. Appl. Polym. Sci.*, 138, 22.

9. Kumar R, Kaur A. 2018. Effect of various reduction methods of graphene oxide on electromagnetic shielding performance of reduced graphene oxide against electromagnetic pollution in X-band frequency. *Mater. Today Commun.*, 16, 374-379.
10. Lin CC, Tsai CT, Deng DJ, Tsai IH, Jhong SY., 2017. Minimizing electromagnetic pollution and power consumption in green heterogeneous small cell network deployment. *Comput. Networks*, 129, 536-547.
11. McLean L., 2011. *The force living safely in a world of electromagnetic pollution*. Scribe Publications.
12. Mishra M, Singh AP, Dhawan SK., 2013. Expanded graphite-nanoferrite-fly ash composites for shielding of electromagnetic pollution. *J. Alloys Compd.*, 557, 244-251.
13. Wang Z, Fu X, Zhang Z, Jiang Y, Waqar M, Xie P, Bi K, Liu Y, Ying X, Fan R., 2019. Paper-based metasurface: Turning waste-paper into a solution electromagnetic pollution. *J. Cleaner Prod.*, 234, 588-596.
14. Wang, M, Tag XH, Cai, JH, Wu H, Shen JB, Guo SY., 2021. Fabrication, mechanisms and perspectives of conductive polymer composites with multiple interfaces for electromagnetic interference shielding: A review. *Carbon*, 177, 377-402.
15. Wongkasem N., 2021. Electromagnetic pollution alert: Microwave radiation and absorption in human organs and tissues. *Electromagn. Biol. Med.*, 40, 2, 236-253.
16. Pandey R, Tekumalla S, Gupta M., 2019. Magnesium-iron micro-composite for enhanced shielding of electromagnetic pollution. *Composites Part B*, 163, 150-157.
17. Rea WJ, Patel KD., 2019. *Air pollution and the electromagnetic phenomena as incitants*. CRC Press, Taylor&Francis.
18. Surducun V, Surducun E, Gutt R., 2020. Harvesting and conversion of the environmental electromagnetic pollution into electrical energy by novel rectenna array coupled with resonant micro-converter. *Energy*, 211, 118645.
19. Yuan B, Bao C, Qian X, Song L, Tai Q, Liew KM, Hu Y., 2014. Design of artificial nacre-like hybrid films as shielding to mitigate electromagnetic pollution. *Carbon*, 75, 178-189.

TURNA YEMİŞİ (*VACCINIUM MACROCARPON*) VE İDRAR YOLU ENFEKSİYONU CRANBERRY (*VACCINIUM MACROCARPON*) AND URINARY TRACT INFECTION

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ÖZET

İdrar yolu enfeksiyonları (İYE), genellikle *Escherichia coli* sebebiyle oluşan ve yüksek prevalansa sahip bakteriyel enfeksiyonlardır. Kadınlar ve çocuklar İYE için risk grubunda bulunmaktadır. İdrar yolu enfeksiyonlarının yanlış veya geç tedavi edilmesi sağlık açısından olumsuz sonuçlar doğurmaktadır. Bu durum gebelerde böbreklere ve fetüse zarar verebilmektedir. Bu nedenle tedavi sürecinin kısaltılması önem taşımaktadır. Berry meyveleri, antimikrobiyal aktivite gösteren fenolik maddeler ve organik asitler gibi zengin biyoaktif bileşiklere sahiptir. Berry sınıfına dahil olan olan turna yemişi ise başta ABD, Kanada ve Şili’de olmak üzere tarımsal üretimi yapılmakta olan önemli bir fonksiyonel besindir. Bu çalışmanın amacı, birçok fonksiyonel besin maddesine sahip turna yemişi ile İYE arasındaki ilişkiyi göstermektir. Literatür taraması ilgili konu üzerine pubmed, sciencedirect ve google veritabanında yapıldı. Turna yemişi idrar yolu sağlığı için en çok araştırılan meyvelerden biridir. Çalışmalarda turna yemişinin ekstraktı, suyu ve tozu olarak farklı formlarının kullanıldığı görülmektedir. Turna yemişi zengin flavonoid ve antosiyanidin / proantosiyanidin kaynağıdır. Buna ek olarak terpenoid, kateşin, askorbik asit ve bazı organik asitleri (sitrik asit, malik asit ve quinic asit) içermektedir. İYE oluşumunu epitel dokusuna bakteri yapışmasını önleyen proantosiyanidin içeriği sayesinde önlemektedir. Quinic asitin hem idrar miktarını arttıran hem de idrarı asitleştirme özelliğine sahip olan hippurik asidin salınımından sorumlu görülmektedir. Yapılan çalışmalarda turna yemişi ekstraktının İYE tekrarlarını önemli oranda azalttığı bildirilmektedir. Sonuç olarak eğer İYE kısa sürede tedavi edilemezse önemli sağlık sorunlarına sebep olabilecek bir hastalıktır. Araştırmalar beslenme tedavisi içerisinde turna yemişi tüketiminin olumlu sonuçları olduğunu göstermektedir. Bu nedenle turna yemişi tüketimi İYE’nin önlenmesinde medikal tedaviye katkı sağlayacak bir seçenek olarak karşımıza çıkmaktadır.

Anahtar Kelimeler: Turna yemişi, idrar yolu enfeksiyonu, besin

ABSTRACT

Urinary tract infections (UTIs) are bacterial infections with a high prevalence, usually caused by *Escherichia coli*. Women and children are in the risk group for UTI. Improper or delayed treatment of urinary tract infections has negative consequences for health. This condition can harm the kidneys and fetus in pregnant women. Therefore, shortening the treatment process is important. Berry fruits have rich bioactive compounds such as phenolic substances and organic acids that show antimicrobial activity. Cranberry, which is included in the berry class, is an important functional food that is produced in agriculture, especially in the USA, Canada and Chile. The aim of this study is to show the relationship between cranberry, which has many

functional nutrients, and UTI. We searched databases such as pubmed, sciencedirect and google databases the related to subject. Cranberry is one of the most researched fruits for urinary tract health. Studies show that different forms of the cranberries are used as extract, juice and powder. Cranberry is a rich source of flavonoids and anthocyanidins / proanthocyanidins. In addition, it contains terpenoid, catechin, ascorbic acid and some organic acids (citric acid, malic acid and quinic acid). It prevents UTI owing to its proanthocyanidin content, which prevents bacterial adhesion to the epithelial tissue. Quinic acid is thought to be responsible for the release of hippuric acid, which both increases the amount of urine and has the ability to acidify the urine. Studies have reported that cranberry extract significantly reduces the recurrence of UTIs. As a result, UTI is a disease that can cause significant health problems if not treated in a short time. Studies show that the consumption of cranberry in nutritional therapy has positive results. Therefore, Cranberry consumption is an option that will contribute to medical treatment in the prevention of UTI.

Keywords: Cranberry, urinary tract infection, nutrient

1. GİRİŞ

İdrar yolu enfeksiyonları (İYE) bakteriyel enfeksiyonlar arasında en çok görülenler arasındadır. Komplike olmayan idrar yolu enfeksiyonu semptomları birinci basamakta sık görülen bir durumdur ve genellikle antibiyotiklerle tedavi edilmektedir (Butler et al. 2015). İdrar yolu enfeksiyonu (İYE) terimi, idrar yolunda eşik değerini aşan bir veya daha fazla patojenik mikroorganizmanın varlığını ifade etmektedir (Kumar et al. 2015). Enfeksiyonlar genellikle mesane, üretra, böbrekler, ureterler veya prostatta lokalizedir. İYE için tanımlanan ana risk faktörleri yaş, önceki İYE öyküsü, cinsel aktivite ve diyabettir (Tandogdu and Wagenlehner 2016). Bununla birlikte tekrarlayan İYE'lerin (6 ay boyunca iki veya daha fazla veya 1 yıl boyunca üç veya daha fazla görülmesi olarak tanımlanır), özellikle genç kadınlarda daha yüksek yeni bir enfeksiyon geliştirme riski ile ilişkili olduğu görülmektedir (Tandogdu and Wagenlehner 2016, Guay 2009).

Geleneksel olarak idrar yolu sağlığı, düşük doz antibiyotik kullanımı da dahil olmak üzere enfeksiyon önleme uygulamalarıyla yönetilmektedir. Ancak bu yaklaşım ile antibiyotik direnci gelişimi olasılığını önemli oranda arttırmaktadır. Bu nedenle halk sağlığı için alternatif stratejiler önemli katkılar sağlayabilmektedir (Pallet and Hand, 2010). Tarihsel olarak bitkiler (özellikle polifenoller) bitkisel ve geleneksel ilaçlarda kullanılmıştır (Wollenweber, 1988). Antimikrobiyal aktiviteleri bir dizi farklı etki mekanizmasına dayandığından ve etkilerden sorumlu bileşikler genellikle karmaşık olduğundan, bakteriler bunlara direnç geliştirememektedir (Ohno et al. 2003).

Turna yemişi (*Vaccinium macrocarpon*), günümüzde Amerika Birleşik Devletleri'nin doğu ve kuzeydoğu bölgelerinde ve Kanada'nın çoğu bölgesinde yetiştirilmektedir (Zhao et al. 2020). İlk olarak 17. yüzyılda mide ve karaciğer rahatsızlıkları, iskorbüt ve kanser dahil olmak üzere çeşitli terapötik endikasyonlar için kullanılan turna yemişi, antibiyotikler keşfedilmeden önce İYE'ler için popüler bir tedavi seçeneği olmuştur (Lynch 2004, Beachy 1981). Ayrıca 1600'lü yıllarda geleneksel olarak yerli Amerikalılar tarafından idrar yolu enfeksiyonlarını tedavi etmek için kullanılmıştır. Buna ek olarak yerliler tarafından hem yiyecek olarak hem de yara ve kan zehirlenmesi tedavisinde kullanılmıştır. Turna yemişinin sağlığa faydaları üzerine araştırmalar 1980'lerde başlamıştır ancak son çeyrek asırda yoğunlaşmış ve hızla gelişmiştir (Zhao et al. 2020).

Bu çalışmanın amacı, birçok fonksiyonel besin maddesine sahip turna yemişi ile İYE arasındaki ilişkiyi göstermektir.

2. TURNA YEMİŞİ BİLEŞENLERİ

Turna yemişleri, su (%88), organik asitler (salisilat dahil), fruktoz, C vitamini, flavonoidler, antosiyanidinler, kateşinler ve triterpenoidleri içermektedir (Guay 2009). Turna yemişi, özellikle flavan-3-ols, A tipi prosiyanidinler, antosiyaninler, benzoik asit ve ursolik asit olmak üzere karmaşık ve zengin bir fitokimyasal bileşime sahiptir. Ayrıca turna yemişi, in vitro olarak antibakteriyel, antiviral, antimutajenik, antikanserojenik, antitümörojenik, antianjiyogenik, antienflamatuar ve antioksidan özelliklerle ilişkilendirilen polifenollerden zengin bir kaynaktır (Blumberg et al. 2013).



Şekil 1. Turna yemişi (*Vaccinium macrocarpon*)

3. ETKİ MEKANİZMASI

Turna yemişinin meyve suyu, ekstrakt veya kapsül halinde tüketiminin idrar yolu enfeksiyonun (İYE) tedavisine katkı sağladığı uzun yıllardır bilinmektedir (Fellero et al. 1933). Turna yemişi *E. coli*'nin, üroepitelyal astara bağlanmasını önleyerek üriner antibiyotiklerin bakterisidal etkilerini artırabilmektedir (Gbinigie et al. 2019). Ancak bugüne kadar, turna yemişinin tekrarlayan İYE'yi önlemedeki profilaktik özelliklerini açıklamak için kesin bir etki mekanizması açıklanmamıştır. Saf turna yemişi suyu çok asidiktir ve pH değeri 2,5'dan düşüktür (Guay 2009). Bu asitliğe dayanarak turna yemişinin idrarı asitlendirerek antibakteriyel etkisine katkıda bulunduğu varsayılmaktadır (Lynch 2004). Ancak turna yemişinin idrarı asitlendirme etkisi yalnızca geçici etkilere neden olmakta ve çoğu insanda bu değişiklikler yaklaşık 15 dakika etkisini sürdürmektedir. Bu nedenle, bu mekanizma ile etkili olması mümkün olmamaktadır (Bazzaz et al. 2021). Bununla ilişkili olarak araştırmalarda artan sıvı alımı ve idrarın asitlenmesi durumu ile ilgili tutarsız sonuçlar bulunmaktadır (Kontiokari et al. 2003, Kontiokari et al. 2004). Ayrıca, idrar asiditesi üzerine kurulan bu hipotez, yapılan in vitro çalışmalarda turna yemişinin ana bileşenlerinden biri olan proantosiyanidinlerin öneminin ortaya koyulmasıyla reddedilmiştir (Howel 2007). Turna yemişinde yüksek oranda bulunan antosiyanidinler ve proantosiyanidinler, mikrobiyal enfeksiyona karşı doğal bir bitki savunma sistemi olarak işlev gören tanenlerdir (polifenoller) ve kadınlarda İYE'leri önlemede klinik olarak en alakalı olduğu düşünülen bileşenlerdir (Hisano et al. 2012). Proantosiyanidinlerin varlığının *Pseudomonas aeruginosa*, *E. coli* ve *Proteus mirabilis*'in motilitesi üzerindeki inhibe edici ve yapışma önleyici etkileri nedeniyle turna yemişinin İYE'nin önlenmesindeki klinik etkisine aracılık etmede en önemli faktör olduğu düşünülmektedir (Hidalgo et al. 2011, O'may and Tufenkji 2011). Proantosiyanidinlerin Tip A ve Tip B olmasına göre etkinliği değişiklik göstermektedir. Bu durumu inceleyen bir çalışmada üzüm suyu, elma suyu, yeşil çay ve bitter çikolata gibi diğer proantosiyanidin içeren gıdalar ile

turna yemişi suyunun etkinliđi karşılaştırılmıştır. Bakteriyel antiadezyon aktivitesini değerlendiren bu çalışmada, turna yemişi tüketen insan gönüllülerinin idrarı, diđer proantosiyanidin içeren gıdaları tüketenlere kıyasla daha fazla yapışma önleyici aktivite göstermektedir ve bu etkinin in vitro olarak doğrulandıđı bildirilmektedir. Bu duruma neden olan en önemli farkın turna yemişi suyundaki proantosiyanidinlerde A-tipi bađlantıların varlıđı ile üzüm suyu, elma suyu, yeşil çay ve bitter çikolatadaki B-tipi bađlantıların varlıđı olarak gösterilmektedir. Bu gözlem, turna yemişinin *E. coli* üzerindeki inhibitör etkisinden A-tipi bađlantının sorumlu olduđunu göstermektedir (Howel et al. 2005).

4. TURNA YEMİŞİ VE İYE İLİŞKİSİ

Yapılan bir çalışmada turna yemişinin içerdıđi ksilo-oligosakkaritler, *E. coli* yapışma önleyici aktiviteye sahip olan bir biyoaktif bileşen olarak bildirilmektedir. Bu nedenle İYE'leri önlemede rol oynayabileceđi öne sürülmektedir (Hotchkiss et al. 2015). Jensen ve arkadaşlarının yapmış olduđu çalışmada turna yemişinde bulunan malik asit, quinic asit ve sitrik asitin İYE tedavisinde etkili olduđu görülmektedir. Taze turna yemişi suyu içen farelerin mesanesinde bakteri sayısının azaldıđı bildirilmektedir (Jensen et al. 2017). Bununla birlikte çocuklar ve hamile kadınlarda turna yemişin etkilerinin araştırıldıđı bir çalışmada, anatomik ürolojik anormalliklerin yokluđunda, iki veya daha fazla İYE öyküsü olan 18 yaşına kadar tuvalet eğitimi almış çocuklarda, 1 yıl boyunca turna yemişi tüketimi sonucu İYE'lerde %65'lik bir azalma olduđu bildirilmektedir (Afshar et al. 2012).

Wang ve arkadaşları, 1.494 hastayı içeren 10 randomize çalışmanın meta-analizini gerçekleştirerek turna yemişi içeren ürünlerin belirli gruplarda (tekrarlayan İYE'si olan kadınlarda ve çocuklarda) İYE sayısını azaltmada etkili olduđunu göstermektedir. Bununla birlikte, çalışmalar arasındaki önemli heterojenlik (incelenen popülasyon, kullanılan İYE tanımı ve araştırılan turna yemişi ürünü ile ilgili olarak) ulaşılan sonuçları sınırlandırmaktadır (Wang et al. 2012). Bununla birlikte yapılan bazı çalışmalarda turna yemişinin İYE tedavisine ilişkin net sonuçlar bulunmamaktadır (Jepson et al. 2012). Bu durumun en önemli nedeni klinik çalışmalarda standardize edilmemiş farklı ekstraktların kullanımınıdır (Rafsanjany et al. 2015).

Araştırmalarda cinsiyete göre tedavi etkinliđinin farklılaştıđı görülmektedir. Turna yemişi ile tedavi edilen erkeklerden alınan idrar örneklerinin üropatojenik *E. coli*'ye karşı yapışma önleyici aktivitesi, kadınlardan elde edilen idrar örneklerine kıyasla önemli ölçüde daha yüksekti (Scharf et al. 2019).

Birçok çalışma, turna yemişi ekstraktının tekrarlayan İYE'yi azaltmadaki etkinliđini değerlendirirken, çok azı akut İYE semptomları üzerindeki etkileri değerlendirmektedir (Vicariotto 2014). Akut İYE'lerin yönetiminde turna yemişini değerlendiren çok az sayıda çalışma vardır; Tanımlanan çalışmaların hiçbiri akut İYE tedavisi olarak öncelikle turna yemişi üzerine odaklanmamaktadır. Akut, komplike olmayan İYE semptomları için bir tedavi olarak turna yemişi özütünün etkinliđi ve güvenliđine dair kanıtlar yetersiz bulunmaktadır (Gbinigie et al. 2021). Bununla birlikte turna yemişinin İYE tedavisi için optimal konsantrasyon, dozaj, rejim ve formülasyonu bilinmemektedir. Bu nedenle miktarıyla ilgili tavsiye bulunmamaktadır (Beerepoot and Geerling 2016, Luis et al. 2017).

5. SONUÇ

Araştırmalar beslenme tedavisi içerisinde turna yemişinin tüketiminin olumlu sonuçları olduđunu göstermektedir. Ancak turna yemişi tüketiminin İYE tedavisinde etkinliđi güvenilir

olmasa da İYE'nin önlenmesinde medikal tedaviye katkı sağlayacak bir seçenek olarak karşımıza çıkmaktadır.

KAYNAKÇA

- Afshar, K., Stothers, L., Scott, H., & MacNeily, A. E. (2012). Cranberry juice for the prevention of pediatric urinary tract infection: a randomized controlled trial. *The Journal of urology*, 188(4S), 1584-1587.
- Bazzaz, B. S. F., Fork, S. D., Ahmadi, R., & Khameneh, B. (2021). Deep insights into urinary tract infections and effective natural remedies. *African Journal of Urology*, 27(1), 1-13.
- Beerepoot, M., & Geerlings, S. (2016). Non-antibiotic prophylaxis for urinary tract infections. *Pathogens*, 5(2), 36.
- Blumberg, J. B., Camesano, T. A., Cassidy, A., Kris-Etherton, P., Howell, A., Manach, C., & Vita, J. A. (2013). Cranberries and their bioactive constituents in human health. *Advances in Nutrition*, 4(6), 618-632.
- Butler, C. C., Hawking, M. K., Quigley, A., & McNulty, C. A. (2015). Incidence, severity, help seeking, and management of uncomplicated urinary tract infection: a population-based survey. *British Journal of General Practice*, 65(639), e702-e707.
- Fellers, C. R., Redmon, B. C., & Parrott, E. M. (1933). Effect of cranberries on urinary acidity and blood alkali reserve. *J Nutr*, 6(5), 455-463.
- Gbinigie, O. A., Spencer, E. A., Heneghan, C. J., Lee, J. J., & Butler, C. C. (2021). Cranberry Extract for Symptoms of Acute, Uncomplicated Urinary Tract Infection: A Systematic Review. *Antibiotics*, 10(1), 12.
- Gbinigie, O., Allen, J., Boylan, A. M., Hay, A., Heneghan, C., Moore, M., ... & Butler, C. (2019). Does cranberry extract reduce antibiotic use for symptoms of acute uncomplicated urinary tract infections (CUTI)? Protocol for a feasibility study. *Trials*, 20(1), 1-9.
- Guay, D. R. (2009). Cranberry and urinary tract infections. *Drugs*, 69(7), 775-807.
- Hidalgo, G., Chan, M., & Tufenkji, N. (2011). Inhibition of Escherichia coli CFT073 fliC expression and motility by cranberry materials. *Applied and environmental microbiology*, 77(19), 6852-6857.
- Hisano, M., Bruschini, H., Nicodemo, A. C., & Srougi, M. (2012). Cranberries and lower urinary tract infection prevention. *Clinics*, 67(6), 661-668.
- Hotchkiss Jr, A. T., Nuñez, A., Strahan, G. D., Chau, H. K., White, A. K., Marais, J. P., ... & Khoo, C. (2015). Cranberry xyloglucan structure and inhibition of Escherichia coli adhesion to epithelial cells. *Journal of agricultural and food chemistry*, 63(23), 5622-5633.
- Howell, A. B. (2007). Bioactive compounds in cranberries and their role in prevention of urinary tract infections. *Molecular nutrition & food research*, 51(6), 732-737.
- Howell, A. B., Reed, J. D., Krueger, C. G., Winterbottom, R., Cunningham, D. G., & Leahy, M. (2005). A-type cranberry proanthocyanidins and uropathogenic bacterial anti-adhesion activity. *Phytochemistry*, 66(18), 2281-2291.

- Jensen, H. D., Struve, C., Christensen, S. B., & Krogfelt, K. A. (2017). Cranberry juice and combinations of its organic acids are effective against experimental urinary tract infection. *Frontiers in microbiology*, 8, 542.
- Jepson, R. G., Williams, G., & Craig, J. C. (2012). Cranberries for preventing urinary tract infections. *Cochrane database of systematic reviews*, (10).
- Kontiokari, T., Laitinen, J., Järvi, L., Pokka, T., Sundqvist, K., & Uhari, M. (2003). Dietary factors protecting women from urinary tract infection. *The American journal of clinical nutrition*, 77(3), 600-604.
- Kontiokari, T., Nuutinen, M., & Uhari, M. (2004). Dietary factors affecting susceptibility to urinary tract infection. *Pediatric Nephrology*, 19(4), 378-383.
- Kumar S., Dave A., Wolf B, Lerma E.V. (2015). Urinary tract infections. *Disease-A-Month* 61: 45-59
- Luís, Â., Domingues, F., & Pereira, L. (2017). Can cranberries contribute to reduce the incidence of urinary tract infections? A systematic review with meta-analysis and trial sequential analysis of clinical trials. *The Journal of urology*, 198(3), 614-621.
- Lynch, D. M. (2004). Cranberry for prevention of urinary tract infections. *American family physician*, 70(11), 2175-2177.
- Ohno, T., Kita, M., Yamaoka, Y., Imamura, S., Yamamoto, T., Mitsufuji, S., ... & Imanishi, J. (2003). Antimicrobial activity of essential oils against *Helicobacter pylori*. *Helicobacter*, 8(3), 207-215.
- O'May, C., & Tufenkji, N. (2011). The swarming motility of *Pseudomonas aeruginosa* is blocked by cranberry proanthocyanidins and other tannin-containing materials. *Applied and environmental microbiology*, 77(9), 3061-3067.
- Pallett, A., & Hand, K. (2010). Complicated urinary tract infections: practical solutions for the treatment of multiresistant Gram-negative bacteria. *Journal of antimicrobial chemotherapy*, 65(suppl_3), iii25-iii33.
- Rafsanjany, N., Senker, J., Brandt, S., Dobrindt, U., & Hensel, A. (2015). In vivo consumption of cranberry exerts ex vivo antiadhesive activity against FimH-dominated uropathogenic *Escherichia coli*: a combined in vivo, ex vivo, and in vitro study of an extract from *Vaccinium macrocarpon*. *Journal of agricultural and food chemistry*, 63(40), 8804-8818.
- Scharf, B., Sendker, J., Dobrindt, U., & Hensel, A. (2019). Influence of cranberry extract on Tamm-Horsfall protein in human urine and its antiadhesive activity against uropathogenic *Escherichia coli*. *Planta medica*, 85(02), 126-138.
- Tandogdu, Z., & Wagenlehner, F. M. (2016). Global epidemiology of urinary tract infections. *Current opinion in infectious diseases*, 29(1), 73-79.
- Vicariotto, F. (2014). Effectiveness of an association of a cranberry dry extract, D-mannose, and the two microorganisms *Lactobacillus plantarum* LP01 and *Lactobacillus paracasei* LPC09 in women affected by cystitis: a pilot study. *Journal of clinical gastroenterology*, 48, S96-S101.
- Wang, C. H., Fang, C. C., Chen, N. C., Liu, S. S. H., Yu, P. H., Wu, T. Y., ... & Chen, S. C. (2012). Cranberry-containing products for prevention of urinary tract infections in susceptible populations: a systematic review and meta-analysis of randomized controlled trials. *Archives of internal medicine*, 172(13), 988-996.

- Wollenweber, E. (1988). Occurrence of flavonoid aglycones in medicinal plants. *Progress in clinical and biological research*, 280, 45-55.
- Zhao, S., Liu, H., & Gu, L. (2020). American cranberries and health benefits—an evolving story of 25 years. *Journal of the Science of Food and Agriculture*, 100(14), 5111-5116.

BESLENME VE SAĞLIK İÇİN MİKROALG MICROALGAE FOR NUTRITION AND HEALTH

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ÖZET

Algler boyutuna göre makro veya mikro algler olarak ayrılmaktadır. Makroalgler gözle görülebilen yosun gibi canlıları ifade ederken mikroalgler ise mikroskop altında görülebilen tek hücreli canlılardır. Mikroalgler dünyadaki en eski yaşam biçimlerinden biridir ve birçok biyoaktif bileşen içermektedir. Mikroalgler bu bileşenler sayesinde antioksidan, antimikrobiyal, antikarsinojen ve antidiyabetik özelliklere sahiptir. Mikroalglerin sahip oldukları, β -karoten, astaksantin, dokozahegzanoik asit, eikozapentanoik asit, polifenoller, flavonoidler, fikobiliproteinler ve klorofiller ile antioksidan, antimikrobiyal, antikarsinojen ve antidiyabetik etkiler göstermektedir. Yapılan araştırmalarda Spirulina (Arthrospira), Chlorella, Dunaliella salina, Haematococcus pluvialis, Coelastrella striolata, Phaeodactylum tricornutum ve Isochrysis galbana mikroalgler arasında öne çıkmaktadır. Mikroalg tüketimi gıda endüstrisinin desteğiyle giderek artmaktadır. Vegan yumurta ikamesi, Spirulina dolgulu kraker, çeşitli içecekler ve fırın ürünleri gibi gıda ürünlerinde mikroalglerden faydalanılmaktadır. Bir mikroalg olan Spirulina (Arthrospira) yüksek protein, karetonid, ksantofil ve A, B1, B2, B12 vitamin içeriğiyle öne çıkmaktadır. Yapılan çalışmalarda Spirulina'nın serbest radikallere karşı önemli bir etkinlik sağlayarak antitümör ve antikanser özellikleri olduğu görülmektedir. Bir mikroalg olan Chlorella hücrelerinde, aktif immünostimülatör olan β -1,3-glukan bulunmaktadır. Yapılan çalışmalarda Chlorella'nın mide ülserleri, konstipasyon, anemi, hipertansiyon, diyabet gibi birçok hastalığa olumlu etkileri görülmektedir. Haematococcus pluvialis doğada en yüksek oranda astaksantin (kuru ağırlıkta % 1.5-3.0) içeren organizma olarak bildirilmektedir. Astaksantin, C, E vitaminlerinden daha çok antioksidan özelliklere sahip olan bir bileşiktir. Yapılan çalışmalarda kanser başta olmak üzere göz hastalıklarında ve kardiyovasküler hastalıklarda iyileştirici ve önleyici etkileri olduğu görülmektedir. Dunaliella, yüksek konsantrasyonda β -karoten üretme kapasitesine sahiptir. Karotenoid ve diğer biyoaktif bileşenlerce zengin bir diyetin oksidatif stresle ilgili çeşitli kronik hastalık ve işlevsel bozukluklara karşı koruyucu etki gösterdiğine dair kuvvetli kanıtlar bulunduğu bildirilmektedir. Ayrıca karotenoidlerin antioksidan özellikleri sayesinde bu hastalıkların başlamasını inhibe edebileceği ifade edilmektedir. Sonuç olarak mikroalgler üzerine yapılan çalışmaların artırılması ve farklı alg türlerinin de çalışmalarda kullanılmasına ihtiyaç bulunmaktadır.

Anahtar Kelimeler: Mikroalgler, sağlık, beslenme

ABSTRACT

Algae are divided into macro or micro algae according to their size. Microalgae are single-celled organisms that can be seen under a microscope, while macroalgae refer to organisms such as algae that can be seen with the naked eye. Microalgae are one of the oldest forms of life

on earth and contain many bioactive components. Thanks to these components, microalgae have antioxidant, antimicrobial, anticarcinogen and antidiabetic properties. Microalgae have antioxidant, antimicrobial, anticarcinogenic and antidiabetic effects with β -carotene, astaxanthin, docosahexanoic acid, eicosapentanoic acid, polyphenols, flavonoids, phycobiliproteins and chlorophylls. In the researches, *Spirulina* (*Arthrospira*), *Chlorella*, *Dunaliella salina*, *Haematococcus pluvialis*, *Coelastrella striolata*, *Phaeodactylum tricornutum* and *Isochrysis galbana* stand out among microalgae. Microalgae consumption is increasing with the support of the food industry. Microalgae are used in food products such as vegan egg substitute, *Spirulina*-filled crackers, various beverages and baked goods. *Spirulina*, a microalgae, stands out with its high protein, carotenoid, xanthophyll and vitamin A, B1, B2, B12 content. Studies have shown that *Spirulina* has antitumor and anticancer properties by providing a significant activity against free radicals. However, *Chlorella* cells, a microalgae, contain active immunostimulatory β -1,3-glucan. Studies have shown that *Chlorella* has positive effects on many diseases such as stomach ulcers, constipation, anemia, hypertension and diabetes. *Haematococcus pluvialis* is reported as the organism containing the highest rate of astaxanthin (1.5-3.0% in dry weight) in nature. Astaxanthin is a compound that has more antioxidant properties than vitamins C and E. Studies have shown that it has curative and preventive effects in cancer, eye diseases and cardiovascular diseases. *Dunaliella* is capable of producing high concentrations of β -carotene. It is reported that there is strong evidence that a diet rich in carotenoids and other bioactive components has a protective effect against various chronic diseases and functional disorders related to oxidative stress. In addition, it is stated that carotenoids can inhibit the onset of these diseases thanks to their antioxidant properties. As a result, there is a need to increase the studies on microalgae and to use different algae species in studies.

Keywords: Microalgae, health, nutrition

1. GİRİŞ

Algler, dünyanın en eski bitkilerinden biri olarak kabul edilmektedir. İlk olarak ortaya çıkmaları yaklaşık 3.5 milyar yıl öncesine dayanmaktadır. Bu fotosentetik türler, 60 m uzunluğa kadar çok hücreli yapıları olan makroalgler ve 0,2 mikrometre kadar küçük boyutta tek hücreli organizmalar olan mikroalglerden oluşmaktadır (Christaki et al. 2011). Mikroalgler, tahmini tür sayısı 800.000'i bulabilen çok çeşitli bir gruptur (Wolkers et al. 2011). Bununla birlikte birçok vitamin ve mineral açısından zengin canlılardır. Mikroalglerin besin kaynağı olarak geniş ölçekli kültürünün üretilmesine 1947-1948 tarihlerinde başlanmıştır (Borowitzka 2018). Mikroalgler A, B1, B2, B6, B12, C ve E vitaminleri ve potasyum, demir, magnezyum, kalsiyum ve iyot gibi mineralleri içeren kaynaklardır (Becker 2013). Aynı zamanda esansiyel yağ asitleri, ksantofil ve karotenoidler gibi faydalı pigmentler içermektedir. Bu biyoaktif bileşenler insanlar tarafından sentezlenememektedir. Bu nedenle *Spirulina* gibi mikroalglerin üretimine önem verilmektedir (Sathasivam et al. 2017).

Günümüzde mikroalg içerikli gıdalar sağlıklı gıdalar olarak pazarlanmakta ve endüstride kapsüller, tabletler, tozlar ve sıvılar olarak tüketiciye sunulmaktadır (Pulz and Gross 2004).

2. MİKROALGLER

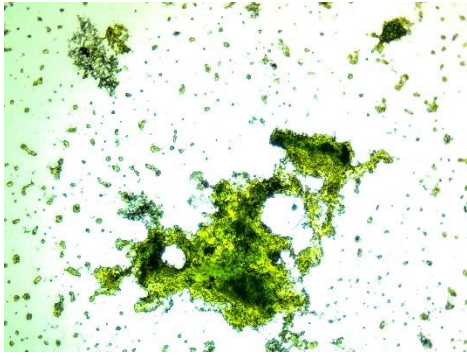
2.1. Chlorella

Chlorella vulgaris sahip olduğu bileşiklerle ve özelliklerle mikroalgler arasında öne çıkmaktadır. *Chlorella*'nın sağlıklı besin olarak ilk geniş ölçekli üretimi 1950 yılında Tayvan

ve Japonya’da bulunan üretim tesislerinde gerçekleşmiştir (Borowitzka 2018). *Chlorella* türleri genellikle 'sağlıklı gıdalar' olarak sunulmakta ve yaygın hastalıkları veya alzheimer, kanser vb. hastalıkları önlemek, iyileştirmek için fonksiyonel gıdalar olarak tanıtılmaktadır (Caporgno and Mathys 2018). Bununla birlikte gıda endüstrisinde *Chlorella* meyve suyu ve smoothie gibi içeceklerde veya bisküvi, çorba gibi gıdalarda kullanılabilir. Ayrıca *Chlorella*'nın renklendirici özelliğinden faydalanılan gıdalarda da bulunmaktadır (Gouveia et al. 2007).

Chlorella'nın %55-67'si protein, %1-4'ü klorofil, %9-18'i diyet lifi ve çok sayıda minerali ve vitamini içermektedir. Aynı zamanda makula dejenerasyonunu önlediği ve tedavi ettiği gösterilen ve katarakt önleyici özelliklere sahip çok miktarda lutein içermektedir (Bishop and Zubeck 2012, Morais et al. 2015). Bununla birlikte *Chlorella*'da bulunan en önemli besinsel bileşik, aktif bir immünostimülatör, serbest radikal süpürücü ve kan kolesterol düzeylerini düşürücü olan β -1,3-glukan olarak görünmektedir (Morais et al. 2015, Iwamoto et al. 2000).

Chlorella ekstraktlarının antitümör, antioksidan, anti-inflamatuar ve antimikrobiyal özelliklere sahip olduğu gösterilmektedir (Tanaka et al. 1995, Miranda et al 1998, Guzman et al. 2003). Ayrıca kan basıncı ve kolesterol, yara iyileşmesi, bağışıklık sistemi, mide ülseri, kabızlık, anemi, hipertansiyon ve diyabete olumlu etkileri görülmektedir (Bishop and Zubeck 2012, Mello-Sampayo et al. 2013).



Şekil 1. *Chlorella vulgaris*

2.2. Spirulina

Arthrospira (Spirulina) platensis, tek hücreli mikroalglerin mavi-yeşil fotoototrofik cinsine aittir. Hücreleri, kuru ağırlığın %70'ine kadar ulaşan protein içeriği ile protein bakımından zengindir. 1950'lerden beri Meksika ve Afrika'nın yerli halkı tarafından kullanılmaktadır (Soletto et al. 2004). Spirulina günümüzde balık yemi, vitamin takviyeleri, gıda boyaları, su ürünleri yetiştiriciliği, farmasötikler ve nutrasötikler için ticari olarak üretilmekte olan prokaryotik bir siyanobakteridir (Bishop and Zubeck 2012).

Spirulina, protein, vitaminler, mineraller ve karotenoidler açısından zengin ve hücreleri hasardan korumaya yardımcı olabilecek antioksidanlara sahip olan mavi-yeşil bir algdir. Spirulina'nın bağışıklık sistemini güçlendirici, sindirimi iyileştirici, yorgunluğu azaltıcı, dayanıklılık geliştirici, kardiyovasküler, karaciğer ve böbrek fonksiyonlarını iyileştirici etkileri bulunmaktadır (Sousa et. al, 2008).

Spirulina zengin bir B vitamini (özellikle B12 vitamini), fikosiyenin, klorofil, E vitamini, ω -6 yağ asitleri ve çok sayıda mineral kaynağıdır. Protein içeriği lösin, valin ve izolösin gibi temel amino asitler dahil kuru ağırlığının %50-70'i arasında değişmektedir. Bununla birlikte birim

başına miktar olarak havuçtan 10 kat daha fazla β -karoten içermektedir (Bishop and Zubeck 2012, Morais et al. 2015, Da Silva Vaz et al. 2016).

Spirulina'nın kilo kaybı, diyabet, yüksek tansiyon ve hipertansiyon üzerinde olumlu sağlık etkileri olduğu bilinmektedir. Ayrıca, antiviral, antifungal, antibakteriyel, antikanser, anti-HIV, anti-inflamatuar ve antioksidan özelliklere sahiptir (Morais et al. 2015). *Spirulina* ayrıca depresyon ve dikkat eksikliği hiperaktivite bozukluğunun tedavisine yardımcı olmak için antijene özgü antikor üretebilmektedir (Bishop and Zubeck 2012). Bununla birlikte *Spirulina*'nın düşük LDL kolesterol ve trigliserit seviyeleri düşük kan basıncı ve kan şekeri kontrolü ile ilişkili olduğu görülmektedir (Parikh et al. 2001, Mazokopakis et al. 2014, Torres-Durán et al. 2012). Ayrıca *Spirulina* sahip olduğu γ -linolenik asit sayesinde besin takviyesi olarak üretilmekte ve kullanılmaktadır (Chu, 2012).



Şekil 2. *Arthrospira (Spirulina) platensis*

2.3. Dunaliella

Dunaliella salina büyük miktarlarda gliserol ve protein ve daha az miktarlarda a-karoten, lutein ve likopen üretmektedir. İçerisinde bulunan karotenoidler, lipid peroksidasyonu ve enzim inaktivasyonunu azaltan ve böylece enzim aktivitesinin geri kazanılmasına yardımcı olan güçlü serbest radikal süpürücülerdir (Bishop and Zubeck 2012). Bununla birlikte *Dunaliella* tozu yaklaşık olarak %1-3 arasında β -karotene sahiptir. Özellikle margarin ve içecekleri renklendirmek için gıda endüstrisinde kullanılmaktadır (Hamed et al. 2015). Beta karoten *Dunaliella*'nın hücre içi iletişim, bağışıklık tepkisi ve birçok neoplazma türüne karşı koruma üzerinde olumlu etkileri bulunmaktadır (Bishop and Zubeck 2012).

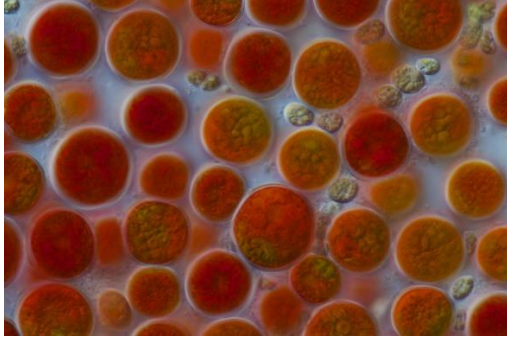
Dunaliella sahip olduğu glutatyon içeriği sayesinde antioksidan, kalp krizi azaltıcı etki, antikanser aktivite, anti-parkinson etkilerini göstermektedir (Li et al. 2004).



Şekil 3. *Dunaliella salina*

2.4. Haematococcus

Haematococcus pluvialis, kuru ağırlığının %1.5-3'üne kadar sahip olduğu astaksantin ile en büyük doğal astaksantin kaynağıdır. Bu pigmentin antioksidan, antikanser, antiinflamatuvar ve antibakteriyel özellikleri bulunmaktadır (Lordan et al. 2011, Bishop and Zubeck 2012, Tanaka et al. 2012). Ayrıca deniz kabuklularında ve balıklarda bulunan astaksantin, su ürünleri çiftliklerinde balıkların pigmentasyonunu sağlamak amacıyla kullanılmaktadır (Hata et al. 2001). Bununla birlikte *Haematococcus*, antimikrobiyal aktiviteye sahip kısa zincirli yağ asitleri içermektedir (Hamed et al 2015).



Şekil 4. *Haematococcus pluvialis*

3.SONUÇ

Mikroalgler içerisinde binlerce farklı türü barındırmaktadır. Mikroalglerden hem gıda endüstrisinde katkı maddesi olarak hem de sağlık alanında gıda takviyesi olarak faydalanılmaktadır. Bununla birlikte pek çok biyoaktif bileşene sahiptirler. Yapılan araştırmalarda sahip oldukları yüksek antioksidan kapasiteli bileşiklerin sağlık üzerine olumlu etkileri bulunmaktadır. Ancak mikroalgler üzerine yapılan çalışmaların artırılması ve farklı alg türlerinin de çalışmalarda kullanılmasına ihtiyaç bulunmaktadır.

KAYNAKÇA

- Becker, W. (2004). Microalgae in human and animal nutrition. Richmond A (ed) Handbook of Microalgal Culture: Biotechnology and Applied Phycology.
- Bishop, W. M., & Zubeck, H. M. (2012). Evaluation of microalgae for use as nutraceuticals and nutritional supplements. *J Nutr Food Sci*, 2(5), 1-6.
- Borowitzka, M. A. (2018). Microalgae in medicine and human health: A historical perspective. In *Microalgae in health and disease prevention* (pp. 195-210). Academic Press.
- Caporgno, M. P., & Mathys, A. (2018). Trends in microalgae incorporation into innovative food products with potential health benefits, *Front. Nutr.* 5 (2018) 1-10.
- Christaki, E., Florou-Paneri, P., & Bonos, E. (2011). Microalgae: a novel ingredient in nutrition. *International journal of food sciences and nutrition*, 62(8), 794-799.
- Chu, W. L. (2012). Biotechnological applications of microalgae. *IeJSME*, 6(1), S24-S37.
- Da Silva Vaz, B., Moreira, J. B., de Moraes, M. G., & Costa, J. A. V. (2016). Microalgae as a new source of bioactive compounds in food supplements. *Current Opinion in Food Science*, 7, 73-77.

- Gouveia, L., Batista, A. P., Miranda, A., Empis, J., & Raymundo, A. (2007). *Chlorella vulgaris* biomass used as colouring source in traditional butter cookies. *Innovative food science & emerging technologies*, 8(3), 433-436.
- Guzman, S., Gato, A., Lamela, M., Freire-Garabal, M., & Calleja, J. M. (2003). Anti-inflammatory and immunomodulatory activities of polysaccharide from *Chlorella stigmatophora* and *Phaeodactylum tricornutum*. *Phytotherapy Research*, 17(6), 665-670.
- Hamed, I., Özogul, F., Özogul, Y., & Regenstein, J. M. (2015). Marine bioactive compounds and their health benefits: a review. *Comprehensive reviews in food science and food safety*, 14(4), 446-465.
- Hata, N., Ogbonna, J. C., Hasegawa, Y., Taroda, H., & Tanaka, H. (2001). Production of astaxanthin by *Haematococcus pluvialis* in a sequential heterotrophic-photoautotrophic culture. *Journal of Applied Phycology*, 13(5), 395-402.
- Iwamoto, T., Hosoda, K., Hirano, R., Kurata, H., Matsumoto, A., Miki, W., ... & Kondo, K. (2000). Inhibition of low-density lipoprotein oxidation by astaxanthin. *Journal of atherosclerosis and thrombosis*, 7(4), 216-222.
- Li, Y., Wei, G., & Chen, J. (2004). Glutathione: a review on biotechnological production. *Applied microbiology and biotechnology*, 66(3), 233-242.
- Lordan, S., Ross, R. P., & Stanton, C. (2011). Marine bioactives as functional food ingredients: potential to reduce the incidence of chronic diseases. *Marine drugs*, 9(6), 1056-1100.
- Mazokopakis, E. E., Starakis, I. K., Papadomanolaki, M. G., Mavroeidi, N. G., & Ganotakis, E. S. (2014). The hypolipidaemic effects of *Spirulina* (*Arthrospira platensis*) supplementation in a Cretan population: a prospective study. *Journal of the Science of Food and Agriculture*, 94(3), 432-437.
- Mello-Sampayo, C., Corvo, M. L., Mendes, R., Duarte, D., Lucas, J., Pinto, R., ... & Gouveia, L. (2013). Insights on the safety of carotenogenic *Chlorella vulgaris* in rodents. *Algal research*, 2(4), 409-415.
- Miranda, M. S., Cintra, R. G., Barros, S., & Mancini-Filho, J. (1998). Antioxidant activity of the microalga *Spirulina maxima*. *Brazilian Journal of Medical and biological research*, 31(8), 1075-1079.
- Morais, M. G., Vaz, B. D. S., de Morais, E. G., & Costa, J. A. V. (2015). Biologically active metabolites synthesized by microalgae. *BioMed research international*, 2015.
- Parikh, P., Mani, U., & Iyer, U. (2001). Role of *Spirulina* in the control of glycemia and lipidemia in type 2 diabetes mellitus. *Journal of Medicinal Food*, 4(4), 193-199.
- Pulz, O., & Gross, W. (2004). Valuable products from biotechnology of microalgae. *Applied microbiology and biotechnology*, 65(6), 635-648.
- Sathasivam, R., Radhakrishnan, R., Hashem, A., & Abd_Allah, E. F. (2019). Microalgae metabolites: A rich source for food and medicine. *Saudi journal of biological sciences*, 26(4), 709-722.
- Soletto, D., Binaghi, L., Lodi, A., Carvalho, J. C. M., & Converti, A. (2005). Batch and fed-batch cultivations of *Spirulina platensis* using ammonium sulphate and urea as nitrogen sources. *Aquaculture*, 243(1-4), 217-224.
- Sousa, I., Gouveia, L., Batista, A. P., Raymundo, A., & Bandarra, N. M. (2008). Microalgae in novel food products. *Food chemistry research developments*, 75-112.

- Tanaka, T., Makita, H., Ohnishi, M., Mori, H., Satoh, K., & Hara, A. (1995). Chemoprevention of rat oral carcinogenesis by naturally occurring xanthophylls, astaxanthin and canthaxanthin. *Cancer research*, 55(18), 4059-4064.
- Tanaka, T., Shnimizu, M., & Moriwaki, H. (2012). Cancer chemoprevention by carotenoids. *Molecules*, 17(3), 3202-3242.
- Torres-Durán, P. V., Ferreira-Hermosillo, A., Ramos-Jiménez, A., Hernández-Torres, R. P., & Juárez-Oropeza, M. A. (2012). Effect of *Spirulina maxima* on postprandial lipemia in young runners: a preliminary report. *Journal of medicinal food*, 15(8), 753-757.
- Wolkers, H., Barbosa, M., Kleinegriss, D. M., Bosma, R., & Wijffels, R. H. (2011). Microalgae: the green gold of the future. *Wageningen UR*.

COMPARISON VALUES ON THE HEAT CAPACITY OF PuN NUCLEAR FUEL BY THE USE OF INTEGER AND NONINTEGER N-DIMENSIONAL DEBYE PARAMETER

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ABSTRACT

Actinite fuels have some higher thermal conductivity and solubility than oxide fuels. Therefore, interest in nitrite fuels is increasing. In addition to these advantages, uranium and plutonium mixed nitrites are among the preferred nuclear fuels in terms of high melting point and high fuel density. However, there are few studies in the literature to determine the physico-chemical properties of these fuels by determining their thermal and mechanical properties. In this study, we have given results for the integer and noninteger values of the n parameter that occurs in the n -dimensional Debye function used to calculate the constant volume heat capacity, which is one of the thermal properties of PuN .

Keywords: Nuclear fuel, Heat capacity, Debye approximation

ÖZET

Aktinit yakıtlar oksit yakıtlara göre bazı daha yüksek termal iletkenlik ve çözünürlüğe sahiptir. Bu nedenle nitrit yakıtlara olan ilgi artmaktadır. Özellikle uranyum ve plutonyum karışımı nitritler bu avantajların yanı sıra yüksek erime noktası ve yüksek yakıt yoğunluğu açısından da tercih edilen nükleer yakıtlar arasındadırlar. Fakat literatürde bu yakıtların termal ve mekanik özelliklerinin belirlenerek fiziko-kimyasal özelliklerinin belirlenebilmesi için yapılmış çok fazla çalışma bulunmamaktadır. Bu çalışmada biz PuN 'ın termal özelliklerinden biri olan sabit hacimde ısı kapasitesinin hesaplanmasında kullanılan n - boyutlu Debye fonksiyonunda ortaya çıkan n parametresinin tamsayı ve kesir sayılı durumları için sonuçlar verdik.

GİRİŞ

Bir plütonyum nitrat PuN yakıtı yüksek erime noktası, yüksek yakıt yoğunluğu ve yüksek ısı iletkenliği gibi arzu edilen birçok özelliği nedeniyle hızlı bir damızlık reaktör yakıtı olarak düşünülmektedir [1-9]. Işınlama sırasında nitrat yakıt davranışını anlamak için, PuN 'ın termal ve mekanik özellikleri gibi fizikokimyasal özellikleri hakkında bilgi sahibi olmak gereklidir. Ancak, literatürde bu özellikler hakkında çok az bilgi vardır. Literatürde daha çok uranyum, uranyum oksit ve nitratlarının termal özellikleri incelenmektedir. Biz ise bu çalışmada alternatif bir yakıt olan ve termal avantajlara sahip Plutonyum elementini baz alarak PuN 'ın ısı kapasitesini Einstein-Debye metodunu kullanarak n parametresinin tamsayı ve kesirli değerleri için hesapladık.

Formüller

Bilindiği gibi Einstein-Debye yaklaşımı dikkate alınarak ısı kapasitesinin sıcaklığa bağlı ifadesi aşağıdaki şekilde verilmektedir [1]:

$$C_V = 3N_A k_B M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right), \quad (1)$$

burada N_A Avagadro sayısı, k_B Boltzman sabiti, θ_D Debye sıcaklığı, θ_E Einstein sıcaklığı, T ise sıcaklıktır. Ayrıca $M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right)$ fonksiyonu aşağıdaki gibidir:

$$M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right) = L_V \left(\frac{\theta_D}{T} \right) + (s-1)A \left(\frac{\theta_E}{T} \right). \quad (2)$$

(2) formülündeki $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu isochoric (sabit hacimde) ısı fonksiyonudur ve s kristal örgü noktasındaki atom sayısıdır. n -boyutlu kristal için, $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu

$$L_V \left(\frac{\theta_D}{T} \right) = n \left(\frac{T}{\theta_D} \right)^n \int_0^{\frac{\theta_D}{T}} \frac{t^{n+1} e^t dt}{(e^t - 1)^2} \quad (3)$$

şeklinde dir.

Ayrıca $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu n -boyutlu tam ve kesir sayılı Debye fonksiyonu kullanılarak aşağıdaki gibi elde edilir:

$$L_V \left(\frac{\theta_D}{T} \right) = (n+1)D_n \left(1, \frac{\theta_D}{T} \right) - \frac{\theta_D}{T} \frac{n}{e^{\frac{\theta_D}{T}} - 1}. \quad (4)$$

Burada $D_n(\beta, x)$ katsayısı n -boyutlu Debye fonksiyonudur ve aşağıdaki gibi gösterilir [10-12]:

$$D_n(\beta, x) = \frac{n}{x^n} \int_0^x \frac{t^n}{(e^t - 1)^\beta} dt \quad (5)$$

Ayrıca (2) formülündeki $A \left(\frac{\theta_E}{T} \right)$ katsayısı Einstein fonksiyonudur ve aşağıdaki şekilde verilir [10]:

$$A \left(\frac{\theta_E}{T} \right) = \left(\frac{\theta_E}{T} \right)^2 \frac{e^{\frac{\theta_E}{T}}}{\left(e^{\frac{\theta_E}{T}} - 1 \right)^2} = \left[\frac{\theta_E}{2T} \frac{1}{\sinh \left(\frac{\theta_E}{2T} \right)} \right]^2. \quad (6)$$

n -boyutlu Debye fonksiyonunun analitik ifadesi aşağıdaki gibi türetilmiştir [11]:

$$D_n(\beta, x) = \frac{n}{x^n} \lim_{N \rightarrow \infty} \sum_{i=0}^N (-1)^i F_i(-\beta) \frac{\gamma(n+1, (i+\beta)x)}{(i+\beta)^{n+1}}. \quad (7)$$

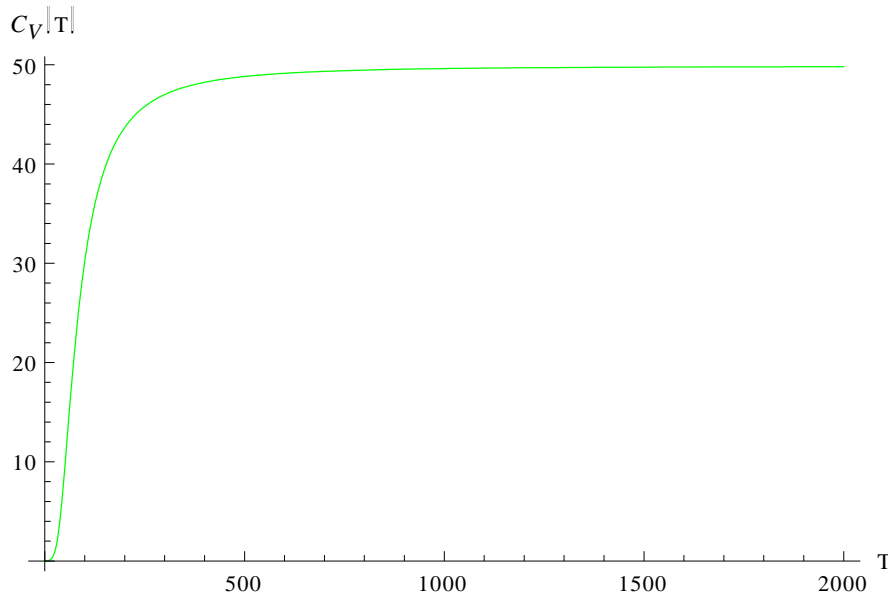
Burada N toplamın üst sınırıdır. Ayrıca $F_i(-\beta)$ ve $\gamma(n+1, (i+\beta)x)$ terimleri de literatürden iyi bilinen binomial katsayısı ve incomplete gamma fonksiyonlarıdır ve aşağıdaki gibi gösterilirler [13]:

$$F_m(n) = \begin{cases} \frac{n(n-1)\dots(n-m+1)}{m!} & \text{for integer } n \\ \frac{(-1)^m \Gamma(m-n)}{m! \Gamma(-n)} & \text{for noninteger } n \end{cases}, \quad (8)$$

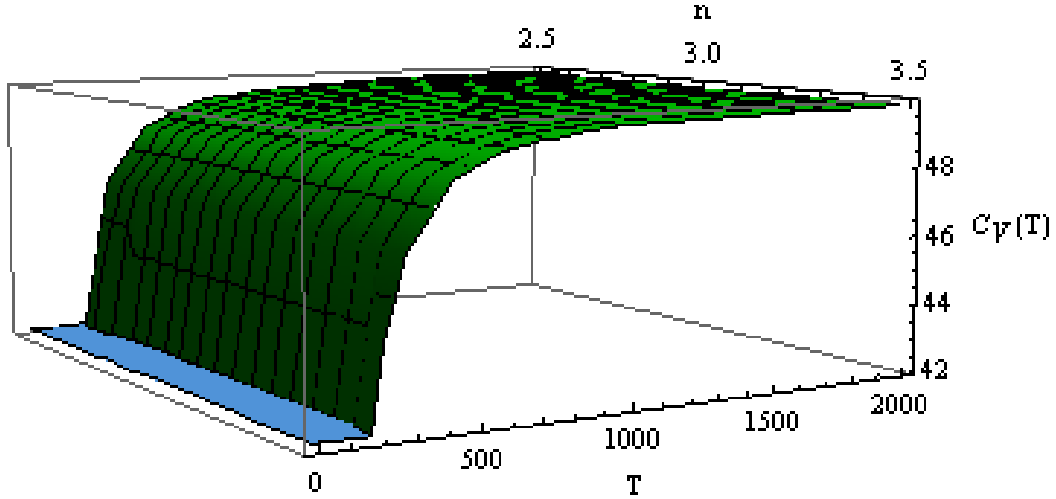
$$\gamma(\alpha, y) = \int_0^y t^{\alpha-1} e^{-t} dt. \quad (9)$$

Görüldüğü gibi sabit hacimdeki ısı kapasitesi için (1) formülü şeklinde verilen ifadeyi farklı maddeler için kullanabiliriz. Biz bu çalışmada PuN nükleer yakıtının ısı kapasitesini belirlemeyi amaçladık. Ayrıca bilindiği gibi n parametresi tamsayı ve kesir sayılı durumları içermektedir. Bu amaç doğrultusunda bu çalışmada n parametresinin aldığı tamsayı ve kesir sayılı durumları için ısı kapasitesinin değişimine dikkat çektik.

Figür 1. PuN nükleer yakıtının C_v sabit hacimde ısı kapasitesinin sıcaklıkla değişimi ($n=3$, $\theta_E=198K$, $\theta_D=255K$)



Figür 2. PuN nükleer yakıtının C_v sabit hacimde ısı kapasitesinin sıcaklığa ve n parametresine bağlı değişimi ($2.5 \leq n \leq 3.5$)



TARTIŞMA VE SONUÇ

Einstein- Debye yaklaşımından alınan (1) formülünün Mathematica 10 yazılım dilinde programı yapılarak PuN nükleer yakıtının ısı kapasitesinin sıcaklıkla değişimi incelenmiştir. Hesaplama sonuçlarının doğruluğunu belirlemek için n sayısının farklı tam ve kesir sayılı değerlerinde hesaplamalar yapılmıştır. Alınan sonuçlar $n = 2.5, 3, 3.5$ değerlerinde grafik olarak Şekil 1’de verilmiştir. Yöntemin doğruluğu ise $n = 3$ için nümerik yöntemle alınan sonuçlar ile n sayısının farklı tam sayı olmayan değerleri için alınan sonuçların uyumluluğundan yola çıkarak belirlenmiştir. Bu durum çizilen grafikten açıkça görülmektedir.

KAYNAKLAR

1. M. Cankurtaran and B. M. Askerov, Equation of State, Isobaric Specific Heat, and Thermal Expansion of Solids with Polyatomic Basis in the Einstein-Debye Approximation, Phys. Stat. Sol. (b) 194, 499 (1996).
2. J. W. Gibbs, Thermodynamics vol I (New York: Dover), 1961.
3. D. Kashchiev, Nucleation: Basic Theory with Applications (Oxford: Heinemann), 2000.
4. T.M.Wang ,J. Lia, Microstructure, thermal and mechanical properties of nanostructured Cu-5.5 Ni-9.2 Sn-6.5 P, Solid State Commun. 94(1995) 201
5. C. Beauvais, D. Rouxel, M. Michailov and B. Mutaftschiev, Two-dimensional overgrowth in the low submonolayer range: the case of c (2× 2)-PbCu (110), Surf. Sci. 324 (1995) 1.
6. V. Likhachev, G. Vinogradov and M. Alymov, Anomalous heat capacity of nanoparticles, Phys. Lett. A, 357 (2006) 236.
7. B.A. Mamedov, Accurate analytical evaluation of heat capacity of nuclear fuels using Einstein–Debye approximation, Nuc. Engin. Desigh, 276 (2014) 124.
8. T. Mehmetoglu, Theoretical Evaluation of Thermal Properties of TiO2 Anatase and Rutile by using Einstein–Debye Approximation, Acta Physica Polonica A, 133(2018) 126.

9. E. Eser, B. Duyuran, M.H. Bölükdemir, H. Koç, A study on heat capacity of oxide and nitride nuclear fuels by using Einstein-Debye approximation, *Nuc. Engin. Technology*, 52(2020) 1208.
10. Landau, L. D., Lifshits, E.M., 1980, *Statistical Physics*, Pergamon Press, London.
11. Askerov, B.M., Cankurtaran, M., 1994, Isobaric specific-heat and thermal expansion of solid in the Debye approximation. *Phys. Stat. Sol. B*, 185, 341-348.
12. Guseinov, I.I., Mamedov, B.A., 2007, Calculation of integer and noninteger n-dimensional debye functions using binomial coefficients and incomplete gamma functions. *Int. J. Thermophys* 28, 1420-1426.
13. Gradshteyn, I.S., Ryzhik, I.M., 1980, *Tables of Integrals, Series and Products*, Academic Press, New York.

DEMONSTRATING HEAT CAPACITY VARIATION OF ThN NUCLEAR FUEL FOR INTEGER AND NONINTEGER N-DIMENSIONAL DEBYE PARAMETER

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ABSTRACT

As is known, the use of nuclear energy plays an important role in the development of many countries. However, the selection of nuclear fuel suitable for both cost and security is essential for the industry. For this reason, nitrite based nuclear fuels have started to take priority among the fuels that are widely preferred in the nuclear industry. Scientists especially emphasize the determination of the thermophysical properties of nitrite based fuels. In this study, comparative results are given for the integer and noninteger values of the n parameter that arises in the n-dimensional Debye approach used to calculate the heat capacity of ThN, which is one of the nitrite based fuels.

Keywords: Nuclear fuel, Heat capacity, Debye approximation

ÖZET

Bilindiği gibi nükleer enerji kullanımı birçok ülkenin kalkınmasında oldukça önemli bir role sahiptir. Fakat hem maliyet hem de güvenlik açısından uygun nükleer yakıt seçimi sektör için esastır. Bu nedenle nükleer endüstride yaygın olarak tercih edilen yakıtlar arasında nitrit bazlı nükleer yakıtlar öncelik almaya başlamıştır. Bilim insanları özellikle nitrit bazlı yakıtların termofiziksel özelliklerinin belirlenmesi üzerinde durmaktadırlar. Bu çalışmada nitrit bazlı yakıtlardan biri olan ThN'in ısı kapasitesinin hesaplanmasında kullanılan n-boyutlu Debye yaklaşımında ortaya çıkan n parametresinin tamsayı ve kesir sayılı değerleri için karşılaştırmalı sonuçlar verilmiştir.

Anahtar Kelimeler: Nükleer yakıt, Isı kapasitesi, Debye yaklaşımı

GİRİŞ

Bilindiği gibi enerji ihtiyacını karşılamak için nükleer santrallerde güvenilir, ucuz ve verimli yakıt kullanımı oldukça önemlidir. Literatürden görüldüğü gibi en yaygın kullanılan nükleer yakıtlar Uranyum bazlı yakıtlardır [1-6]. Ayrıca Nitrit yakıt formlarının, hem oksit hem de metal alternatiflerine göre avantajlarının sayısı oldukça fazladır. Bunların başında genellikle yüksek ısı iletkenliği, yüksek erime noktası ve yüksek sile yoğunluğu gelir. Enerji ihtiyacının çoğunu nükleer santrallerden sağlayan ülkelerde nükleer atık problemi minimuma indirmek temel ihtiyaçtır. Uranyum-Plütonyum mononitridlerinin yanı sıra Toryum elementinin ve toryum mononitridlerinin (ThN) maliyet ve temizlik anlamında avantaj sağladığı görülmektedir [7]. Ayrıca dünyada Uranyum rezervlerinin dört katı kadar Toryum rezervi bulunmaktadır.

Nükleer yakıt olarak Toryum mononitritleri dikkate alındığında bu yakıtların verimlilik ve güvenlik açısından termal özelliklerinin belirlenmesi oldukça önemlidir. Literatürden görülebileceği üzere Uranyum-Plütonyum mononitridlerinin termal özelliklerinin belirlenmesi için yapılan çalışmalar Toryum mononitritlerine göre oldukça fazladır. Bu nedenle biz bu çalışmada ThN'in termal özelliklerinden biri olan ısı kapasitesini n-boyutlu Debye

yaklaşımını kullanarak hesapladık ve n parametresinin tamsayı ve kesir sayılı durumları için hesaplama sonuçlarını sunduk.

Formüller

Einstein-Debye yaklaşımı dikkate alınarak ısı kapasitesinin sıcaklığa bağlı ifadesi aşağıdaki gibidir [8-13]:

$$C_V = 3N_A k_B M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right), \quad (1)$$

burada N_A Avagadro sayısı, k_B Boltzman sabiti, θ_D Debye sıcaklığı, θ_E Einstein sıcaklığı, T ise sıcaklıktır. Ayrıca $M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right)$ fonksiyonu aşağıdaki gibidir:

$$M \left(\frac{\theta_D}{T}, \frac{\theta_E}{T} \right) = L_V \left(\frac{\theta_D}{T} \right) + (s-1)A \left(\frac{\theta_E}{T} \right). \quad (2)$$

(2) formülündeki $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu isochoric (sabit hacimde) ısı fonksiyonudur ve s kristal örgü noktasındaki atom sayısıdır. n -boyutlu kristal için, $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu

$$L_V \left(\frac{\theta_D}{T} \right) = n \left(\frac{T}{\theta_D} \right)^n \int_0^{\frac{\theta_D}{T}} \frac{t^{n+1} e^t dt}{(e^t - 1)^2} \quad (3)$$

şekindedir.

Ayrıca $L_V \left(\frac{\theta_D}{T} \right)$ fonksiyonu n -boyutlu tam ve kesir sayılı Debye fonksiyonu kullanılarak aşağıdaki gibi elde edilir:

$$L_V \left(\frac{\theta_D}{T} \right) = (n+1)D_n \left(1, \frac{\theta_D}{T} \right) - \frac{\theta_D}{T} \frac{n}{e^{\frac{\theta_D}{T}} - 1}. \quad (4)$$

Burada $D_n(\beta, x)$ katsayısı n -boyutlu Debye fonksiyonudur ve

$$D_n(\beta, x) = \frac{n}{x^n} \int_0^x \frac{t^n}{(e^t - 1)^\beta} dt \quad (5)$$

şeklinde gösterilir.

Ayrıca (2) formülündeki $A \left(\frac{\theta_E}{T} \right)$ katsayısı Einstein fonksiyonudur ve aşağıdaki gibi gösterilir [11]:

$$A \left(\frac{\theta_E}{T} \right) = \left(\frac{\theta_E}{T} \right)^2 \frac{e^{\frac{\theta_E}{T}}}{\left(e^{\frac{\theta_E}{T}} - 1 \right)^2} = \left[\frac{\theta_E}{2T} \frac{1}{\sinh \left(\frac{\theta_E}{2T} \right)} \right]^2. \quad (6)$$

Yukarıdaki formüllerden görüldüğü gibi n-boyutlu Debye fonksiyonunun analitik ifadesi aşağıdaki gibi türetilmiştir[14]:

$$D_n(\beta, x) = \frac{n}{x^n} \lim_{N \rightarrow \infty} \sum_{i=0}^N (-1)^i F_i(-\beta) \frac{\gamma(n+1, (i+\beta)x)}{(i+\beta)^{n+1}} \quad (7)$$

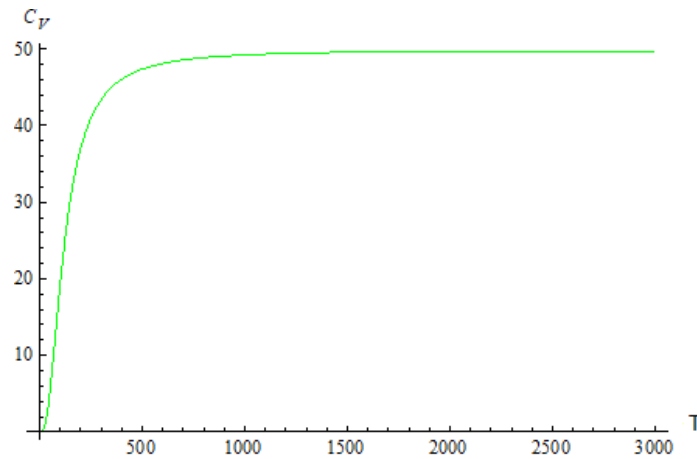
Burada N toplamın üst sınırıdır. Ayrıca $F_i(-\beta)$ ve $\gamma(n+1, (i+\beta)x)$ terimleri de literatürden iyi bilinen binomial katsayısı ve incomplete gamma fonksiyonlarıdır ve aşağıdaki gibi gösterilirler [15]:

$$F_m(n) = \begin{cases} \frac{n(n-1)\dots(n-m+1)}{m!} & \text{for integer } n \\ \frac{(-1)^m \Gamma(m-n)}{m! \Gamma(-n)} & \text{for noninteger } n \end{cases}, \quad (8)$$

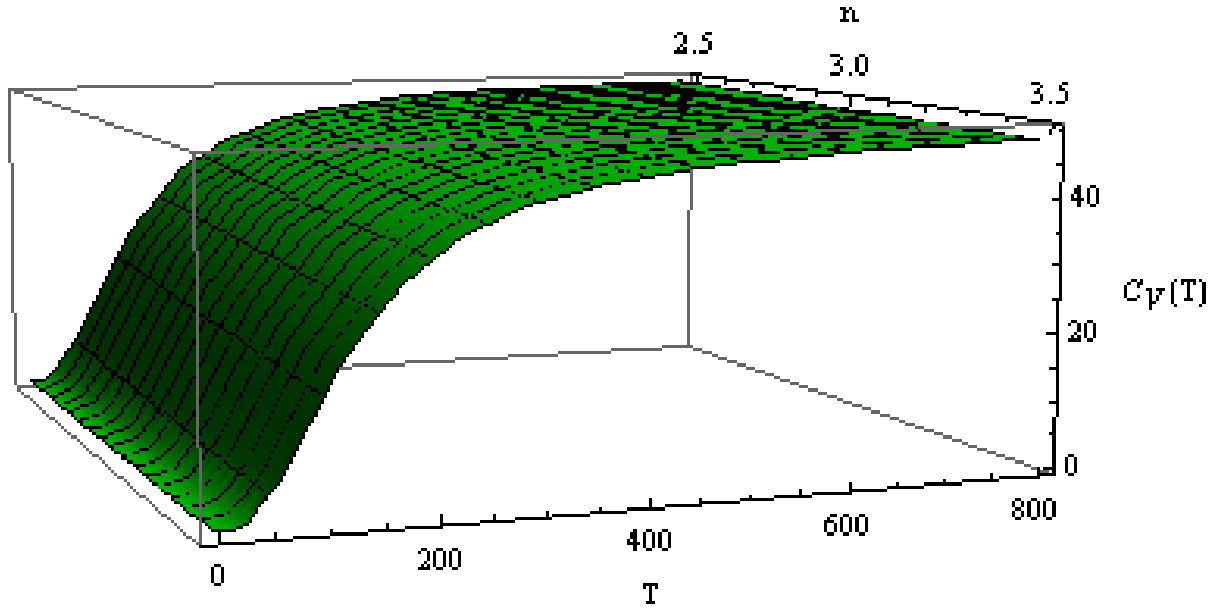
$$\gamma(\alpha, y) = \int_0^y t^{\alpha-1} e^{-t} dt. \quad (9)$$

Görüldüğü gibi sabit hacimdeki ısı kapasitesi için (1) formülü şeklinde verilen ifadeyi farklı maddeler için kullanabiliriz. Biz bu çalışmada ThN nükleer yakıtının ısı kapasitesini belirlemeyi amaçladık. Ayrıca bilindiği gibi n parametresi tamsayı ve kesir sayılı durumları içermektedir. Bu amaç doğrultusunda bu çalışmada n parametresinin aldığı tamsayı ve kesir sayı durumları için ısı kapasitesinin değişimine dikkat çektik.

Figür 1. ThN nükleer yakıtının C_V sabit hacimde ısı kapasitesinin sıcaklıkla değişimi ($n=3$, $\theta_E = 495K$, $\theta_D = 340K$)



Figür 2. ThN nükleer yakıtının C_V sabit hacimde ısı kapasitesinin sıcaklığa ve n parametresine bağlı değişimi ($2.5 \leq n \leq 3.5$)



TARTIŞMA VE SONUÇ

Bu çalışmanın konusu n -boyutlu Debye fonksiyonunu kullanarak ThN nükleer yakıtının termal özelliklerinden biri olan sabit hacimde ısı kapasitesinin, Debye fonksiyonunun değişeni olan n parametresinin tamsayı ve kesir sayılı durumları için nasıl değiştiğini inceledik. Yaptığımız tüm hesaplamalar Mathematica 10.0 programlama dilinde yapılmış olup elde ettiğimiz veriler Figür 1 ve Figür 2 şeklinde verilmiştir. Figür 1'de n parametresinin literatürde alınan değeri olan $n=3$ için hesaplama sonuçları verilmiştir. Figür 2'de ise n parametresinin 2.5 ve 3.5 değerleri aralığındaki tüm kesir ve tamsayı durumları için ısı kapasitesinin aldığı değerler verilmiştir.

REFERANSLAR

1. Peng, S, Grimvall, G., 1994, [Heat capacity of actinide dioxides](#). J. Nucl. Mater. 210, 115-122.
2. Hoch, M., Vernadakis, T., 1976, Thermodynamic properties of solid and liquid metals and
3. Ronchi, C., 2007, Thermophysical properties affecting safety and performance of nuclear fuel, High Temperature 45, 552-571.
4. Carbajo, J. J., Yoder, G. L., Popov, S. G., Ivanov, V. K., 2001, A review of the thermophysical properties of MOX and UO₂ fuels. J. Nucl. Mater. 299, 181-198.
5. Szpunar B. , Szpunar J.A., 2014, International Journal of Nuclear Energy, 2014, 7.

6. Pioro I.L., Khan M., Hopps V. et al., 2008, Journal of Power and Energy Systems, 2, 874.
7. Rogozkin, B. D., Stepenova, N. M., & Proshkin, A. A. 2003, Mononitride fuel for fast reactors. Atomic Energy, 95(3), 624-636.
8. Mamedov B.A., 2014, Nuclear Engineering and Design, .
9. Kang, K. H., Song, K. C., Yang, M. S., Lee, S. H., Ko, J. B., Kim, S. W., 2006, Thermophysical properties of multi-walled carbon nanotube-reinforced polypropylene
10. Koç, H., Eser, E., Mamedov, B.A., 2011, Calculation of heat capacity of the nuclear fuels
11. Landau, L. D., Lifshits, E.M., 1980, Statistical Physics, Pergamon Press, London.
12. Askerov, B.M., Cankurtaran, M., 1994, Isobaric specific-heat and thermal expansion of solid in the Debye approximation. Phys. Stat. Sol. B, 185, 341-348.
13. Cankurtaran, M., Askerov, V., 1996, Equation of state, isobaric specific heat, and thermal expansion of solids with polyatomic basis in the Einstein-Debye approximation. Phys. Stat. Sol. B, 194, 499-507.
14. Guseinov, I.I., Mamedov, B.A., 2007, Calculation of integer and noninteger n-dimensional debye functions using binomial coefficients and incomplete gamma functions. Int. J. Thermophys 28, 1420-1426.
15. Gradshteyn, I.S., Ryzhik, I.M., 1980, Tables of Integrals, Series and Products, Academic Press, New York.

**BURDUR GÖLÜ HAVZASINA FONKSİYONEL YAŞAM ALANLARI EKLENEREK
SÜRDÜRÜLEBİLİR EKOLOJİK YAŞAM ALANLARI OLUŞTURMAK****CREATING SUSTAINABLE ECOLOGICAL LIVING SPACES BY ADDING
FUNCTIONAL LIVING SPACES TO THE BURDUR LAKE****Dr. Ayşe ARICI**¹ Uluslararası Vizyon Üniversitesi, Mühendislik ve Mimarlık Fakültesi, İnşaat Mühendisliği
Bölümü, Gostivar, Kuzey Makedonya.¹ORCID ID: <https://orcid.org/0000-0002-8449-6052>**ÖZET**

Ulusal ve yerel ölçekte ekonomiye ve insan yaşantısına katkısı olan turizm ve rekreasyon faaliyetlerinin doğru ve etkin gelişimi için doğal ve kültürel değerlerin korunması, planlı ve sürdürülebilir gelişiminin dikkate alınması gerekir. Burdur Gölü Söğüt Dağı ile Sulu dere Yayla dağ kütleleri arasında kuzeydoğu-güneybatı doğrultusunda uzanan oluk şeklindeki tektonik çöküntünün sularla dolması ile oluşmuştur. Göl su seviyesinin son yıllardaki aşırı düşüşüne gölü besleyen dere ve çaylar üzerinde yapılan barajlar ve son yıllardaki bölgede yaşanan aşırı kuraklığın neden olduğu sanılmaktadır. Çevre sorunları, günümüzün en önemli yaşamsal konuları arasında yer almaktadır. Özellikle Burdur gölünün kuruması sonrasında bölgenin ekolojik dengesi üzerine artan bilinçsiz tüketim ile birçok olumsuz sonucu beraberinde getirmektedir. Bu çerçevede, Türkiye'nin altıncı büyük gölüdür. Burdur Gölü Havzası'nın ekolojisinin ve özellikle alanın endemik bitki türlerinin ve özel kuş türlerinin korunması, burdur gölünün giderek kuruması sonucunda göl çevresinde olumsuz etkiler gözlemlenmektedir. Burdur göl çevresi sahip olduğu doğal güzellikleri küresel sorunlardan dolayı kaybetmektedir. Bu nedenlerden dolayı bu alanda konutlarda yasayacak olan halk içinde tercih sırasını kaybetmekte turizm açısından da cazibesini kaybetmektedir. Söz konusu nedenlerin çözülmesi amacıyla bu çalışmada, ulusal ve uluslararası literatüre ve ayrıca bölgedeki gözlemlere dayanarak havzayı etkileyen etmenlerin incelenerek bu havzada nasıl bir planlama- yapılaşma – sosyal yaşam alanları ve çözümler eklenerek olası çözümler üretilerek yenilikçi öneriler üzerinde durulmuştur.

Anahtar Kelimeler: Burdur gölü, çevre sorunları, ekoloji, fonksiyonel yapılar.

ABSTRACT

For the correct and effective development of tourism and recreation activities that contribute to the economy and human life on a national and local scale, the protection of natural and cultural values and their planned and sustainable development should be taken into account. It is formed by the filling of a single submerged depression in the form of a mountainous gutter between the northeast-south S between Burdur Söğüt Mountain and Su Lake and Yayla mountain stacks. It is thought that the extreme decrease in the lake water level in recent years is caused by the dams built on the streams and streams feeding the lake and the extreme drought in the region in recent years. The environmental problem is among the vital places for us. Especially after the drying of the Burdur lake, the increased unconscious consumption on the ecological balance of the region brings many negative consequences. In this context, it is Turkey's sixth largest lake. As a result of the protection of the ecology of the Burdur Lake Basin, especially the endemic plant species and special bird species of the area, and the gradual drying of the Burdur lake, negative effects are observed around the lake. The natural beauties of the Burdur lake environment are

those who have gone through global problems. For these reasons, it loses the order of preference among the people who will live in residences in this area and loses its attractiveness in terms of tourism. In order to solve the aforementioned reasons, in this study, based on the national and international literature, as well as the observations in the region, the factors affecting the basin were examined and innovative suggestions were emphasized by producing possible solutions by adding planning-building-social living spaces and solutions in this basin.

Keywords: Burdur lake, environmental problems, ecology, functional structures.

1. GİRİŞ

Burdur Gölü Söğüt Dağı ile Sulu dere Yayla dağ kütleleri arasında kuzeydoğu-güneybatı doğrultusunda uzanan oluk şeklindeki tektonik çöküntünün sularla dolması ile oluşmuştur. Gölün batı kesimi boyunca uzanan fay hattı nedeniyle bu kısımda kıyı çizgisi çok dardır. Bu dar bölgelerde göl birden derinleşir. Gölün güney ve kuzeyinde ise alüvyonların birikmesi ile sazlarla kaplı ve delta oluşumu başlamıştır. Kapalı bir havzada yer alan gölün akıntısı yoktur. Göl suyu oldukça tuzlu olup ülkemizin en derin göllerinden birisidir. Derinlik bazı bölgelerde 100 metreyi bulur. Göl su seviyesinin son yıllardaki aşırı düşüşüne gölü besleyen dere ve çaylar üzerinde yapılan barajlar ve son yıllardaki bölgede yaşanan aşırı kuraklığın neden olduğu sanılmaktadır. Göl üzerinde yapılan araştırmalara göre besin maddeleri yönünden çok zengin olmadığı belirtilmektedir. Buna karşılık gölün yüze yakın kuş türüne ve yaklaşık olarak 300 bine yakın su kuşuna ve özellikle Dünyada nesli tükenmekte olan "dikkuyruk" ördeklerinin % 70'ine ev sahipliği yapmaktadır. Endemik kuş türlerinin barınma alanı olan Burdur Gölü uluslararası öneme sahip bir sulak alandır. 85 kuş türü yaşar.(URL;1)

2. BURDUR GÖLÜ VE ÇEVRESİ MEVCUT DURUM TESPİTİ VE DEĞERLENDİRİLMESİ

Burdur Gölü'nün fauna açısından özel değerlerini kuşlar oluşturmaktadır. Burdur Gölü kuş varlığı bakımından Türkiye'nin en önemli göllerinden birisidir. Sığ alanlar çok kısıtlı olmasına rağmen her yıl sonbahar ve kış mevsimlerinde 100 000 den fazla sığına ev sahipliği yapmaktadır. Bazı yıllar bu sayı 300 000 i aşmaktadır. Göl çok tuzlu olması sebebiyle kış aylarında donmadığı için Sakarmeke, Ördek ve Batağanlar kalabalık topluluklar oluştururlar. Tür sayısı çoğu zaman 100'ü aşmaktadır (Çevre Bakanlığı, 1998).

Burdur Havzası'nda arazi kullanımının bir bölümü ise sanayi faaliyetleri şeklindedir. Havzadaki sanayi merkezleri başlıca iki noktada toplanmıştır. Bunlardan biri Burdur şehri çevresi ve ikincisi havzanın kuzeydoğusundaki düzlükte yer alan Süleyman Demirel Organize Sanayi Bölgesi'dir. Burdur havzasının kuzeydoğu ucu idari bakımdan Isparta iline bağlıdır. Süleyman Demirel Organize Sanayi Bölgesi, Isparta şehir merkezine 26 km mesafede, Gümüşgün mevkiinde, 160 hektar ilave rezerv ve 252 hektar alanı ile İzmir-Antalya-Ankara karayolu kavşağında olup, bölünmüş yolla Isparta'ya bağlanmıştır. Demiryolu yükleme boşaltma istasyonuna 600 metre mesafede kurulmuştur. 1998 yılında işletmeye alınan Süleyman Demirel Devlet Hava Limanı bölgeye 4 km mesafededir. Burdur Organize Sanayi Bölgesi daha çok küçük sanayi kuruluşları içermektedir. Burdur il merkezindeki büyük sanayi kuruluşları ise havzadaki tarımsal ürünleri değerlendirmektedir. Bunlardan en büyüğü Burdur Şeker Fabrikası'dır, önceki yıllarda özel sektöre ait büyük süt fabrikası bugün kapalı durumdadır. Ancak Burdur Gölü Havzası'nda üretilen günlük 800 ton süt küçük işletmelerde veya çevre illerdeki fabrikalarda işlenmektedir. (H. YİĞİTBAŞIOĞLU , vd, 2010)

Gerçekte sulak alanlar, yeryüzünün en zengin ve en üretken ekosistemlerini oluşturmaktadır. Bu alanlar yöre insanlarına ve ülkenin geneline hizmet veren doğal sistemlerdir ve yeryüzündeki başka hiçbir ekosistemle karşılaştırılmayacak ölçüde değerlere sahiptir (Anonim, 2015).

Burdur Gölü ve çevresindeki tarım alanlarında ekolojik ve çevresel koşullara uygun olmayan ve su isteği yüksek tarımsal ürünlerin yetiştirilmesi, yoğun kültür çalışmaları ile toprağın besin maddesi açısından fakirleştirilmesi gibi yanlış ve bilinçsizce yapılan tarımsal faaliyetler bütüncül ekosistem üzerinde olumsuz etkiler meydana getirmektedir (Gül ve ark., 2015).

Göldeki tuzluluk oranına rağmen gölde yaşamaya adapte olmuş *Aphanius sureyanus* dünyada sadece Burdur Gölü'nde yaşamakta ve gölün yok olmasıyla birlikte nesli tehlike altına girmektedir. Bununla birlikte nesli küresel ölçekte tehlike altında olan dikkuyruk ördeğinin gölün seviyesindeki düşüşün etkilemesinden endişe edilmektedir.

Son yıllarda gölü besleyen akarsuların göle ulaşmaması ve gölün buharlaşma ile su kaybetmektedir. Gölün su seviyesinin düşmesinden dolayı tuzluluk oranı artmaktadır. Su seviyesindeki düşüşün en önemli nedeni tarımsal sulama amaçlı plansız bir şekilde gölü besleyen akarsular üzerine baraj ve göletlerin inşa edilmesidir. Havzada gölü besleyen en büyük akarsu gölün güneybatısındaki Bozçay'dır. Diğer akarsular ise Kıravgaz, Kurna, Çerçin, Lengüme dereleri ile kuzeydoğuda Keçiborlu'dan gelen Adalar Çayı'dır. Akarsular dışında Senir beldesi yakınlarındaki gür kaynak göle su sağlamaktadır. Ancak, bu kaynağın suları da Burdur Şehri'ne içme suyu sağlanması amacıyla kaynaktan alınarak iki boru yardımıyla gölün üstünden geçirilerek Burdur içme suyu şebekesine bağlanmıştır (Yiğitbaşıoğlu ve Uğur, 2005; Ataol, 2010; DSİ, 2015).

Mermer rezervleri bakımından oldukça zengin olan Burdur'da plansız ve kontrolsüz şekilde yürütülen mermercilik faaliyetleri havzayı çeşitli açılardan olumsuz etkilemektedir. Mermer ocaklarında su tüketimi fazla olmakta ve bu yeraltı suyunu dolayısıyla Burdur gölünü tehdit etmektedir(L.G.KAYA ve arkadaşları, 2015)

Havzadan geçip, gölü besleyen irili ufaklı dere ve çaylarla gerçekleşen yüzeysel akışla taşınan böcek öldürücü kimyasal madde ve sedimanlar da gölün kirlenmesine yol açmaktadır. Bunların dışında gölü doğrudan doğruya çevreleyen birincil derecedeki zonlarda bulunan 10-15 irili ufaklı yerleşim biriminden kaynaklanan kirleticiler de göle intikal etmektedir. Göle ulaşan akarsularda bol miktarda tarım ilacı ve yapay gübre taşımaktadırlar. (L.G.KAYA ve arkadaşları, 2015)

Sulama için doğal döngüsünden çıkarılan suyun büyük kısmı ilkel sulama yöntemleriyle israf edilmektedir. Göldeki su azaldıkça su kalitesi bozulmaktadır. Göl havzasının iklim koşullarında karasallık yönünde değişim görülecek, kış mevsiminde daha da düşecek olan gece sıcaklıkları nedeniyle özellikle meyvecilik zarar görecektir. Burdur kent sınırındaki ovalarda 72 adet sulama kooperatifi, 374 adet işletme sondaj kuyusu ile 12405 ha net, 14663 ha brüt arazi yeraltından sulanmaktadır (Anonim, 2009).

Gölde balıkçılık yapılmaması ve turizmin çok sınırlı olması nedeniyle çok az sayıda tekne bulunmaktadır. Geniş ve açık su yüzeyi, burada kışlayan kuşlar için güvenli bir ortam sağlamaktadır. Gölün güneybatı ve kuzeydoğu uçlarındaki sığ kesimler ve kıyılardaki çamur düzlükleri ise zengin besin varlığı ile kuşların beslenmesine olanak sağlamaktadır. Burdur Gölü Karaboyunlu Batağan ve Sakarmeke için hem sonbahar göçü esnasında hem de kış aylarında önem kazanmaktadır. 1997 yılı ekim ayında gölde 26.075 Karaboyunlu Batağan ve 252.726 adet Sakarmeke tespit edilmiştir. Göç sırasında çok sayıda kara sumru ve flamingo konaklamaktadır. Mahmuzlu kızkuşu, Angıt, Taş Bülbülü ve Kızılkiraz kuşu gölde üreyen

önemli türler arasındadır. Ayrıca, Mahmuzlu kızkuşu, Suna, Sakarmeke, Uzunbacak ve Bahri de kuluçkaya yatmaktadır (URL;2)

3. MATERYAL VE YÖNTEM

Çalışma evreni olarak belirlenen alan Burdur gölü ve çevresi mevcut durum, konut tipleri mevcut ticari faaliyet türleri tespit edilerek ihtiyaçlarını karşılayıp karşılamadığı ve beklentileri belirlenmiştir. Araştırma için değişik kaynaklardan yararlanılmıştır. Literatür, haritalar, hava fotoğrafları ve uydu görüntüleri yardımıyla gerek günümüzdeki durum gerekse geçmişten bugüne kadar olan değişim incelenmiştir. Arazi çalışmaları ile arazi kullanım özellikleri incelenmiştir. Uydu görüntüleri ve kamu kurumlarınca hazırlanan veriler incelenerek bölge için sürdürülebilir mimari ve sürdürülebilir yapı malzemeleri ile ekolojik bir formda modern ve konforlu yapı malzemeleri ile farklı plan önerileri araştırılmıştır. Ayrıca, yerel halk ve yöneticilerle sorunlar ve çözüm önerileri hakkında görüşmeler yapılmıştır. Daha önce bölge için yapılan çözüm önerileri incelenmiştir ve yeni öneriler geliştirilmiştir.

4. BULGULAR

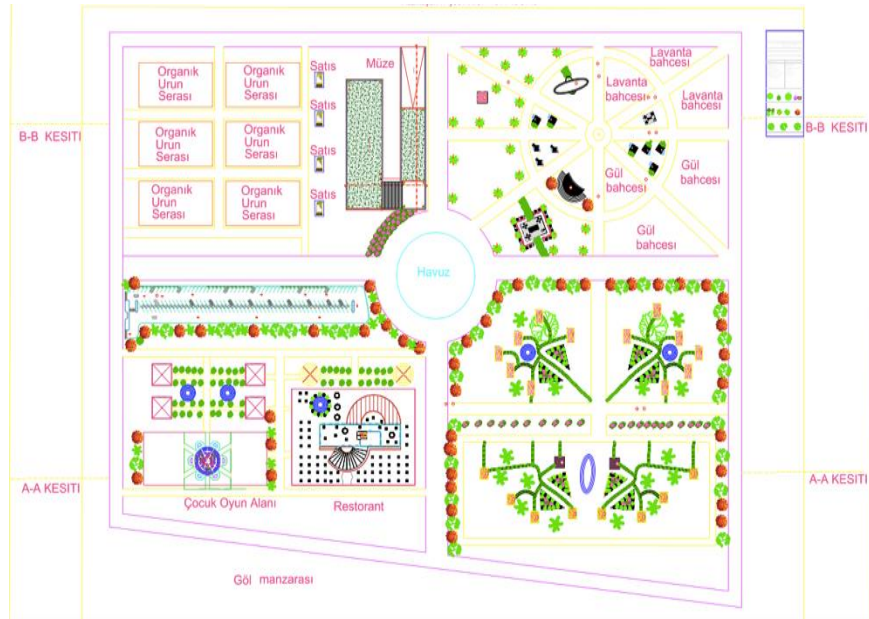
Araştırmanın evreni olarak, Burdur gölü ve çevresi 'dir. Öncelikle burdur gölü ve çevresi için kamu kurumlarınca hazırlanan verilere ulaşarak göl çevresinde bir alan belirlenmiştir. Çalışmada elde edilen bulgular üzerinde geliştirilen yeni form aşağıda resimlerde gösterilmiştir. Örneklem çalışma alanı olarak belirlenen alan (Resim 1)' de gösterilmiştir. Çalışma alanı autocad programında tasarım yapılarak 2 boyutlu şekilde çizilmiştir. Vaziyet planı ve vaziyet planı üzerinde 2 farklı kesit alınarak kesit görselleri oluşturulmuştur. (resim 3 ve resim 4) Daha sonra ise revit 3d programı ile üç boyutlu görselleri oluşturulmuştur.



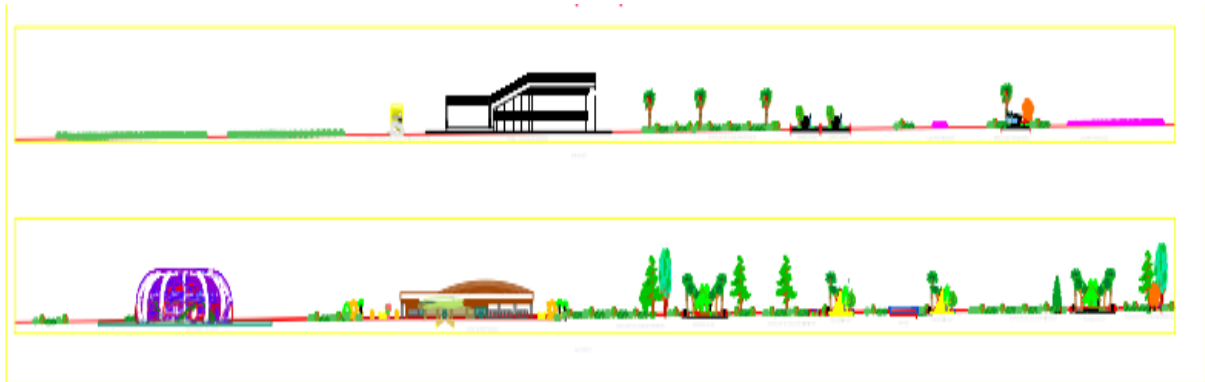
Resim 1 (URL;3)

Çalışma alanı olarak belirlenen bölgede ışınsal bir merkez tasarlandı ve 4 parselle ayrılarak parseller kendi içersinde amacına göre çözümlendi. Öncelikle yerel ürünlerin -doğal ürünlerin üretiminin gerçekleştirileceği seralar tasarlandı bölgeye turistik amacı ile gelen misafirlere hizmet sağlayacaktır yada yöre halkı isterse bu alanda ürünleri yetiştirebileceklerdir. Ürünlerin tohumlarının ve işlenmemiş doğal yerel tohumların sergileneceği bir müze yer almaktadır. Yetiştirilen yerel ürünlerin satışının gerçekleştirilmesi için bozulmadan saklanarak paketlenmesi için satış noktaları tasarlanmıştır. Diğer parselde millet bahçesi şeklinde tasarlanmıştır. İçersinde botanik bir bahçe bulunmaktadır, gül bahçeleri, lavanta bahçeleri fotoğraf turizmi sağlayacaktır ayrıca ferah ve huzur verici bir manzara sağlayacaktır. Yörenin

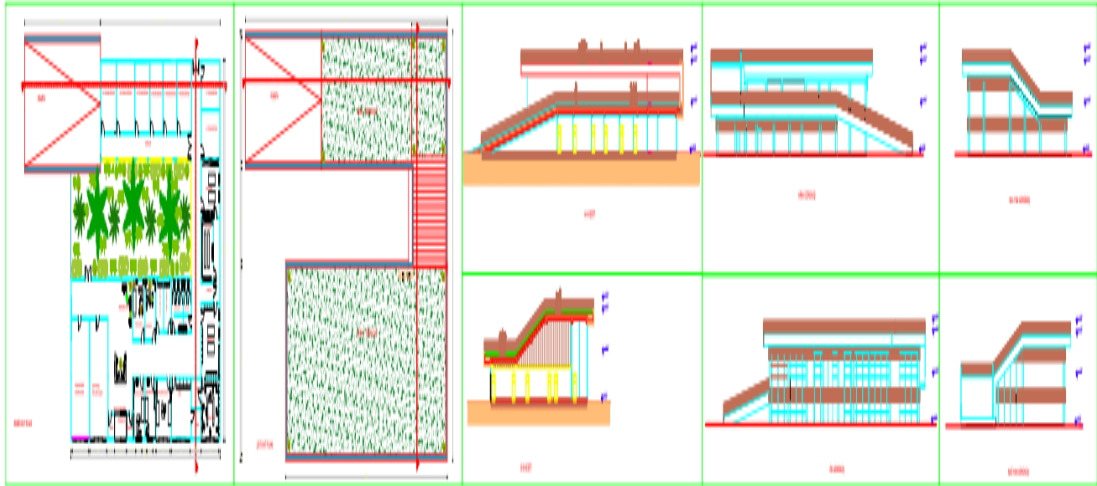
iklimi uygundur ve su ihtiyacı oldukça az olacaktır. Bu millet bahçesi içerisinde ışınal bir form kullanılmıştır. Cafeler ve kamelyalardan oluşan dinlenme alanları oluşturulmuştur. 3.parselde ise çocuk oyun alanı ve restoran-cafe özelliği olan bir restoran tasarlanmıştır. Geniş yeşil alanlara sahiptir. Post-covid döneminde sosyal mesafeler uygun şekilde tasarlanmıştır. Güvenli ve ferah alanlar elde edilmiştir. Herhangi bir salgın hastalık dönemi içinde güvenli şekilde kaliteli zaman geçirmek için tasarlanmıştır. Son parselde ise doğal yaşam koşullarında huzurlu ve sosyal mesafelere uygun şekilde iki tip bungalow ev tasarlanmıştır. Bungalow evler ahşap yapı malzemesi kullanılarak tasarlanmıştır. Doğal nefes alan ahşap malzeme sayesinde ekolojik bir ortamda misafirlerini ağırlayabilecek şekilde tasarlanmıştır.



Resim 2 Vaziyet Planı (Arıcı,2021)



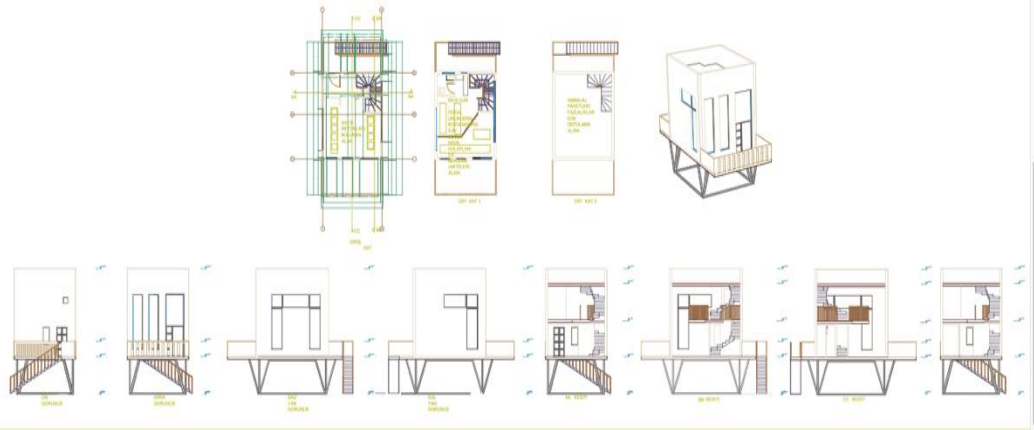
Resim 3 Vaziyet Planı - kesitleri (Arıcı,2021)



Resim 4 Yerel Tohumlar Müzesi Plan-Kesitler Ve Görünüşler (Arıcı,2021)



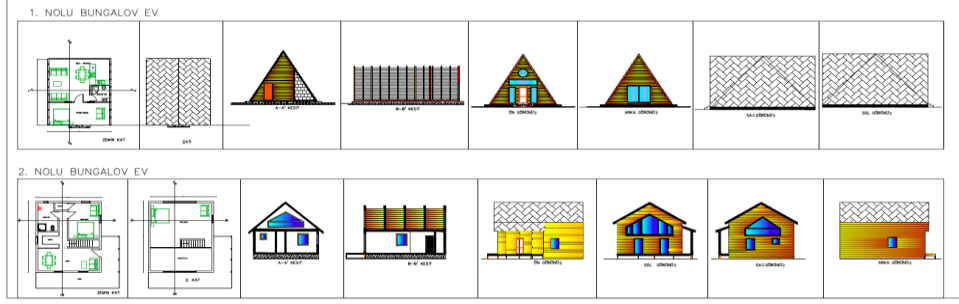
Resim 5 Yerel Tohumlar Müzesi Üç Boyutlu Görünüşler (Arıcı,2021)



Resim 6 Yerel Ürünler Satış Noktaları Plan-Kesitler-Görünüřler (Arıcı,2021)



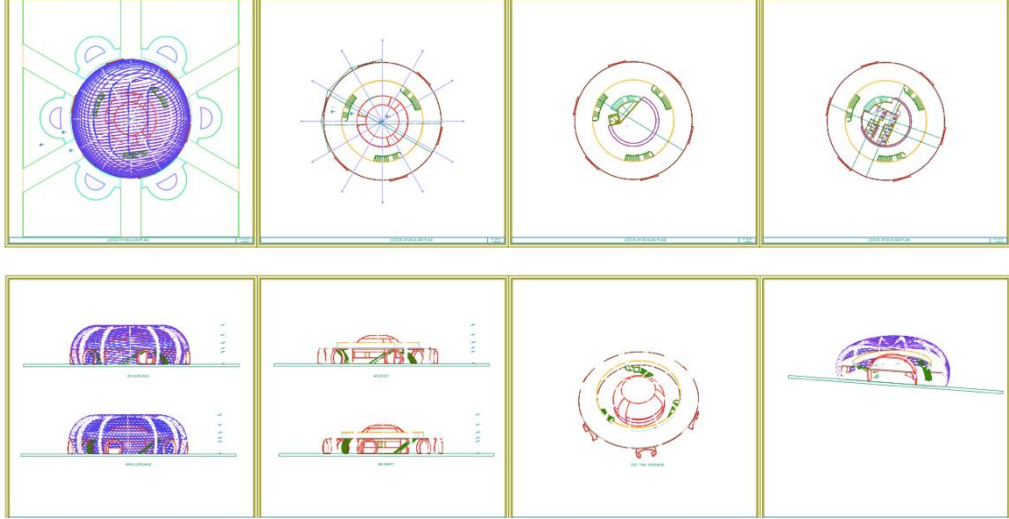
Resim 7 Yerel Ürünler Satış Noktaları Üç Boyutlu Görünüřler (Arıcı,2021)



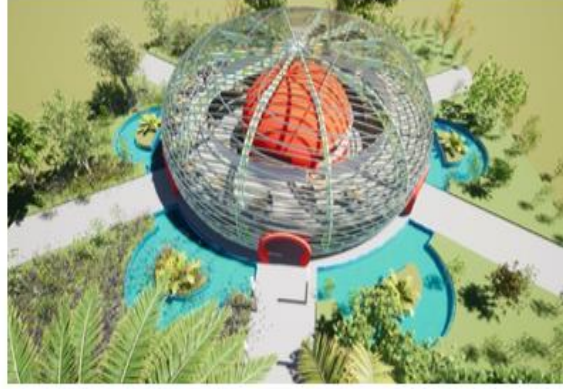
Resim 8 Bungalow Evler Tip 1 Ve Tip 2 Planlar-Ksitler-Görünüřler (Arıcı, 2021)



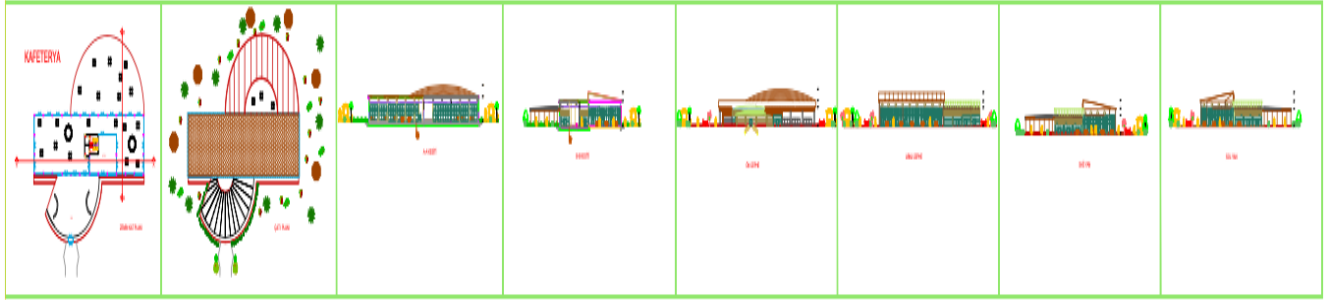
Resim 9 Bungalow Evler Tip 1 Ve Tip 2 Üç Boyutlu Görünüřler (Arıcı, 2021)



Resim 10 Çocuk Oyun Alanı – Planlar-Kesitler- Görünüřler (Arıcı, 2021)



Resim 11 Çocuk Oyun Alanı Üç Boyutlu Görünüřler (Arıcı, 2021)



Resim 12 Restoran Plan-Kesitler-Görünüşler (Arıcı, 2021)



Resim 13 Restoran Üç Boyutlu Görünüşler (Arıcı, 2021)

5. TARTIŞMA, SONUÇ VE ÖNERİLER

Çalışmada, Burdur Gölü Havzası'nı tehdit eden başlıca unsurların barajlar, endüstriyel atıklar, bilinçsiz tarımsal faaliyetler, mermer rezervlerinin su tüketimi olduğu anlaşılmıştır. Çalışma alanında verimli bir planlama ve planlamada kullanılan yapı malzemelerinin uygun seçimi ile kullanışlı – sürdürülebilir bir yaşa alanı oluşturulacaktır. Bu unsurlara ilişkin çözüm önerileri aşağıda maddeler halinde sunulmuştur;

Kentteki atık su arıtma tesisi aktif şekilde kullanılması gerekmektedir. Burdur Organize Sanayi Bölgesi için arıtma tesisi inşaatı yapılmalıdır. Bu su arıtma tesisinin uygun kapasitede olması ve fonksiyonel kullanıma sahip olması yalıtım sistemleri malzeme seçimi doğru şekilde yapılmalıdır. Kentte bulunan Şeker fabrikasının da atıklarını doğrudan göle verilmemelidir. Buradan çıkacak olan atık sular için düzgün çalışacak bir atık su arıtması sağlanmalıdır. Bu tesislerin inşaatının aşamaları uygun proseslerden geçirilmelidir. Yapı malzemeleri seçimi standartlara uygunluğu denetlenmelidir.

Tarımsal faaliyetlerde damlama sulama sisteminin yaygınlaştırılması sağlanmalıdır. Doğru ve bilinçli tarım faaliyetleri yöre halkına öğretilmeli ve bilinç oluşturulmalıdır. Az su tüketen ve

daha verimli ıslah edilmiş bitki türleri yetiştirilmelidir bu şekilde hem tarımsal faaliyetler sürdürülecektir hemde su tüketimi en az seviyede kalacaktır. Ayrıca, bazı araştırmacıların (örneğin Yüksel ve Yüksel, 2011) sunduğu, enerji tasarruflu bilgi ve iletişim teknolojilerinin (RFID Sistemleri, Kablosuz Algılayıcı Ağlar vb.) tarımsal faaliyetlerde etkin kullanımı da sağlanabilir.

Kent alanının genişlemesi kontrollü ve planlı şekilde cazibe merkezi haline getirilebilir. Kuş gözlem rasathaneleri tasarlanarak inşası yapılmalıdır. Çalışması denetlenmelidir. Kent koruma sit alanları

Mermer ocaklarının işletilmesi ile ilgili mevcut yasal düzenlemelerin acilen revize edilmesi ve ek düzenlemelerin gerçekleştirilmesi gerekmektedir. Mermer ocaklarının faaliyeti sonlandırıldıktan sonra o alanın restorasyon çalışmalarının da tamamlanmalıdır. Mermer ocakları yerine az su gerektiren bitki ve ağaçlarla güzel ve estetik alanlar oluşturulmalıdır.

Göl çevresine geniş bir millet bahçesi yapılmalıdır içerisinde amfi tiyatro alanı, kamelyalar, cafeler bulunduran geniş lavanta ve gül bahçeleri ile fotoğraf turizmi içinde misafirlerin ilgisini çekebilecek şekilde tasarlanmalıdır. Bungalov evler ile doğaya uyumlu yaşam alanları oluşturulmalıdır. Yapı malzemesi doğa ile uyumlu olmalıdır. Çocuk oyun alanları, restoranlar ile farklı misafirlerde hizmet sunabilecek potansiyeli olmalıdır. Yerel tohum müzesinde işlenmemiş değiştirilmemiş tohumlar bulundurulacak doğa ile uyumlu yeşil ve canlı bitkilerle ferah bir alan tasarlanmalıdır. İlgili ve uygun alanlara yamaç paraşütü için tesis tasarlanmalıdır. Bu bölgede farklı zevkleri olan misafirlerin kendilerinden birsey bularak ziyaret edip kaliteli zaman geçirebilecekleri sosyal mesafeleri uygun kullanışlı sürdürülebilir yapılar yapılmalıdır.

KAYNAKLAR

1. (A. Arıcı, 2019) ‘‘Kırsal Yapıların Sürdürülebilirliğinin İncelenmesi: Çankırı İli Örneği’’ Doktora Tezi, İnşaat Mühendisliği Ve Mimarlık Fakültesi, Uluslararası Travnik Üniversitesi, Travnik.
2. Çevre Bakanlığı, 1998. Burdur Gölü. Çevre Koruma Müdürlüğü, Ankara
3. (Hakan YİĞİTBAŞIOĞLU , Abdullah UĞUR) Burdur Gölü Havzasında Arazi Kullanım Özelliklerinden Kaynaklanan Çevre Sorunları Ankara Üniversitesi Çevrebilimleri Dergisi 2(2), 129-143 (2010)
4. Anonim (2015). <http://bolge9.ormansu.gov.tr>.
5. Gül, A., Yılmaztürk, A., Caran, Ş., Ünal, Y., Örucü, Ö.K., Ber- beroğlu, E. (2015). Burdur Gölü Ve Çevresinde Ekosistem Üzerindeki Çevresel Etkiler Ve Stratejik Mekansal Çözümler. Uluslararası Burdur Deprem ve Çevre Sempozyumu 7-9 Mayıs 2015, Mehmet Akif Ersoy Üniversitesi, Burdur- Türkiye.
6. Yiğitbaşıoğlu, H., Uğur, A. (2005). Burdur Gölü'nün Jeoekolojik Özellikleri ve Sorunları. Türkiye Kuvaterner Sempozyumu V Bildiri Özetleri, İstanbul, 100-1003.
7. Latif Gürkan KAYA, Cengiz YÜCEDAĞ, Özge DURUŞKAN (2015) Burdur Gölü Havzasının Çevresel Açından İrdelenmesi, Mehmet Akif Ersoy Üniversitesi Fen Bilimleri Enstitüsü Dergisi 6(1): 6-10 (2015) The Journal of Graduate School of Natural and Applied Sciences of Mehmet Akif Ersoy University 6(1): 6-10 (2015)
8. Anonim (2009). http://cdr.cevre.tr/icd_raporlari/burduricd2009.pdf.
9. (URL;1) <https://burdur.ktb.gov.tr/TR-154880/burdur-golu.html>
10. (URL;2) www.burdur-cevreorman.gov.tr/files/burdur.htm(Kasım 2010)
11. (URL;3) <https://parselsorgu.tkgm.gov.tr/>

18 YAŞ ALTI HASTALARA VERİLEN EVDE SAĞLIK HİZMETLERİNİN DEĞERLENDİRİLMESİ

EVALUATION OF HOME HEALTH SERVICES PROVIDED TO PATIENTS UNDER 18
YEARS OF AGE

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ÖZET

Evde bakım hizmeti; fiziksel, sosyal ve ruhsal açıdan bakıma ihtiyaç duyan bireylere evde ve aile ortamında tedavi, rehabilitasyon ve koruyucu amaçlı sağlık hizmetlerinin sürekli ve etkili bir biçimde sunulması şeklinde tanımlanmıştır. Evde bakım hizmetlerinden faydalanan yaş grupları değerlendirildiğinde, çoğunlukla yaşlı hastalar olduğu ancak bebek ve çocukların da bu hizmetlerden faydalandığını gördük. Çocuklar fiziksel, ruhsal, sosyal açıdan erişkinlerden farklılıklar gösterdiğinden , çocuklara verilen evde bakım hizmetleri de özel bir ilgi ve emek gerektirir. Çocukların sadece hastalığını değil aynı zamanda ruhsal ve sosyal ihtiyaçlarını da göz önünde tutmak gerekmektedir. Evde bakım hizmetlerinin, çocukların hastaneye yeniden yatışlarını azaltmada etkinliğine dair bir kanıt bulunmamış olsa dahi , hastanede yatış sürelerini önemli ölçüde azalttığı tespit edilmiştir. Ülkemizde son yıllarda evde bakım hizmetlerine ilgi hızla artmaktadır. Bu çalışma bir Eğitim ve Araştırma Hastanesi'nde Mayıs 2021 itibarıyla Evde Sağlık Hizmetleri (ESH) Birimine kayıtlı 18 yaş altı pediatrik grubun cinsiyet, yaş, eşlik eden hastalıkları, fiziksel gereksinimlerini karşılama durumları gibi parametreleri değerlendirmiştir. 51 hastanın 26 sı(%51) kız ,25'i (%49) erkekti.Yaş ortalamaları 11,078 yıl olup en küçüğü 2, en büyüğü 18 yaşındaydı.Hastaların yeme,içme,tuvalet,banyo ihtiyacı ve kişisel gereksinimlerini karşılama durumları incelendiğinde ; %74.5 'inin (n:38) yatağa tam bağımlı,%21'i (n:11) yatağa yarı bağımlıyken sadece 2 hastanın fiziksel gereksinimlerini karşılarken kimseye ihtiyaç duymadıkları görüldü.Hastaların %16'sı (n:8) yardımcı araç olarak tekerlekli sandalye kullanıyorken %12'si (n:6) ev tipi ventilatör kullanıyordu. 1 hasta koltuk değneği, 1 hasta akülü araba kullanıyordu. 5 hastada trekeostomi ,3 hastada nazogastrik sonda(NG) mevcutken, 3 kişi perkütan endoskopik gastrotomi (PEG) yardımıyla besleniyordu. 18 yaş altı ESH alan tüm pediatrik yaş grubunda en az 1 komorbit hastalık mevcuttu. Hastaların çok büyük bir kısmı %41'i Serebral Palsi tanısı ile takip edilmekteyken, %37'sinde(n:19) Epilepsi ,%16 'sında (n:8) Motor Mental Retardasyon (MMR) mevcuttu. 2 hastada Down Sendromu ve 2 hastada hipotiroidi tanısı vardı. Birer hastada West Sendromu,Spinal Muscular Atrofi ,Fenilketonüri, Duchenne Muskuler Distrofi, Spina Bifida, Osteogenesis Imperfecta, Guillain Barre , Atrial Septal Defekt, Extrofia Vezika mevcuttu.

Anahtar Sözcükler: Evde Sağlık, Hizmetler, 18 Yaş Altı Hasta

ABSTRACT

Home Care Service; It is defined as the continuous and effective provision of treatment, rehabilitation and preventive health services at home and in the family environment to individuals who need physical, social and spiritual care. When the age groups benefiting from home care services are evaluated, we see that mostly elderly patients, but infants and children also benefit from these services. Since children differ from adults physically, mentally and

socially, home care services for children also require special attention and effort. It is necessary to take into account not only the illness of children, but also their mental and social needs. Although there is no evidence of the effectiveness of home care services in reducing children's hospital readmissions, it has been found to significantly reduce the length of hospital stay. In our country, interest in home care services has been increasing rapidly in recent years. This study evaluated parameters such as gender, age, comorbidities, and physical needs of the pediatric group under the age of 18 registered to the Home Health Services (HHS) Unit in a Training and Research Hospital as of May 2021. Twenty-six (51%) of 51 patients were female and 25 (49%) were male. The mean age was 11,078 years, with the youngest 2 years old and the oldest 18 years old. When the patients' eating, drinking, toilet, bathroom needs and meeting their personal needs are examined; While 74.5% (n:38) were fully bedridden and 21% (n:11) semi-bounded, it was observed that only 2 patients did not need anyone while meeting their physical needs. While 16% (n:8) of the patients were using a wheelchair as an aid, 12% (n:6) were using a home ventilator. 1 patient was using crutches, 1 patient was using a battery car. While 5 patients had trecheostomy, 3 patients had nasogastric tube (NG), 3 patients were fed with percutaneous endoscopic gastrostomy (PEG).

There was at least 1 comorbid disease in all pediatric age group who received HHS under the age of 18. While 41% of the patients were followed up with the diagnosis of Cerebral Palsy, 37% (n: 19) had Epilepsy and 16% (n: 8) had Motor Mental Retardation (MMR). 2 patients had Down Syndrome and 2 patients had hypothyroidism. One patient each had West Syndrome, Spinal Muscular Atrophy, Phenylketonuria, Duchenne Muscular Dystrophy, Spina Bifida, Osteogenesis Imperfecta, Guillain Barre, Atrial Septal Defect, Extrophia Vesica.

Keywords: Home Health, Services, Patients Under 18

1.GİRİŞ

Evde Bakım Hizmetleri ; koruyucu tedavi ve rehabilite edici hizmetlerin sürekli ve etkin bir şekilde sağlanması, sağlık hizmetlerini destekleyip güçlendirmek prensibini hedefleyen bir bakım sistemidir. (Evde Bakım Derneği Yönetim Kurulu, 2010)

Evde Sağlık Bakımı, Dünya Sağlık Örgütü tarafından "birey ve ailenin yaşadıkları ortamda, hastalık ve engel durumunun etkisini en aza indirmek, bireylerin sağlıklarını korumak, sürdürüp geliştirmek ve yeniden yapılandırmak ya da kişilerin bağımsızlıklarını en üst seviyeye getirmek için verilen hizmet" şeklinde tanımlanmıştır (World Health Organization (WHO),2012)

Birey ve ailesinin ihtiyaç duyduğu fiziksel, duygusal, sosyo-ekonomik ve çevresel tüm boyutları içeren evde bakım hizmetleri ekip çalışmasını zorunlu kılmaktadır. Ekip içinde doktor, hemşire, solunum terapisti, fizyoterapist, konuşma terapisti, sosyal hizmet uzmanı, diyetisyen ve çocuğun gereksinimine göre pek çok meslek grubu yer almaktadır. (Pillitteri A. ,2014), (Törüner EK. ,2018)

Evde sağlık hizmeti, farklı branş ve mesleklerin işbirliği içinde yürüttüğü, devamlılık arz etmesi gereken bir hizmettir. Bu ekip içerisinde profesyonel meslek üyeleri olarak; hekim, hemşire, sosyal hizmet uzmanı, fizyoterapist, , konuşma terapisti, beslenme ve diyet uzmanının yer alması uygundur. Bu ekibin vazgeçilmez bileşeni ise hastanın kendisi ve hasta ile birlikte yaşayan diğer aile bireyleridir. Kişinin bakımına yardım eden kişiler de varsa ,onlar da bu ekibin parçası olarak görev üstlenirler. Evde bakım hizmetleri ekibinin bütün üyelerinin işbirliği içerisinde çalışmalarını önem arz etmektedir. (Paksoy-Erbaydar N. , 2012)

Çocuklara sunulan evde bakım hizmetleri özel bir ilgi ve yetenek gerektirir. Çocuklar fiziksel, ruhsal, sosyal açıdan erişkinlerden farklılıklar gösterdiğinden onların sadece hastalığını değil aynı zamanda ruhsal ve sosyal ihtiyaçlarını da göz önünde tutmak gerekir.(Uçman ve diğerleri, 2015

Evde bakım hizmetlerinin, çocukların hastaneye yeniden yatışlarını azaltmada etkinliğine dair bir kanıt bulunmasa da, hastanede kalış sürelerini önemli ölçüde azalttığı tespit edilmiştir.

(Parab ve diğerleri ,2013)

Sağlığı korumak ve yaşam kalitesini artırmak için en uygun yöntemlerden birisi kabul edilen Evde Sağlık Hizmetleri pek çok ülkede uygulanmakta ve bu uygulama ülkemizde de hızla gelişmektedir. Evde bakım birimlerden hizmet alan yaş grupları değerlendirildiğinde, çoğunlukla yaşlı hastalar olduğu ancak kronik hastalığa sahip her yaş grubundan, bebek ve çocukların da bu sağlık hizmetlerinden faydalanabildiği görülmektedir.

2. MATERYAL VE YÖNTEM

Çalışmamızda Adıyaman Eğitim ve Araştırma Hastanesi'nde Mayıs 2021 tarihi itibarıyla Evde Sağlık Hizmetleri (ESH) Birimine kayıtlı 18 yaş altı pediatrik grubun cinsiyet, yaş, eşlik eden hastalıkları, fiziksel gereksinimlerini karşılama durumları ve kullandıkları yardımcı araçlara ait özellikleri retrospektif olarak değerlendirilmiştir. Çalışmanın yapılabilmesi için Adıyaman Eğitim ve Araştırma Hastanesi'nden Başhekimlik Onayı alınmıştır. Çalışmaya Mayıs 2021 itibarıyla ESH'ye kayıtlı 18 yaş altı tüm hastalar (n:51) dahil edilmiştir. Hastane kayıtları taranarak elde edilen veriler SPSS 20.0 (Statistical Package for Social Sciences) paket programı ile sayı ve yüzdelik testi kullanılarak değerlendirilmiştir.

3.BULGULAR

Hastanenin evde bakım biriminde kayıtlı olan veriler değerlendirildiğinde; 18 yaş altı 51 hastanın %51'i(n=26) kadın, %49'u (n= 25) erkekti. Hastaların yaş ortalaması 11,0784 ($\pm 4,91871$) yıldır. Hastaların en küçüğü iki (2),en büyüğü on sekiz (18) yaşındaydı.

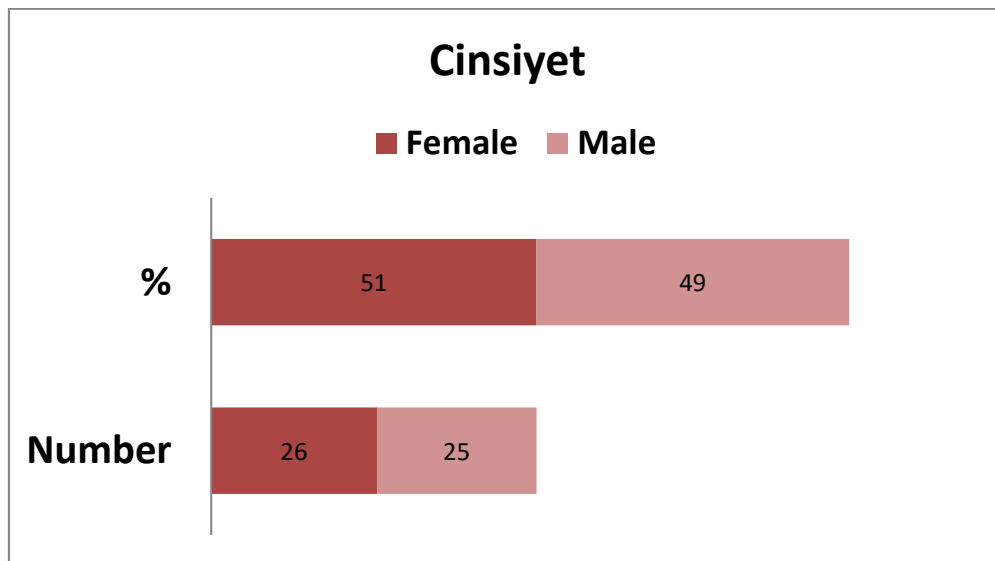


Figure 1. Evde Sağlık Hizmeti Alan Pediatrik Grubun Cinsiyet Dağılımı

Hastaların yeme,içme,tuvalet,banyo ihtiyacı ve kişisel gereksinimlerini karşılama durumları incelendiğinde ; %74.5 'inin (n:38) yatağa tam bağımlı,%21'i (n:11) yatağa yarı bağımlıyken sadece 2 hastanın fiziksel gereksinimlerini karşılarken kimseye ihtiyaç duymadıkları görüldü.Bu dağılım Tablo 2'de sunulmuştur.

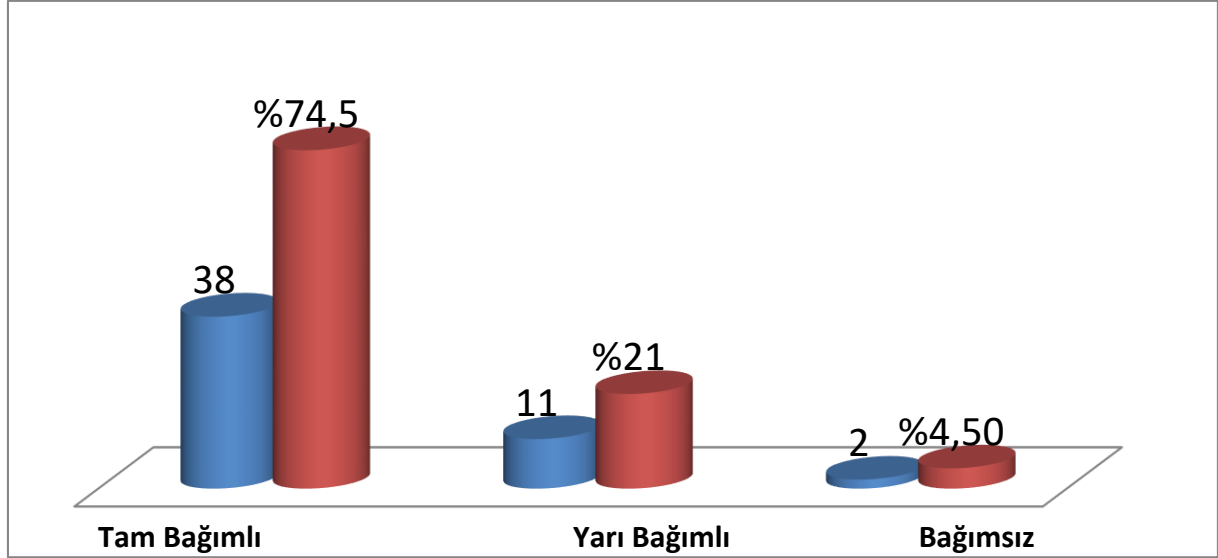


Figure 2. Hastaların Fiziksel Gereksinimlerini Karşılama Durumları

18 yaş altı ESH alan tüm pediatrik yaş grubunda en az 1 komorbid hastalık mevcuttu. Hastaların çok büyük bir kısmı %41'i Serebral Palsi tanısı ile takip edilmekteyken, %37'sinde(n:19) Epilepsi ,%16 'sında (n:8) Motor Mental Retardasyon (MMR) mevcuttu. 2 hastada Down Sendromu ve 2 hastada hipotiroidi tanısı vardı. Birer hastada West Sendromu,Spinal Muscular Atrofi ,Fenilketonüri, Duchenne Muskuler Distrofi, Spina Bifida, Osteogenesis Imperfecta, Guillain Barre , Atrial Septal Defekt, Extrofia Vezika mevcuttu. Çalışma grubumuzun hastalık tanılarına ait dağılımı Tablo 3'de sunulmuştur.

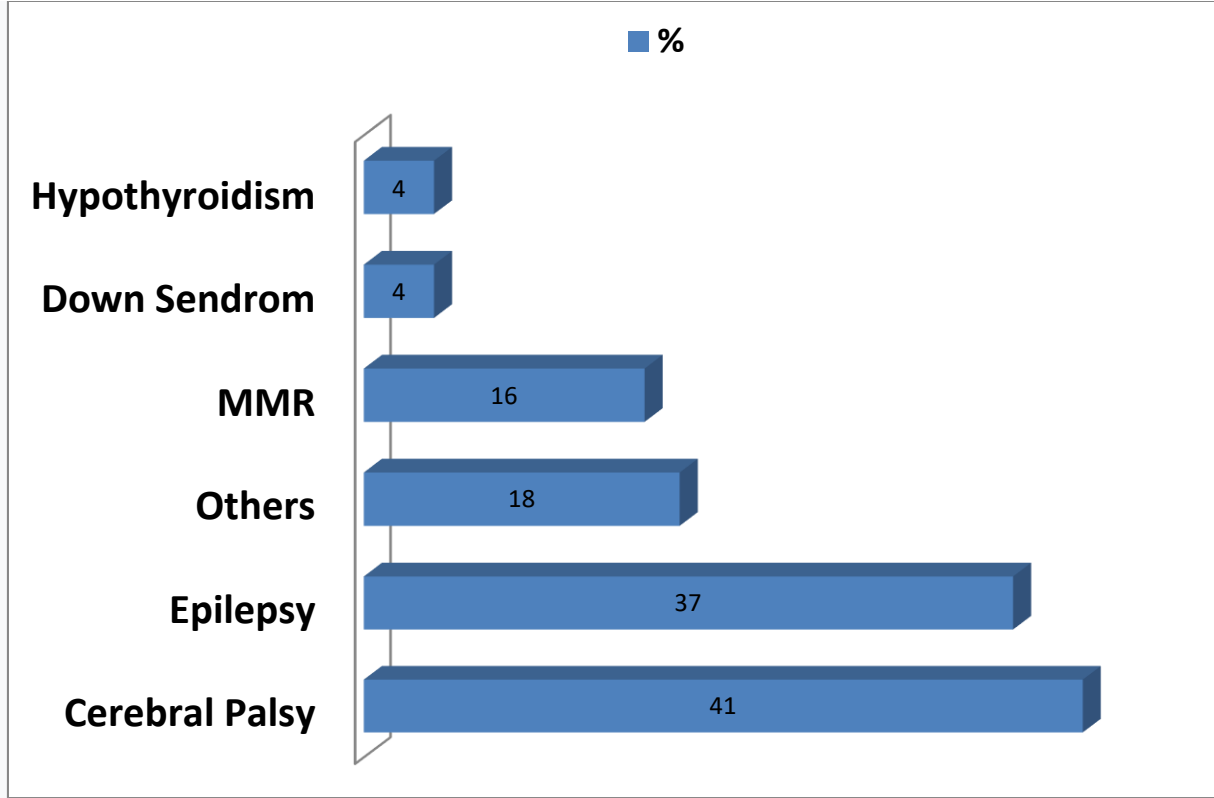


Figure 3. Hastaların Tanı Dağılımları

4.TARTIŞMA-SONUÇ VE ÖNERİLER

Çocuk evde bakım hizmetlerini değerlendirdiğimiz çalışmamızda erkek/ kız oranı 0.96 iken iken, yaş ortalaması ise 11,0784 (± 4,91871) yıl olarak tespit edildi. Çadırcı ve arkadaşlarının yaptığı çalışmada yaş ortalaması 11±4,2 olup çalışmamızla uyumludur. (Çadırcı ve diğerleri, 2019)

Adıyaman ilinde yapılmış bu çalışma ile komşu ili Şanlıurfa'da Çadırcı ve arkadaşlarının yaptıkları çalışmanın birbiriyle paralellik gösterip; yaş ortalamalarının benzer çıkması ancak literatür çalışmalarına göre (Ayar ve diğerleri, 2014) ile (Palfrey ve diğerleri 2004)daha yüksek çıkma sebebi ; bölgenin verilen sağlık hizmetleri konusunda bilinç düzeyinin daha az olması ve hastaları için Evde Sağlık Hizmetleri Birimine daha geç müracaat etmeleri şeklinde yorumlanabilir.

Hastaların fiziksel gereksinimlerini karşılama durumları incelendiğinde ; %74.5 'inin (n:38) yatağa tam bağımlı,%21'i (n:11) yatağa yarı bağımlıyken sadece 2 hastanın fiziksel gereksinimlerini karşılarken kimseye ihtiyaç duymadıkları görüldü. Bu durum Evde Sağlık Hizmetlerinden faydalanan pediatrik grubun neredeyse tamamının ,hastaneye gelemeyecek ve mutlak evde bakım hizmeti alması gerekli kişilerden oluştuğunu gösteriyordu.

Çalışmamızda çocukların hastalık dağılımları incelendiğimizde hastaların yaklaşık yarısında Serebral Palsi(CP)(%41) olduğunu tespit ettik.Çadırcı ve ark. pediatrik hastalarının %57.9'unu CP bulurken Ayar ve ark. tarafından yapılan çalışmada ise SP oranı %58,7 olarak bulunmuş ve yapılmış her üç çalışmada da CP Evde Sağlık Hizmeti alan çocuk hasta grubunda en sık eşlik eden hastalık olarak bulunmuştur. Hastalarımızda 2. Sıklıkta (%37)epilepsi hastalığı mevcut olup Ayar G. ve ark da yaptığı bir çalışmada takip ettikleri hastaların hastaların %50.8 inde primer hastalığına ek olarak Epilepsi tanısı da aldıklarını görmüşlerdir.(Ayar ve diğerleri, 2014) Yapılmış başka bir çalışmada ise takipli ESH takipli

hastaları sadece %3.9’unda Epilepsi bulunmuş olup,bizim bu tanıyla takip ettiğimiz hastaların onda biri civarındaydı. (Çadircı ve diğerleri, 2019)

Çalışmamızda tanı olarak Palfrey ve ark.’nın çalışmasına benzer oranda(%12.5) MMR görülmekteydi.(Palfrey ve diğerleri 2004)

Yapılmış birtakım çalışmalarda (Çadircı ve diğerleri, 2019) (Ayar ve diğerleri, 2014) SSPE oranı %10 oranlarında bulunmuş olsa da bizim çalışmamızda hiç SSPE vakası yoktu.

Çalışmamızda hastaların çok büyük bir kısmı(%88) oral besleniyorken Şanlıurfa’da yapılmış başka bir çalışmada da aynı şekilde yüksek oran tespit edilmiş olup(%94.7), sonucumuzla paralellik bulunmuştur. (Çadircı ve diğerleri, 2019)

Sonuç olarak evde sağlık hizmetleri ülkemizde hızla gelişmekte olan bir hizmet olup, çocuk hastalara yönelik verilen bu hizmetlerle ilgili literatür tarandığında sınırlı sayıda çalışma olduğu ve daha çok çalışma yapılması gerektiği kanaati oluşmuştur. Evde Sağlık Hizmetleri bir ekip çalışması olup ; birey ve ailesinin de tüm boyutlarıyla bu ekibe dahil edilmesi önem arz etmektedir.Yapılmış birçok çalışmada bu hastaların yüksek oranda eşlik eden nörolojik hastalıklarının varlığı,beslenme ve fiziksel kısıtlılıkları olduğu göz önünde bulundurulursa; ülke genelinde evde sağlık ekiplerine çocuk nörolojisi,çocuk psikiyatrisi,diyetisyen,psikolog,fizyoterapist ve sosyolog gibi spesifik birimlerin de eklenmesi verilen hizmet kalitesini katbekat artıracaktır.

5.KAYNAKLAR

- 1.Evde Bakım Derneği Yönetim Kurulu. Evde Bakım Tanımı,Kapsamı,Temel Kavramlar ve Ülkemizdeki Mevcut Durum. İstanbul,2010.
- 2.World Health Organization (WHO), Home care across europe, current structure and future challenges. WHO Regional Office for Europe, Scherfigsvej 8, DK-2100 Copenhagen, Denmark. 2012. p. 9-10.
- 3.Pillitteri A. Maternal and child health nursing: Care of the Childbearing and Childrearing Family. Philadelphia: Lippincott; 2014. p. 59-74.
- 4.Törüner, EK. Çocukların evde bakımında hemşirenin primer ve farklılaşan rolleri. Türkiye Klinikleri Journal of Pediatric Nursing-Special Topics, 2018; 4.1: 65-71
5. Paksoy-Erbaydar N. Evde Bakım. Halk Sağlığında Temel Bilgiler Kitabında (Güler Ç, Akın L, Editörler). Hacettepe Üniversitesi Yayınları, 2012, pp 1870-93.
- 6.Uçman Ö.T, Öngel K. Evde bakım ve özel gruplar. Ünlüoğlu İ, Saatçı E, ed. Aile Hekimliğinde Evde Bakım, Türkiye Aile Hekimliği Vakfı Yayınları, İstanbul, 2015: 65-70.
- 7.Parab CS, Cooper C, Woolfenden S et al. Specialist home-based nursing services for children with acute and chronic illnesses. Cochrane Database Syst Rev 2013;6: CD004383
- 8.Çadircı D, Kepenek E, Örenler M, Dağlıoğlu E.B, Güzelçiçek A, Çocuk Hastalara Verilen Evde Bakım Hizmetlerinin Değerlendirilmesi, Konuralp Tıp Dergisi 2019;11(3): 377-383
- 9.Ayar G, Şahin Ş, Uysal Yazıcı M et al. Çocuk hastalarda evde bakım hizmetlerinin değerlendirilmesi. Türkiye Çocuk Hastalıkları Dergisi. 2014;9:1-6.
10. Palfrey JS, Sofis LA, Davidson EJ et al. The pediatric alliance for coordinated care: evaluation of a medical home model. Pediatrics. 2004;113(4):1507-1516

SPORTİF PERFORMANSTA KAYROPRAKTİK MANİPÜLASYON TEDAVİSİNİN ETİKLİĞİNİN ARAŞTIRILMASI

INVESTIGATION OF THE EFFICACY OF CHIROPRACTIC MANIPULATION THERAPY IN SPORTS PERFORMANCE

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ÖZET

Sporcular sakatlık döneminde kayropraktik manipülasyon tedavisine sıklıkla başvurmaktadır. Özellikle Amerika kıtasında spor kulüplerinin sağlık kurullarında kayropraktik uzmanı bulunmaktadır. Günümüzde sporların rekabetçi doğası gereği, sportif performansı etkileyebilecek yasal tüm yöntemlere ilgi sürekli artarak devam etmektedir. Bu çalışmada kayropraktik manipülasyon tedavisinin sportif performansa olan etkisini araştırmak amacıyla planlanmıştır. Spor performansının artırılması amacıyla kullanılan kayropraktik manipülasyon tedavisini belirlemek amacıyla literatür taraması yapılmıştır. MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), AMED (Alternative Medicine), Alt HealthWatch (Alternative Health), Psychology & Behavioral Sciences Collection, The Cochrane Library, ICL ve Google Scholar veri tabanında, 2000 ile 2021 yılının Mayıs ayı arasında, ücretsiz ve tam metin erişimi hakkı olan araştırma makalesi, vaka ve pilot çalışmalardan konu ile ilgili 'chiropractic', 'spinal manipulation', 'manipulation', 'sports', 'athletes', 'performance', 'sports medicine', 'physical performance', 'athletic performance', 'sprint performance', 'exercise performans', 'grip strength', 'kicking speed performance', 'handgrip strength', 'power output', 'HVLA' ve 'performance enhancement' anahtar kelimeler ile taranmıştır. Yapılan literatür taraması sonucunda 75 adet çalışmaya ulaşılmıştır. Bu çalışmalardan kayropraktik manipülasyon tedavisinin, sportif performansını etkinliğini özel olarak araştıran ve tartışan 19 adet çalışma dahil edilmiştir. Çalışmaya temas içeren, bireysel ve takım halinde yapılan farklı branşlardaki 343 elit veya amatör sporcu katılmıştır. Tedavi ve değerlendirme protokolü en az 4 hafta, en fazla ise 14 hafta sürmüştür. Dahil edilen çalışmada genellikle kayropraktik manipülasyon tedavisi, kontrol, sham ve diğer teknikler (germe, pilometrik ve dirençli egzersiz vb.) ile karşılaştırılmıştır. Birçok çalışmada teorik açıdan bu konu öne sürülmüş ve tartışılmıştır. Gelişmiş sportif performans test sonuçlarında pozitif yönde etki etiğine dair zayıf kanıtlara ulaşılmıştır. Ancak kayropraktik manipülasyon tedavisinin performansı artırıcı umut verici verilere ulaşılmıştır. Bu alandaki araştırmaların niceliği ve niteliği artırılarak ikna edici kanıtlara ulaşılabilir.

Anahtar Kelimeler: Kayropraktik, Manipülasyon, Sportif Performans

ABSTRACT

Athletes frequently resort to chiropractic manipulation treatment during disability. Especially in the Americas, there are chiropractic specialists in the health boards of sports clubs. Today, due to the competitive nature of sports, interest in all legal methods that can affect sports performance continues to increase. In this study, it was planned to investigate the effect of

chiropractic manipulation treatment on sportive performance. A literature review was conducted to determine the chiropractic manipulation therapy used to increase sports performance. 2000 and May of 2021 in MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), AMED (Alternative Medicine), Alt HealthWatch (Alternative Health), Psychology & Behavioral Sciences Collection, The Cochrane Library, ICL and Google Scholar databases Among the research articles, case and pilot studies with free and full-text access, 'chiropractic', 'spinal manipulation', 'manipulation', 'sports', 'athletes', 'performance', 'sports medicine', ' With keywords physical performance', athletic performance', 'sprint performance', 'exercise performance', 'grip strength', 'kicking speed performance', 'handgrip strength', 'power output', 'HVLA' and 'performance enhancement' scanned. As a result of the literature review, 75 studies were reached. Among these studies, 19 studies that specifically investigated and discussed the effectiveness of chiropractic manipulation therapy on sportive performance were included. 343 elite or amateur athletes in different branches, which involve contact, individually and as a team, participated in the study. The treatment and evaluation protocol lasted for a minimum of 4 weeks and a maximum of 14 weeks. The included study generally compared chiropractic manipulation therapy with control, sham, and other techniques (stretching, pilometric and resistance exercise, etc.). In many studies, this issue has been proposed and discussed from a theoretical point of view. There is weak evidence of a positive effect on advanced sportive performance test results. However, promising data have been obtained to improve the performance of chiropractic manipulation therapy. Convincing conclusions can be reached by increasing the quantity and quality of research in this area.

Keywords; Chiropractic, Manipulation, Sports performance

1. GİRİŞ

Performans, genel tanımı ile davranışın göreceli olarak kısa zamanlı, sınırlı bir kısmıdır. Genellikle belirtilebilen, somut bir işi yapmaya yönelik eylem olarak nitelendirilebilir (Karakuş ve Kılıç 2006). Diğer bir tanım da performans; bir fiziksel aktivitenin gerektirdiği fizyolojik, biyomekanik ve psikolojik verim olarak tanımlanmaktadır (Kuter ve Öztürk 1997). Günümüzde sporcunun, iş üretme kabiliyeti üzerine etkili fiziksel ve psişik birçok mekanizmanın olduğu bilinmektedir. Bu yüzden sportif performansı tüm olumlu etkenlerle birlikte ve tüm olumsuz etkenlere rağmen gerçekleşen, sporcunun atletik iş üretebilme becerisi, üretim kalitesi ve kapasitesinin bileşkesi olarak kabul etmek uygun olacaktır (Bayraktar ve Kurtoğlu 2004).

Sportif performansın karmaşık yapısının sebebi, sonucu etkileyen faktörlerin sayısının çokluğu ve çeşitliliğidir. Bu faktörler, performansı olumlu ve olumsuz etkileyebilirler ve oluşum kaynaklarına göre içsel ve dışsal faktörler olarak ikiye ayrılırlar (Bayraktar ve Kurtoğlu 2009).

İçsel faktörler; genel anlamda insanda mevcut olan, kısmen kalıtsal gelen, zaman içinde küçük değişikliklerle farklılaşabilen ve dışarıdan üzerine etki imkanı çok sınırlı olan veya hiç etki yapılamayan etkenlerdir. Yaş, cinsiyet, anatomik yapı, genetik, zeka, lokomotor sistemin durumu, psikolojik denge, otonom sinir sistemi, salgı bezlerinin fonksiyonları, metabolizma, enerji kullanım mekanizmaları, organ sistemlerinin durumu, allerji, nöromusküler ileti hızı, kardiyovasküler yapı özellikle içsel faktörlerin en başlıcalarıdır. Bu listeyi uzatmak ve detaylandırmak çok mümkündür (Bayraktar ve Kurtoğlu 2009).

Dışsal faktörler; ise adından da anlaşılacağı gibi insanın vücudundan ve yapısından kaynaklanmayan dışarıdan gelen ve bu nedenle de dolaylı yolla sportif performansı fiziksel veya psişik bileşen üzerinden etkileyen faktörlerdir (Bayraktar ve Kurtoğlu 2009). Sayıları içsel olanlara göre çok daha fazla olan dışsal faktörlerden bazılarını; sıcaklık, iklim, malzeme, seyirci, sosyal çevre, arkadaşlık, aile, tüm ekonomik bileşenler, beslenme, geçirilmiş

sakatlıklar, doping, ergojenik yardım, dışarıdan gelen olumsuz sözler, saat farkı, boş zamanları değerlendirme yöntemleri, cinsellik, rol mode belirleme, takdir edilme güdüsü, antrenman teknikleri antrenman niteliği, niceliği, ısınma, esneklik, antrenör, dinlenme aralığı, soğuma, uyku düzeni ve kalitesidir (Bayraktar ve Kurtoğlu 2004).

Dünya Sağlık Örgütü'nün 2005 yılında yayınladığı kılavuza göre; Kayropraktik, sinir kas-iskelet sistemlerine ait bozukluklarının teşhisi, tedavisi ve önlenmesiyle subluksasyon (çıkık ve kırık olmadan eksen bozulmuş normal eklem) üzerinde özel bir odaklanma ile patolojik eklem biyomekaniğini düzeltmeyi amaçlayan ve bu alan içerisine giren tüm manuel teknikleri uygulayan bir uzmanlıktır (Yıldız ve Ağaoğlu 2013). Uluslararası Spor Kayropraktik Federasyonu (Federation Internationale de Chiropratique de Sport (FICS)) 1987 yılında Dr. Stephen Press tarafından Londra kuruldu.

2. MATERYAL VE YÖNTEM

Bu çalışmada kayropraktik manipülasyon tedavisinin sportif performansa olan etkisini araştırmak amacıyla planlanmıştır. Spor performansının artırılması amacıyla kullanılan kayropraktik manipülasyon tedavisini belirlemek amacıyla literatür taraması yapılmıştır. MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), AMED (Alternative Medicine), Alt HealthWatch (Alternative Health), Psychology & Behavioral Sciences Collection, The Cochrane Library, ICL ve Google Scholar veri tabanında, 2000 ile 2021 yılının Mayıs ayı arasında, ücretsiz ve tam metin erişimi hakkı olan araştırma makalesi, vaka ve pilot çalışmalardan konu ile ilgili 'chiropractic', 'spinal manipulation', 'manipulation', 'sports', 'athletes', 'performance', 'sports medicine', 'physical performance', 'athletic performance', 'sprint performance', 'exercise performans', 'grip strength', 'kicking speed performance', 'handgrip strength', 'power output', 'HVLA' ve 'performance enhancement' anahtar kelimeler ile taranmıştır.

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Yapılan literatür taraması sonucunda 75 adet çalışmaya ulaşılmıştır. Bu çalışmalardan kayropraktik manipülasyon tedavisinin, sportif performansını etkinliğini özel olarak araştıran ve tartışan 19 adet çalışma dahil edilmiştir. Çalışmaya temas içeren, bireysel ve takım halinde yapılan farklı branşlardaki 343 elit veya amatör sporcu katılmıştır. Tedavi ve değerlendirme protokolü en az 4 hafta, en fazla ise 14 hafta sürmüştür. Dahil edilen çalışmada genellikle kayropraktik manipülasyon tedavisi, kontrol, sham ve diğer teknikler (germe, pilometrik ve dirençli egzersiz vb.) ile karşılaştırılmıştır.

4. TARTIŞMA, SONUÇ VE ÖNERİLER

Sporcular sakatlık döneminde kayropraktik manipülasyon tedavisine sıklıkla başvurmaktadır. Özellikle Amerika kıtasında spor kulüplerinin sağlık kurullarında kayropraktik uzmanı bulunmaktadır. Günümüzde sporların rekabetçi doğası gereği, sportif performansı etkileyebilecek yasal tüm yöntemlere ilgi sürekli artarak devam etmektedir. Bu çalışmada kayropraktik manipülasyon tedavisinin sportif performansa olan etkisini araştırmak amacıyla planlanmıştır.

1980'den beri ABD, Olimpiyat Oyunlarındaki sporcuları için kayropraktik manipülasyon tedavisini kullanıyorlardı. Brezilyalılar 2000 yılından beri Olimpiyat Oyunları ve Pan-Amerikan Oyunları'nda da bu tedavi yönteminden faydalanmışlardır. 1995 yılında Tüm Afrika

Oyunları'nda 6000 sporcudan 1135 sporcuya toplam 1957 kayropraktik tedavisi uygulandı. Hafif sporcular (%38) ve dövüş sanatçıları (%14,7) bu tedavileri aldı. 2007 yılında Rio de Janeiro'da düzenlenen Pan-Amerikan Oyunları'nda toplam 660 Brezilyalı sporcu (%14.40) tarafından 95 sporcuya 209 kayropraktik tedavi uygulandı. Başka bir araştırma, Amerikan Futbol Ligi sporcularının %77'sinin bir chiropractor kullandığını buldu. Sporcuların %31'inin sağlıklı ekibinin bir parçası olan kayropraktörleri vardı. (Thiele 2019).

Ek olarak, fizyoterapistler gibi tıp uzmanları ve bir dizi alternatif ve tamamlayıcı sağlık profesyoneli ortaya çıkmıştır. Kayropraktik bunlardan biridir. Geleneksel tıbbı benzer şekilde, sportif amaçlı kayropraktik uygulaması olan ayrı bir "özel grup" geliştirildi. Bu sadece manipülasyonla ilgili değildir. Spor kayropraktörleri genellikle geleneksel tıbbi yaklaşımları sınırlı olarak dikkate alan tek modlu uygulayıcılar olarak kabul edilir. Bu "modern" multimodal spor kayropraktik yönetimi, pasif ve aktif kaynağın bileşenlerini içermelidir. Hem akut, inflamatuvar ağrı evresi hem de kronik yaralanma, rehabilitasyon ve önleme evresi tedavi edilmelidir. Tipik yaklaşım, alevlenmeleri dışlamak, semptomatik dokuları teşhis etmek ve tedavi etmek ve spor yaralanmalarından sorumlu olan fonksiyonel eksiklikleri ve etiyolojik faktörleri belirlemek ve değerlendirmektir. Geleneksel ortopedik ve nörolojik testler, kayropraktik değerlendirmeler, yapısal analiz, palpasyon (hareket ve statik), radyolojik analiz için sevk ve diğer özel hizmetler gerekebilir. (Pollard ve diğ. 2007)

Deutschmann ve arkadaşları, lomber omurgada, sakroiliak ekleme veya her ikisinin kombinasyonunda SMT yapıldıktan sonra hareket açıklığını ve tekme hızında artış meydana geldiğini bulmuşlardır. (Deutschmann ve diğ. 2015)

Costa ve arkadaşlarının çalışması, tek başına SMT'yi değil, SMT'yi germe ile birlikte analiz eden tek çalışmadır. İki grup golfçü, tek başına veya SMT ile birlikte gerdirmeden sonra tam vuruş performansı açısından karşılaştırıldı. Dördüncü haftalık müdahaleden sonra kombine germe ve SMT grubunda tam vuruş top menziline artış gözlemlendi (Costa ve diğ. 2009)

Sandell ve diğerleri, Shrier ve diğerleri tarafından yapılan çalışmalarda, her biri ortak koşu hızına sahip 2 farklı sporla ilgili sonucu değerlendirdi. Shrier ve arkadaşları atlama yüksekliğini ve 40 metrelik koşu hızını değerlendirirken, Sandell ve arkadaşları 30 metrelik bir pistte hızı ve kalçayı ekstansiyonu değerlendirdi. Her iki çalışma da daha önce örneklem büyüklüğünü hesaplamamıştı ve büyük veri değişkenliğine ve düşük istatistiksel güce sahipti. Koşu hızında herhangi bir değişiklik gözlenmedi ve Sandell ve arkadaşları, kalça ekstansiyon yeteneğinin arttığını bulmuşlardır. (Sandell ve diğ. 2008; Shrier ve diğ. 2006)

Judo sporcularında için yapılan kayropraktik manipülasyon tedavisinin kavrama gücü üzerine etkisini araştıran bir çalışma yapılmıştır. Üç kez spinal manipülasyon tedavisi uygulanan müdahale grubunda şu sonuçlara ulaşıldı: 1. müdahaleden sonra: ortalama %6.95 sağ el ve %12.61 sol el, 3. müdahaleden sonra: ortalama %10.53 sağ el ve %16.82 sol elde artış olduğu saptanmıştır. Üç kez belirgin spinal manipülasyon tedavisi uygulanan kontrol grubunda, kavrama gücü ölçümleri arasında istatistiksel olarak anlamlı bir fark ölçülmedi. Bu, servikal spinal manipülasyon tedavisinin judo sporcularının kavrama gücünü önemli ölçüde artırdığını açıkça göstermektedir. (Botelho ve Andrade 2012).

Birçok çalışmada teorik açıdan bu konu öne sürülmüş ve tartışılmıştır. Gelişmiş sportif performans test sonuçlarında pozitif yönde etki etğine dair zayıf kanıtlara ulaşılmıştır. Ancak kayropraktik manipülasyon tedavisinin performansı artırıcı umut verici verilere ulaşılmıştır. Bu alandaki araştırmaların niceliği ve niteliği artırılarak ikna edici kanıtlara ulaşılabilir. Daha çok sayıda ve nitelikte randomize kontrollü ve kör çalışmalar yapılarak kayropraktik manipülasyon tedavisinin sportif performansına etkisine yönelik çalışmalar yapılabilir. Çalışmalarda sham grupları ile karşılaştırma yapılarak kanıt düzeyi artırılabilir.

KAYNAKLAR

1. Yıldız S, Ađaođlu MH. Kayropratik uygulama endikasyonları. İntegratif Tıp Dergisi 2013;1(6):73-6.
2. Karakuş, S., & Kılıç, F. (2006). Postür ve sportif performans. Kastamonu Eğitim Dergisi, 14(1), 309-322.
3. KUTER, M., ÖZTÜRK, F.:Antrenör ve Sporcu El Kitabı, Bursa Gazetecilik ve Yayıncılık A.Ş. Matbaası, 1997, Bursa, s.17
4. Bayraktar, B., & Kurtođlu, M. (2004). Sporda performans ve performans artırma yöntemleri. Doping ve futbolda performans artırma yöntemleri, İstanbul, 269-296.
5. Bayraktar, B., & Kurtođlu, M. (2009). Sporda performans, etkili faktörler, değerlendirilmesi ve artırılması. Klinik Gelişim, 22(1), 16-24.
6. Costa, S. M., Chibana, Y. E., Giavarotti, L., Compagnoni, D. S., Shiono, A. H., Satie, J., & Bracher, E. S. (2009). Effect of spinal manipulative therapy with stretching compared with stretching alone on full-swing performance of golf players: a randomized pilot trial. *Journal of chiropractic medicine*, 8(4), 165-170.
7. Deutschmann, K. C., Jones, A. D., & Korporaal, C. M. (2015). A non-randomised experimental feasibility study into the immediate effect of three different spinal manipulative protocols on kicking speed performance in soccer players. *Chiropractic & manual therapies*, 23(1), 1-10.
8. Sandell, J., Palmgren, P. J., & Björndahl, L. (2008). Effect of chiropractic treatment on hip extension ability and running velocity among young male running athletes. *Journal of chiropractic medicine*, 7(2), 39-47.
9. Shrier, I., Macdonald, D., & Uchacz, G. (2006). A pilot study on the effects of pre-event manipulation on jump height and running velocity. *British journal of sports medicine*, 40(11), 947-949.
10. Thiele, R. (2019). Chiropractic Treatment in Sports: Systematic Review of Randomized Controlled Trials. *International Journal of Clinical Medicine Research*, 6(2), 6-12.
11. Pollard, H., Hoskins, W., McHardy, A., Bonello, R., Garbutt, P., Swain, M., ... & Vitiello, A. (2007). Australian chiropractic sports medicine: half way there or living on a prayer?. *Chiropractic & Osteopathy*, 15(1), 1-13.
12. Botelho, M. B., & Andrade, B. B. (2012). Effect of cervical spine manipulative therapy on judo athletes' grip strength. *Journal of manipulative and physiological therapeutics*, 35(1), 38-44.

INVESTIGATION OF THE RELATIONSHIP BETWEEN TEMPERATURE AND GELLING TIME IN SOIL SILICATE GROUTING

ZEMİN SİLİKAT ENJEKSİYONLARINDA SICAKLIK İLE JELLEŞME SÜRESİ ARASINDAKİ İLİŞKİNİN İNCELENMESİ

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ABSTRACT

In this experimental study, the relationship between gelling time and ambient temperature in sodium silicate injection process was investigated. In the experiments, sodium silicate was used as the main material and formamide (amide of formic acid) was used as the reactant. Gelling time is one of the most important parameters to be considered in injection studies. The most important parameters affecting the gelling time are material and temperature. Gelling time measurements were made at different ambient temperatures for Sodium Silicate and Formamide solutions prepared at different mixing ratios. Atmospheric temperature is one of the external factors affecting the gelling time. In this study, gelling times were investigated under three different atmospheric temperatures (+10 °C, +20 °C and +30 °C). Gelling time was recorded in minutes. In addition, a comparison was made between the gelling times of 10 °C, 20 °C and 30 °C. The materials and methods used in the study were the same for all gelling temperatures. The average gelling time was calculated as 855 minutes for 10 °C, 303 minutes for 20 °C and 239 minutes for 30 °C. The gelling time of the materials increases approximately 1.27 times when the temperature drops from 30 °C to 20 °C. When the ambient temperature drops from 20 °C to 10 °C, the gelling time increases by 2.82 times. Regression analysis was performed to measure the relationship between gelling times. The coefficient of determination of the models were above 0.91. The highest coefficient of determination was obtained for the relationship between 20 °C and 30 °C with $R^2 = 0.99$. According to the results of the regression analysis, the correlation value between the gelling time at different temperature values is quite high. According to the results of experimental and analytical studies performed on solutions prepared with sodium silicate and formamide mixtures, it was observed that the gelling time decreased at high temperature values and increased at low temperature values.

Keywords: Grouting, Gelling Time, Sodium Silicate

ÖZET

Bu deneysel çalışmada, sodyum silikat enjeksiyon işleminde jelleşme süresi ile ortam sıcaklığı arasındaki ilişki incelenmiştir. Deneylerde ana malzeme olarak sodyum silikat, reaktant olarak formamid (formik asitin amidi) kullanılmıştır. Enjeksiyon çalışmalarında dikkate alınması gereken en önemli parametrelerin başında jelleşme zamanı gelmektedir. Jelleşme süresini etkileyen en önemli parametreler malzeme ve sıcaklıktır. Farklı karışım oranlarında hazırlanmış sodyum silikat ve formamid solüsyonları üzerinde farklı ortam sıcaklıklarında jelleşme ölçümleri yapılmıştır. Atmosferik sıcaklık jelleşme süresini etkileyen dış faktörlerin başında

gelmektedir. Bu çalışmada üç farklı atmosferik sıcaklık (+10 °C, +20 °C ve +30 °C) altında jelleşme süreleri incelenmiştir. Jelleşme zamanı dakika cinsinden kayıt edilmiştir. Ayrıca 10 °C, 20 °C ve 30 °C jelleşme zamanları arasında karşılaştırma yapılmıştır. Çalışmada kullanılan malzemeler ve yöntemler bütün jelleşme sıcaklıkları için aynı kullanılmıştır. 10 °C için ortalama jelleşme süresi 855 dakika, 20 °C için ortalama 303 dakika ve 30 °C için ise 239 dakika olarak hesaplanmıştır. Malzemenin jelleşme süresi, sıcaklık 30 °C'den 20 °C'ye düştüğü zaman yaklaşık 1,27 kat artmaktadır. 20 °C'den 10 °C'ye düştüğü zaman ise 2,82 kat kadar bir artış göstermektedir. Jelleşme sürelerinin kendi aralarındaki ilişkiyi ölçmek için regresyon analizi yapılmıştır. Regresyon analizi sonucunda belirlilik katsayıları 0,91'in üzerinde çıkmıştır. En yüksek belirlilik katsayı değerini 20 °C ile 30 °C arasında kurulan modelden elde edilmiştir. Regresyon analizi sonuçlarına göre farklı sıcaklık değerlerindeki jelleşme zamanı arasındaki ilişki derecesi oldukça yüksektir. Sodyum silikat ve formamid karışımları ile hazırlanan solüsyonlara yapılan deneysel ve analitik çalışmaların sonuçlarına göre yüksek sıcaklık değerlerinde jelleşme zamanı azalmakta düşük sıcaklık değerlerinde ise arttığı görülmüştür.

Anahtar Kelimeler: Zemin Enjeksiyonu, Jelleşme Süresi, Sodyum Silikat

1. INTRODUCTION

Many techniques are used to improve the engineering properties of soils. Soil injections are one of the widely used improvement techniques (Hausmann, 1990; Bell, 1993; Shroff and Shah, 1999). Grouting is the injection of grouting material under pressure into pores and cracks in soil and/or rock. Permeation injection is widely used among injection techniques (Henn, 1996; Warner, 2004). Permeation grouting is the injection of grouting material into the soil under low pressures without any displacement. While the strength of the soil increases after injection, the permeability coefficient decreases (Burwell, 1958; Nonveiller, 1989). Solution and suspension type injection materials are used on the soil injections. Chemical injections are included in the solution type injections (Baker, 1982; Karol, 2003). Acrylamides, Lignosulfonates, Aminoplasts, Phenoplasts and Sodium Silicates are used as chemical injection materials. The largest group among chemical injection materials is silicates. These are methyl silicates, silicon esters, fluorosilicates and sodium silicates. Among these, sodium silicates are the most widely used (Karol, 2003). Sodium silicates are known as water glass and are made ready by heat treatment of any form of silica (Na_2CO_3) at 900°C. After refining, sodium silicate becomes a fluid solution (Clifton, 1986). By adding a weak acid or hydrochloric acid to the sodium silicate solution as a reactant, neutralization occurs and the solution gels after neutralization. The rheological properties of chemical materials are used in the selection of the most appropriate ratio to be used in injections. The rheological properties of chemical injection materials consist of gelling time, viscosity and syneresis. The time elapsed until the chemical injection material loses its fluidity and starts to solidify is called gelling time. During injection, it is desired that the injection material does not gel before reaching the desired point (Hausman, 1990). Gelling time is very important in chemical injections. The reactant, inhibitor and catalyst added to the solution affect the gelling time (Karol, 2003). Other factors affecting the gelling time are the sodium silicate ratio in the solution and the ambient temperature (Karol, 2003). With the gelation of the solution, the gel begins to gain strength rapidly and the time remaining between the gelation time and the completion of the neutralization reaction is called the curing period (Karol, 2003). In this study, the effect of ambient temperature on gelling time was investigated in sodium silicate injections.

2. MATERIALS AND METHODS

The gelling time of sodium silicate injections depends on many parameters. These are sodium silicate content, $\text{SiO}_2/\text{Na}_2\text{O}$ ratio, temperature, amount and type of reactant, and pH value of the soil (Karol, 2003). Visual inspections were used to determine the gelling times of sodium silicate solutions. Gelling time determination tests were carried out on 177 different mixtures at different temperatures (+10 °C, +20 °C and +30 °C) on sodium silicate mixtures (Figure 1). It was observed that the gelation was completely white and homogeneous.



Figure 1. Gelling time tests

3. RESULTS AND DISCUSSION

The gelling times of the solutions prepared using different ratios and amounts of sodium silicate and formamide chemicals were found in minutes for the temperature values of 10 °C, 20 °C and 30 °C. Average gelling times (minutes) for the temperatures were calculated as 855 for 10 °C, 303 for 20 °C and 238 for 30 °C. The bar graph of gelling times for the temperature values is shown in Figure 2. It is seen that the gelling times at 10 °C are significantly higher than the gelling times at 20 °C and 30 °C. It is seen that the gelation times at 10 °C are significantly higher than the gel times at 20 °C and 30 °C. Comparing the gelling times at 20 °C and 30 °C, it is seen that the gelling time is shorter at 30 °C. Accordingly, the gelation time increased approximately 1.27 times when the temperature decreased from 30 °C to 20 °C. Similarly, gelling time increased 2.82 times when the temperature decreased from 20 °C to 10 °C.

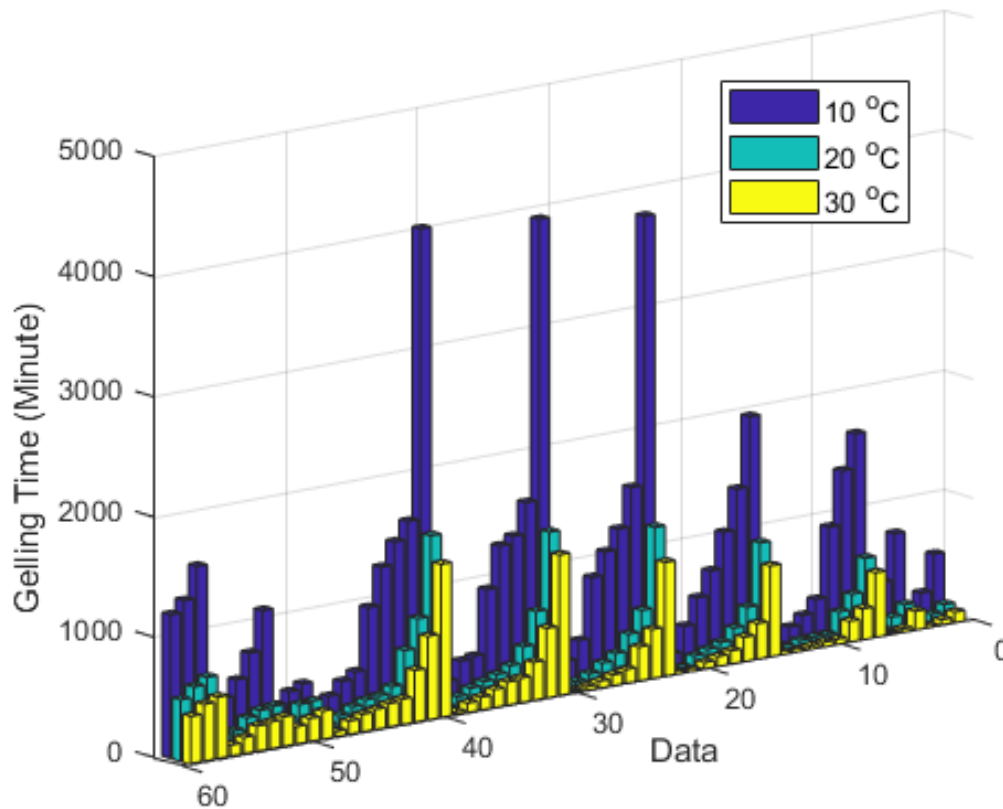


Figure 2. Gelling times for temperatures of 10 °C, 20 °C and 30 °C

The relationship between the observed gelling times for the temperature values were examined by the regression method. For this purpose, a total of three linear regression models were created. The created models consist of an input and an output. In the first model, the input and output consist of 10 °C and 20 °C gelling time data, in the second model, the input and output consist of 10 °C and 30 °C gelling time data and in the third model, the input and output consist of 20 °C and 30 °C gelling time data. The coefficients of determination were calculated by creating scatter plots for all three models. The coefficient of determination shows the degree of relationship between the variables. The coefficient of determination takes a value between 0-1. Figure 3 shows the graphs of gelling times obtained at temperature values and their relations with each other. The coefficients of determination of the models were calculated between 0.91 and 0.99 (Figure 3). According to the coefficient of determination values, there is a very strong relationship between the gelling times measured for the temperature values. The relationship between the data can be explained with empirical formulas. The same inputs were used in the regression models in which the relationship between gelling times was examined. The bar graphs of the gelation times in Figure 3 show a relationship between each other.

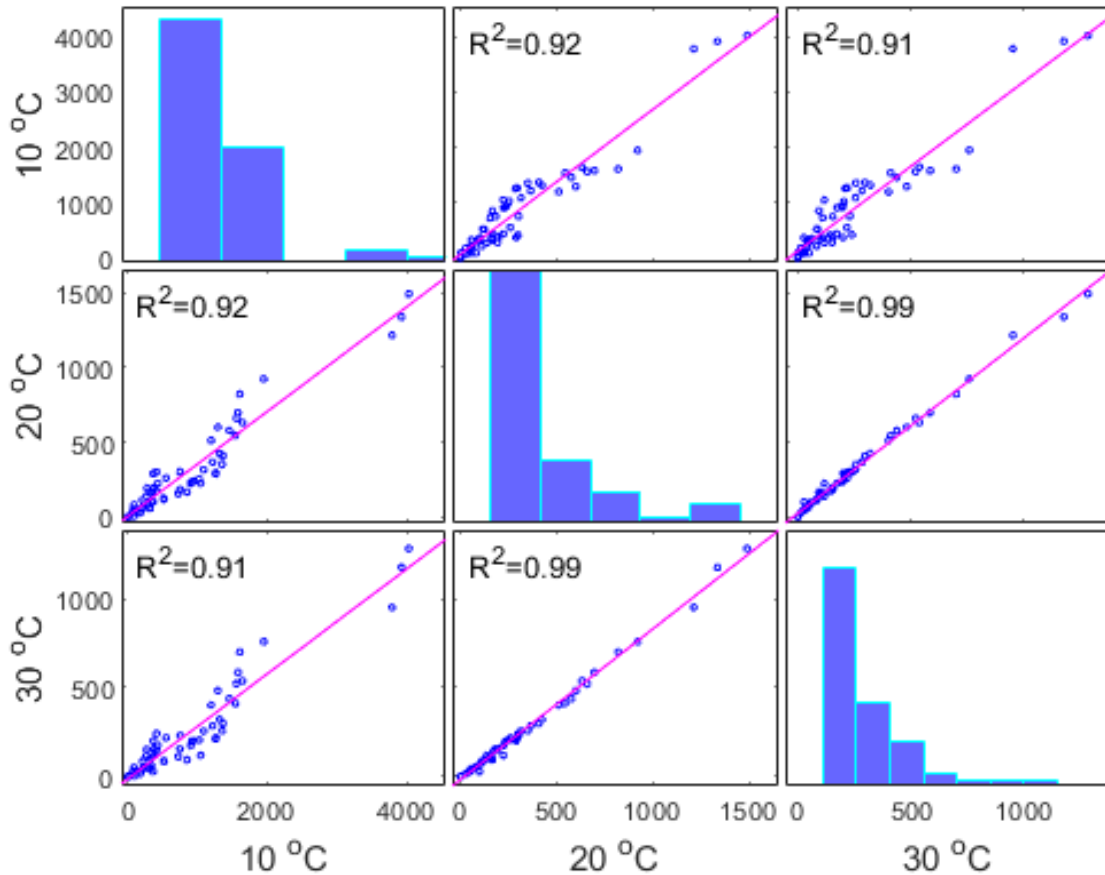


Figure 3. Correlation matrix for temperatures of 10 °C, 20 °C and 30 °C

4. CONCLUSIONS

In this study, the relationship between temperature and gelling times in the soil silicate grouting applications was investigated with regression method. Gelling time is a very important parameter in grouting studies and should be observed carefully. In soil silicate grouting applications, it is necessary to estimate the gelling times by considering the atmospheric temperature values. The gelling time at 10 °C is longer than at 20 °C and 30 °C. The shortest gelling times were obtained at 30 °C. The relationship between the gelling times obtained at 10, 20 and 30°C was examined by regression analysis. The determination of coefficients values of regression models were found in a range from 0,91 to 0,99. According to the results of the regression analysis, the gelling times obtained for temperatures were found to have a very high correlation with each other.

REFERENCES

1. Hausmann MR., 1990. Engineering Principles of Ground Modification. New York/USA: McGraw-Hill.
2. Baker WH., 1982. Planning and performing structural chemical grouting. Grouting in Geotechnical Engineering, ASCE, 1(1), 515-539.
3. Bell FG., 1993. Engineering Treatment of Soils. London/UK: E&FN Spon.
4. Burwell EB., 1958. Cement and Clay Grouting of Foundations. ASCE Journal of Soil Mechanics and Foundation Division., 84(1), 1-22.

5. Shroff AV, Shah DL., 1999. Grouting Technology in Tunneling and Dam Construction (2nd ed.). Rotterdam/The Netherlands: A.A. Balkema.
6. Henn RW., 1996. Practical Guide to Grouting of Underground Structures. London/UK: Thomas Telford.
7. Nonveiller E., 1989. Grouting Theory and Practice. Amsterdam/The Netherland: Elsevier Science Publishers B.V.
8. Karol RH., 2003. Chemical Grouting and Soil Stabilization. New Jersey/USA: Marcel Dekker Inc.
9. Clifton W., 1986. Chemical grouts for potential use in bureau of reclamation projects. Denver/USA: U.S. Dept. of the Interior-Bureau of Reclamation.
10. Warner J., 2004. Practical Handbook of Grouting Soil Rock and Structures. New Jersey/USA: John Wiley&Sons.

FLOW OPTIMIZATON OF A GLOBE CHECK VALVE WITH NUMERICAL METHOD

BİR GLOBE ÇEKVALFTE NÜMERİK YÖNTEM İLE DEBİ OPTİMİZASYONU

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Valves are elements that have in one's sights controlling the flow of fluids and gases, setting flow rate, preventing reverse flow and changing the direction, limiting flow pressure and flow safety in an installation. They can be classify as relief valve, butterfly valve, ball valve, check valve, gate valve and globe valve generally. The energy that is required to provide flow is increased beacuse of local pressure drops along an installation that have these elements that are valves and also pipes, elbows etc. These drops can be reduced by geometrical optimization of the elements. The globe valves that work by cutting or opening the fluid passage by placing or lifting the clack attached to the end of a shaft on the fluid passage hole (orifice). Globe valves can also be classified as spring check valve or controlled check valve according to the clack-shaft connection type. They can be used with these fluids that are water, hot water, steam, hot oil, compressed air, fuel oil, LPG, heat transfer oils and chemical fluids. These valves have high pressure losses and low flow coefficients due to their geometrical structure and cause energy losses. Optimizing the valve geometry can eliminate these losses as possible. In this study, the geometrical optimization was realized thanks to Ansys Fluent packet program that uses numerical analysis with finite volume method. This analysis was performed for three different values of the inner opening diameter and six different values of the outer passage diameter by choosing the globe check valve's inner opening diameter (orifice diameter) and outer passage diameter as the important design parameters to be optimized. The optimized values of them were occurred by calculating the flow coefficients for each 18 different geometries and optimized geometries. As a result, it was determined that there was a 22.22% improvement in the flow coefficient of the examined globe check valve compared to the first design.

Keywords: Optimization, globe check valve, finite volume numerical method.**ÖZET**

Valfler, sıvı ve gazların hareketini kontrol etmek, debisini ayarlamak, geri dönüşünü engellemek, akış yönünü değiştirmek, akış basıncını sınırlamak ve akış emniyetini sağlamayı hedefleyen tesisat elamanlarıdır. Valfler, genel olarak emniyet valfi (relief valve), kelebek valf (butterfly valve), küresel valf (ball valve), çekvalf (check valve), sürgülü valf (gate valve),

globe valf (globe valve) olarak sınıflandırılabilirler. Bir tesisatta akışın sağlanabilmesi için gereken enerji, sistem üzerinde bulunan vafler ayrıca borular, dirsekler vb. elemanlardan kaynaklanan yerel basınç kayıpları nedeniyle artmaktadır. Bu kayıplar, tesisat elemanlarının geometrik optimizasyonu ile en az seviyeye indirilebilir. Tesisat elemanlarından globe valfler; bir milin ucuna bağlı klape, akışkan geçiş deliğinin üstüne oturtulması veya kaldırılması ile akışkan geçişini kesip, açarak çalışan vanalardır. Ayrıca globe valfler, klape-mil bağlantı şekline göre kumandalı çekvalf veya yaylı çekvalf olarak sınıflandırılabilirler. Globe valfler, su, sıcak su, kızgın su, buhar, kızgın yağ, basınçlı hava, akaryakıt, LPG, ısı transfer yağları ve kimyasal akışkanlar ile kullanılabilirler. Bu valfler, geometrik yapıları nedeniyle basınç kayıpları yüksek ve akış katsayıları düşük olan valflerdir ve enerji kayıplarına neden olurlar. Bu kayıpların olabildiğince azaltılması, valf geometrisinin optimum hale getirilmesi ile sağlanabilir. Bu çalışmada, bir globe çekvalfin geometrik optimizasyonu, sonlu hacimler nümerik yöntemini kullanan Ansys Fluent paket programı yardımıyla gerçekleştirilmiştir. Bu analiz, optimize edilecek önemli tasarımsal parametreler olarak globe çekvalfin iç açıklık çapı (orifis çapı) ve dış geçiş çapı seçilerek, iç açıklık çapının üç farklı ve dış geçiş çapının altı farklı değeri için gerçekleştirilmiştir. Her bir incelenen 18 farklı geometri ve optimize olan geometriler için akış katsayıları hesaplanmış ve optimum iç açıklık çapı (orifis çapı) ve dış geçiş çapı elde edilmiştir. Sonuç olarak, incelenen globe çekvalfin akış katsayısında ilk tasarıma göre % 22,22 iyileşme olduğu belirlenmiştir.

Anahtar sözcükler: Optimizasyon, globe çekvalf, sonlu hacimler nümerik yöntemi.

1. INTRODUCTION

Valves are used to control the behavior of flow in an installation. They are the elements that set the flow rate to change amount of fluid that flows inside, prevent possible damage to the compressor or pump caused by reverse flow, change the direction of flow, limit the pressure and provide safety in installations. There are different types for any specific systems. Basic valve types are that, gate valve, butterfly valve, piston valve, ball valve, globe valve, relief valve. The other types are checkvalves which are self-propelled, they can be sorted as lifted check valve, swing check valve, diaphragm check valve. In installation systems, flow is generated by the turbomachines that are pump or compressor. The required electrical energy for this machines is increased because of this structures such as valves, tubes and elbows etc. They creates pressure drops across the system because of the friction conditions and seperation of flow. To consume less energy in an installation, geometrical optimization of valves can decrease these pressure drops. Hence, the energy which is required can be used as efficient.

In refrigeration cycle, check valves are used to prevent reverse flow back to the compressor. Thus, compressor is prevented from reverse flow for possible damage. The globe valves that work by cutting or opening the fluid passage by placing or lifting the clack attached to the end of a shaft on the fluid passage hole (orifice). Globe valves can also be classified as spring check valve or controlled check valve according to the clack-shaft connection type. They can be used with these fluids that are water, hot water, steam, hot oil, compressed air, fuel oil, LPG, heat transfer oils and chemical fluids. These valves have high pressure losses and low flow coefficients due to their geometrical structure and cause energy losses. Besides, the level of control of flow rate is high.

In this study, the flow rate of the globe check valve was optimized with design parameters. Important design parameters that directly affect the flow rate were chosen to investigate. These parameters are diameters of the areas whose flow passes through directly. They were defined as orifice diameter and outer passage diameter. After that, for three values of the orifice diameter, outer passage diameter were changed for six different values. The investigation was

done with mathematically by using curve fitting with occurred datas. These datas are pressure drops and flow rate. Flow analysis were realized with Ansys Fluent packet programme that uses finite volume numerical analysis. The flow coefficients were calculated for all check valve geometries which are investigated and optimized designs. The changing of flow coefficient with respect to design parameters ratio, provide to create a mathematical method for determination of optimized designs.

2. CONCEPTUAL FRAMEWORK

Valves are commonly used in piping systems, to control flow rates by varying the head loss until the desired flow rate is achieved. Valves are required to have a very low loss coefficient when fully open to cause minimal head loss. The check valve only allows fluid to flow in one direction, like a diode in an electrical circuit. The loss coefficient increases greatly as the valve is closed. In addition, there are variations in the loss coefficients depending on the various valve geometries for different manufacturers (Çengel & Cimbala, 2006).

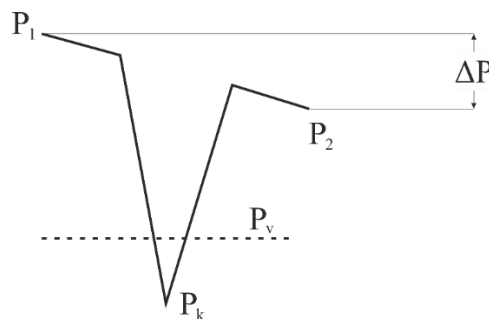


Figure 1. Pessure change across a valve (Bahadori, 2014)

The pressure drop is depend on that, the valve having a partially closed seat geometry, gradual slowing of flow due to friction, separation of the flow and high velocity fluid at the narrow valve passage (Çengel & Cimbala, 2006).

The figure above shows the behavior of pressure changes occurring between the inlet and outlet points of the valve. Here, the pressure of the fluid entering the valve decreases in the throttling region and its velocity increases in terms of the effects that create the head loss mentioned above. As a result of the dynamic pressure that occurs with the increase in flow velocity, the total pressure increases and continues to move at a relatively lower pressure value at the outlet than the inlet. In addition, the fluid continues along the pipeline with a continuous pressure drop due to friction.

2.1 Lifted Check Valves

Check valves allow the movement of the fluid in one direction, in other words, they prevent reverse flow on the installation. It is a valve that can be closed and opened automatically depending on the pressure differences of the fluid with its own physical internal mechanism without any external force or electrical signal. However, although it prevents reverse flow, the valve does not close suddenly due to friction and inertia, which are its physical properties. It varies depending on the spring mechanisms used in the check valve. In addition, the closing tightness of the check valves varies depending on the reverse pressure drop. It provides a much better closure if the upstream pressure is higher than the inlet pressure. Occurrence of reverse flow can pose a hazard to pumps seals and brush gears (Gürel, 2003) (Skousen, 1998).

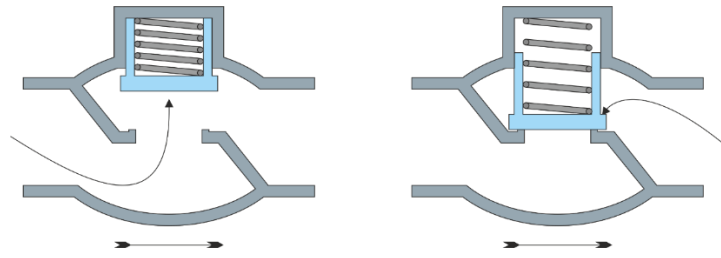


Figure 2. Lifted check valve schema with open and closed position

2.2 Sizing of Check Valve

Depending on the location and structure of the closing element, which varies according to the design of the check valve, the area through which the flow passes determines the highest value of the flow. The most important element in the design of the closing element of a check valve is to ensure that the element has low inertia in response to the required closing forces (Skousen, 1998).

When placing check valves in vertical or horizontal lines, a light (loose) spring must be placed, since the closing element working with gravity cannot close in vertical lines. The springs in the check valves prevent sticking of the closing element (piston) inside the top of the stroke, except for vertical placement only. It also provides better closure at low pressure differences during the reverse movement of the flow (Skousen, 1998).

2.3 Investigated Check Valve

Globe check valves ensure the flow and regulation of the fluid in one direction. In addition, when the fluid tries to pass in the opposite direction, globe check valves are a convenient design in terms of preventing leaks. However, in globe check valves, relatively higher energy losses occur compared to other types of check valves. The examined globe check valve belonging to Valf Sanayii A.Ş. is shown in the figure below.

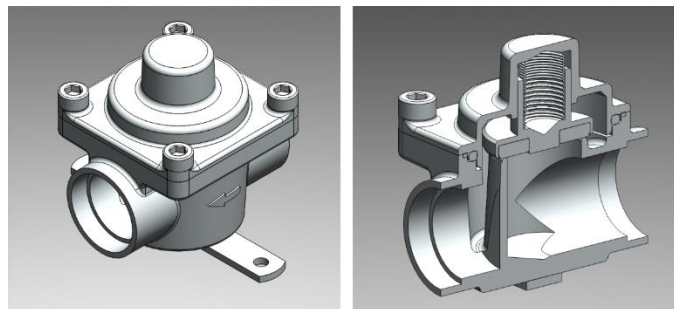


Figure 3. Check valve's solid structure with cross section

The diameters of the cross sectional areas that are boundaries of the region where the fluid flow is separated were selected to investigate. These diameters are defined as orifice diameter (D_a) and outer passage diameter (D_b). In the Figure 4, other parameters are depends on the production method. For example, h_a , h_c , h_b are depended on the spring.

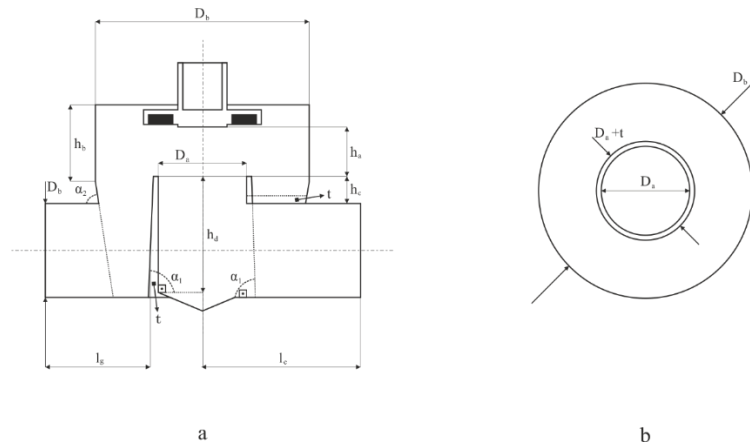


Figure 4. Design parameters of check valve, (a) is left section and (b) is upper section view

For the three different value of orifice diameter, outer passage diameter were changed with six different values. Orifice diameter was changed, 21 mm to 25 mm and outer passage diameter was changed, 38 mm to 48 mm with 2 mm steps. After that, the internal volume of check valve was designed for all diameter values.

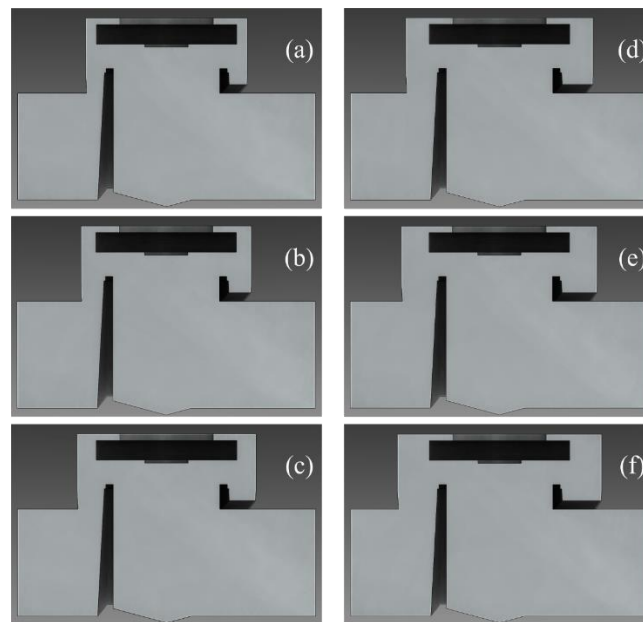


Figure 5. Internal volumes of check valve for $D_a=25$ mm with changing of D_b

2.4 Computational Fluid Dynamics (Finite Volume Numerical Method)

Computational fluid dynamics encompasses a wide range of engineering problems from design solutions, to the study of the behavior of flows in nature, and to the use of detailed solutions of the Navier-Stokes equations. Computers are needed to solve the problems described here numerically with high approximate results in a short time (Ferziger & Peric, 2002).

To decrease analysis time and element number, internal volume of the check valve was cut in half because of it's bilateral symmetry.

According to the European Test Standars, test tubes were connected to inlet and outlet of check valve. The inlet tube's length must be greater than nominal diameter of check valve as two

times. It is also required for outlet tube as ten times. ($D = 25$ mm, $L_{in}=60$ mm and $L_{out}=300$ mm). For the analysis, flow also must be turbulent and it's Reynolds number must be greater than $4e4$ (BSI, 2012).

Each geometry was meshed to provide a finite number of suitable quality for numerical analysis. Check valve's internal volume was meshed with tetrahedrons because it has complicated structure more than tubes. In addition, considering the friction between the fluid and the wall in turbulent flow, 5 layers were assigned for the boundary layers (inflation). As a result of the flow analysis of the boundary layer, the y^+ value was obtained and all analysis were carried out with the appropriate mesh structure by testing whether the analysis was suitable for the selected turbulence model. The two-equation k-epsilon turbulence model, which is common in academic studies, was used as the turbulence model.

Boundary conditions for flow analysis; 15 m/s velocity input was assigned to the input and absolute zero pressure was assigned to the output. All operations were carried out in the Ansys/Fluent package program ($Re=37.321e4 > 4e4$ when velocity is 15 m/s, $\rho=998.2$ kg/m³ and $\mu= 0.001003$ N.s/m²).

2.5 Calculations

The Reynolds number is a dimensionless measure, which is the ratio of the inertial force to the viscous force on the fluid, that allows the evaluation of the friction force in the analysis of the motion of a fluid (Çengel & Cimbala, 2006).

Reynolds number for internal flow is given below (BSI, 2012):

$$Re = u \frac{D}{\nu}, \quad (1)$$

$$\nu = \frac{\mu}{\rho}. \quad (2)$$

Pressure difference is given in eq (3) (BSI, 2012):

$$\Delta P_v = \Delta P_{v+t} - \Delta P_v. \quad (3)$$

Flow coefficient is given in eq. (4) (BSI, 2012):

$$K_v = q_v \sqrt{\frac{\rho}{\Delta P_v \times \rho_0}}. \quad (4)$$

Flow resistance coefficient is given in eq. (5) (BSI, 2012):

$$\zeta = \frac{2 \times \Delta P_v}{\rho \times u^2}. \quad (5)$$

The flow coefficient for water will be

$$K_v = q_v \sqrt{\frac{1}{\Delta P_v}}, \quad (7)$$

because the relation for water is:

$$\frac{\rho}{\rho_0} = 1 \quad (6)$$

The ratio of the areas formed by the investigated parameters was defined as δ (delta) as seen in the equation below:

$$\delta = \frac{A_h}{A_a} \quad (8)$$

Annular cross-sectional area was found by determining the desired orifice diameter and multiplying the delta which can be found with the intersection of the optimization curve in the chart by the orifice area. This equation can be created for the outer passage diameter.

Annular cross-sectional area is given in eq. (9):

$$A_h = \frac{(D_b^2 - D_t^2) \times \pi}{4} \quad (9)$$

Orifice cross-sectional area is given in (10):

$$A_a = \frac{D_a^2 \times \pi}{4} \quad (10)$$

When eq. (9) ve (10), substituting in eq. (8) gives

$$\frac{(D_b^2 - D_t^2) \times \pi}{4} = \delta \times \frac{D_a^2 \times \pi}{4} .$$

Rewriting the above equality as simplified for outer passage diameter, gives:

$$D_b = \sqrt{D_t^2 + \delta \times D_a^2} . \quad (11)$$

Here is $D_t = 29 \text{ mm}$ as constant orifice's wall diameter.

Flow coefficient curves are polinomial functions:

$$f_n(\delta) = A_n \delta^2 + B_n \delta + C_n \quad (12)$$

First derivative that equal to zero gives peak point of functions:

$$\frac{d}{d\delta} f_n(\delta) = 2A\delta + B = 0$$

Delta of the peak point is given below:

$$\delta_n = -\frac{B_n}{2A_n} . \quad (13)$$

Flow coefficient of peak point is given:

$$K_{v_n} = f_n(\delta_n) . \quad (14)$$

As a result the peak point of curves can be defined as below,

$$O_n(\delta_n, K_{v_n})$$

Error of $K_{v_{mathematical}}$ to the $K_{v_{analysis}}$ can be found as relatively in percent.

$$\% H_K = \frac{|K_{v_{mathematical}} - K_{v_{analysis}}|}{K_{v_{mathematical}}} \times 100 \quad (15)$$

Maximum error can be defined as $\% H_{K-max}$ for all optimized designs. Then numerical flow coefficient can be written as:

$$K_v = K_{v_{math}} \pm K_{v_{math}} \times H_{K-max} \% . \quad (16)$$

3. FINDINGS AND DISCUSSION

For the numerical method to be consistent, mesh qualities and boundary layer structure were examined. Then, the pressure and velocity distributions also obtained, the effects of the selected parameters on the flow, and the calculated flow coefficients were consistent with each other. Optimization diagram was formed by mathematically, examining the flow coefficients. In this

way, it can be ensured that the optimized geometry can be designed according to the desired design criteria and other dimensioning considerations.

3.1 Mesh Structure

The figure below contains the entire geometry for which the flow analysis is performed.

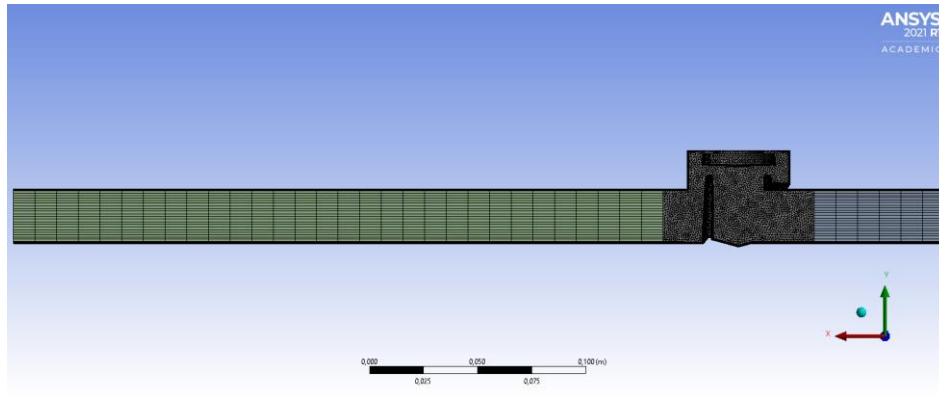


Figure 6. Mesh structure of entire analyzed body

The distribution of the separated volumes according to the mesh structure statistics below, shows a distribution between 0 and 0.5 on the left side of the graph for the skewness values(Figure 7.a), with an average of approximately 0.2. The same is true for orthogonality, with an average of about 0.8(Figure 7.b). The quality values of the elements with the lowest quality are above the acceptable level for the mesh structure criteria (The largest skewness is 0.9 and the smallest orthogonality is e-2).

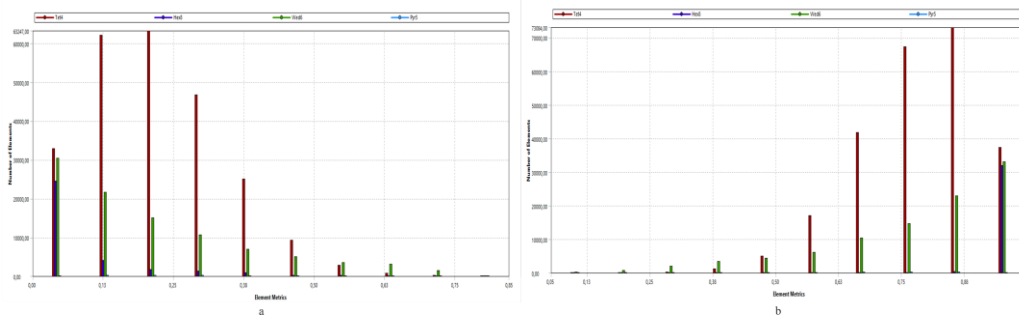


Figure 7. Skewness and orthogonality statistics respectively from (a) to (b)

In addition, the (y^+) values of the wall layer vary between 49 and 62. The dimensionless value of the boundary layer should be in these ranges, $5 \leq y^+ \leq 30$ and $30 \leq y^+ \leq 300$. The first range is viscous sublayer and u^+ is equal to y^+ , between 5 and 30 there is no velocity profile, between 30 and 300 the u^+ value is equal this mathematical expression which is “ $1/k \cdot \ln y^+ + B$ ”. This region is called overlap layer. Therefore, the y^+ value cannot be used between 5 and 30. Here

the boundary layer is in the overlap layer and there is a velocity profile. Therefore y^+ values are suitable for analysis.

3.2 Pressure and Velocity Profiles

The following figure shows the pressure profile formed as a result of the flow analysis. When looking from the upper left corner to the lower right corner, it is clearly seen how the low pressure region at the exit of the check valve decreases with the increasing of the outer passage diameter. In addition, the amount of high pressure decreases at the entrance region. Thus, the pressure difference on the check valve gradually decreases compared to the initial state. In this case, the flow coefficient increases and the flow resistance coefficient decreases.(Initial case is (c)).

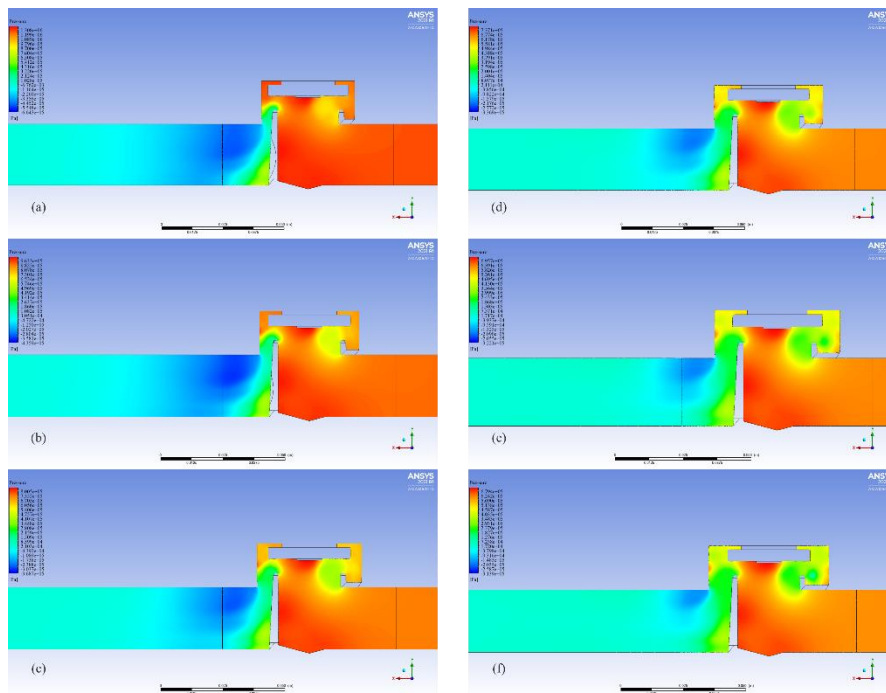


Figure 8. Pressure profiles

The velocity vector field shows that, velocity of vectors was increased with decreasing of outer passage diameter. In this region pressure value was also decreased. Therefore, it is consistent with pressure profile.

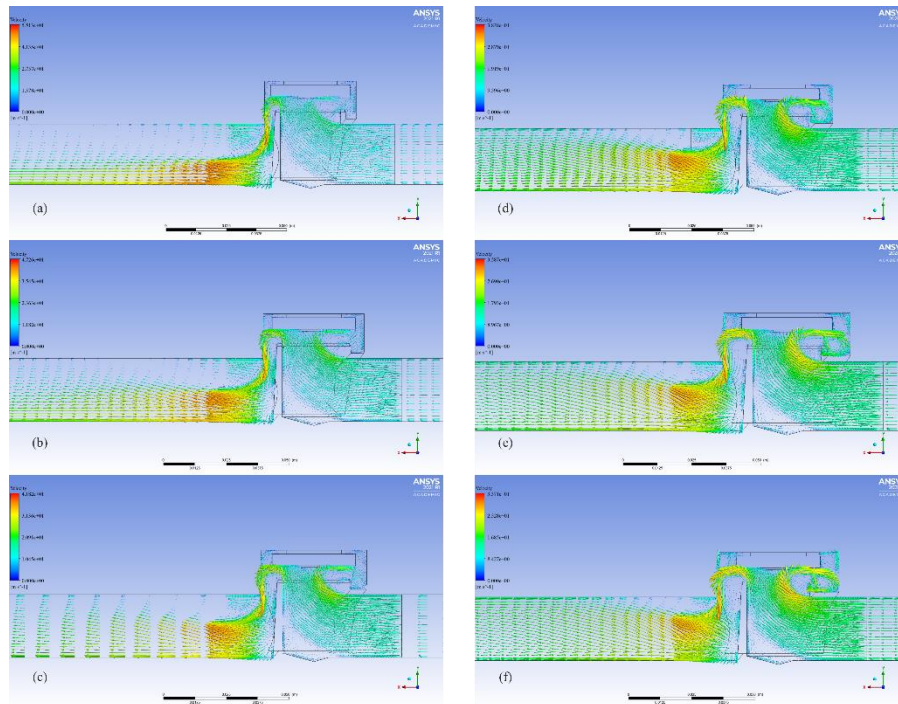


Figure 9. Velocity vector fields

Table 1. Optimized design pressure and flow coefficient values

D_a (m m)	Tube inlet pressure (bar)	Tube outlet pressure (bar)	Valve inlet pressure (bar)	Valve outlet pressure (bar)	Pressure difference (bar) ΔP_v	Flow coeffic nt (m^3/sa)	Flow resistance coefficient
27	6.53	1.13	6.49	1.13	5.36	11.44	4.77
25	7.22	1.14	7.17	1.09	6.08	10.74	5.41
23	8.22	1.14	8.17	1.05	7.12	9.92	6.34
21	9.72	1.14	9.67	0.98	8.69	8.98	7.74

3.3 Optimization Curves

The changes in the flow coefficients according to the ratios of the cross-sectional areas for the design parameters were examined by the curve fitting method by using the Tracker data analysis program. Each data set is dependent on the orifice diameter. The charts below indicate the variation of the outer passage diameter for a constant value of 21, 23 and 25 mm for orifice diameter. The horizontal axis is defined by the area ratios created by the parameters. The vertical axis is the flow coefficient.

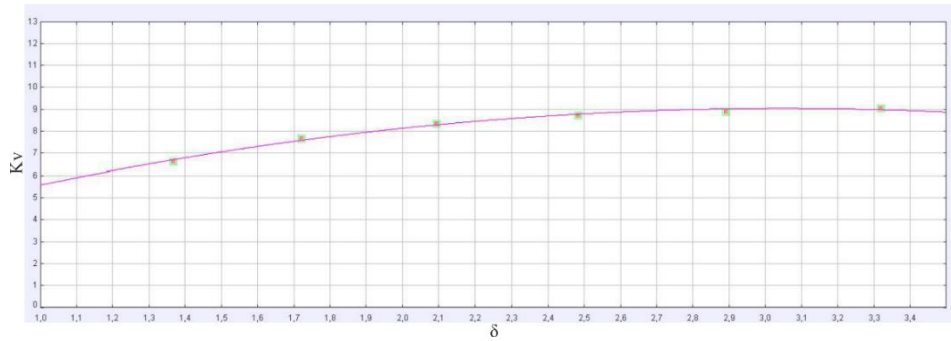


Chart 1. For $D_b=[38;48;2]$ when $D_a=21$. Changes of K_v with respect to δ

Equation of Chart 1: $f_1(\delta) = -0.8278 \delta^2 + 5.045 \delta + 1.355$ (17)

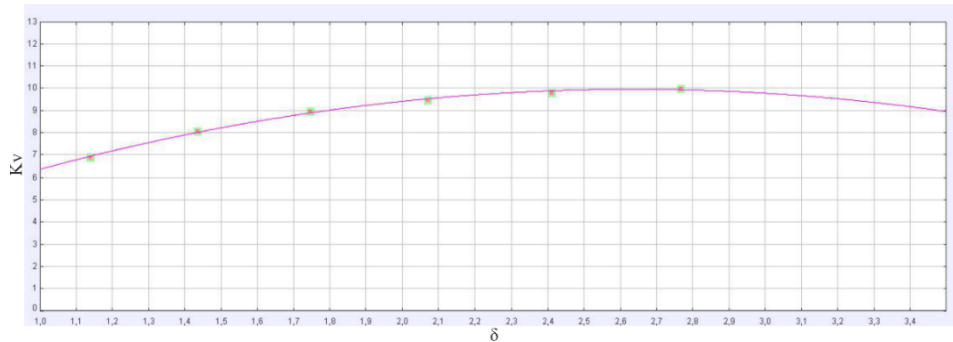


Chart 2. For $D_b=[38;48;2]$ when $D_a=21$. Changes of K_v with respect to δ

Equation of Chart 2: $f_2(\delta) = -1.348 \delta^2 + 7.106 \delta + 0.5875$ (18)

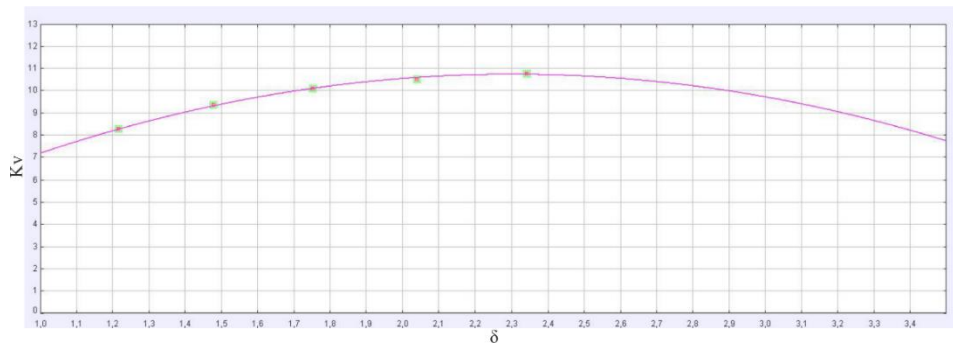


Chart 3. For $D_b=[38;48;2]$ when $D_a=21$. Changes of K_v with respect to δ

Equation of Chart 3: $f_3(\delta) = -2.097 \delta^2 + 9.659 \delta - 0.3782$ (19)

When the curve is refitted according to the peaks of the flow coefficient curves shown above, the optimization curve below is formed, which determines all possible peaks. The optimization curve intersects all flow coefficient curves with their highest point.

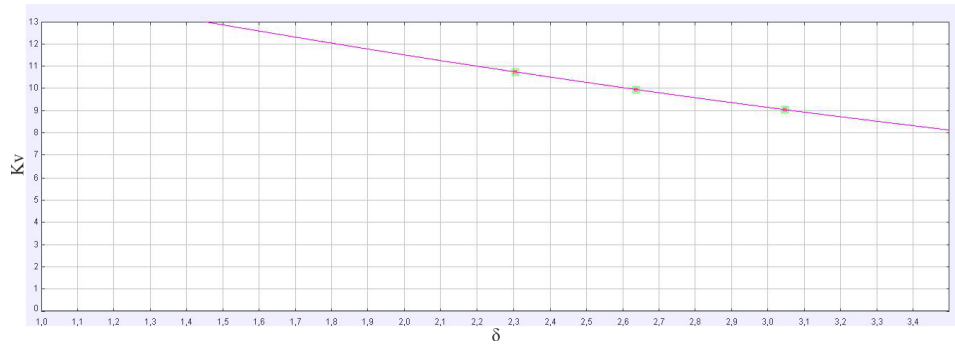


Chart 4. Change of flow coefficient of optimized points with respect to δ

Equation of Chart 4: $Opt(\delta) = 0.2233 \delta^2 - 3.484 \delta + 17.58$ (20)

After that, flow coefficient’s curves and optimization curve were combined in same plane with same scale. The optimization chart was created. It provides to select optimized point for design criterias as desired.

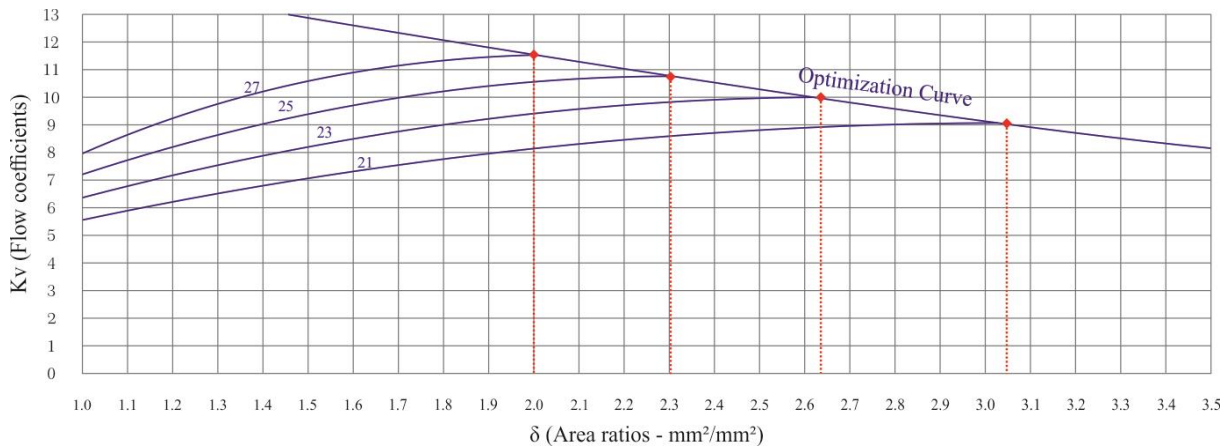


Chart 5. Optimization chart with optimized points for investigated orifice diameter

Firstly, the curve which was drawn for orifice diameter equals to 27 mm was created with coherence between these curves whose orifice diameter were 21, 23 and 25 mm. Intersection point of it and optimization curve was read as 11.53 for flow coefficient. To test it is right or not, geometry was designed with diameter values that comes from chart by using delta. ($D_a=27$ mm and $D_b=47.95$ mm). Thanks to flow analysis , the flow coefficient was calculated as 11.44.

3.4 Errors between the analysis and optimization chart

The erros that occur was calculated for all optimized points from the optimization chart. They were shown in below table clearly. From this result, the meximum error is approximately % 0.8.

Table 2. Errors between mathematical and analysis result for flow coefficient

δ	D_a (mm)	D_b (mm)	K_v -mathematical (m ³ /sa)	K_v -analysis (m ³ /sa)	H_K Relative error (%)
3.047	21	46.74	9.0416	8.9831	0.647009
2.6358	23	47.28	9.9523	9.9226	0.298423
2.3031	25	47.75	10.7444	10.7391	0.049328
2	27	47.95	11.53	11.44	0.780572

In this manner, the general flow coefficient can be written as,

$$K_v = K_{v_{math}} \pm K_{v_{math}} \times 0.8\% \tag{21}$$

3.5 Flow Coefficient’s Derivatives and Convergence of Area Ratio

Derivative of flow coefficient’s curves define a line which cross the horizontal axis at optimized point. These lines intersect each other in same plane with same scale. The points which occurred from intersection of a line and it’s previous line were investigated by using curve fitting. This operation created a exponential curve whose equation is (22). It was shown with dotted line. In this way, it was tried to understand what kind of approach the lines were in.

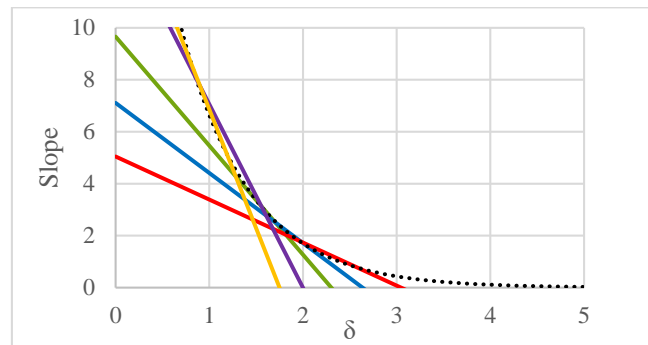


Chart 6. Derivatives of flow coefficient curves and their intersection

Considering the intervals formed by the lines intersecting the horizontal axis and intersection of the exponential curve and the purple line, the yellow line was created. (The line equation with two known points). The resulting line also exhibited the same approach as the others. From here, it was seen that the horizontal axis of the lines is getting closer to the 1 gradually. In other words, the highest flow coefficient will be obtained when the ratio between areas is 1 (Equality of areas). However, since the outer diameter (wall diameter) of the orifice diameter of the check valve is constant at 29 mm, the flow coefficient curves cannot increase more than this value which is 27 mm for orifice diameter. Even if it increases, this increase does not produce a realizable product.

$$\gamma = 25.93e^{-1.362\delta} \tag{22}$$

$$\gamma = -9.143\delta + 16$$

(23)

$$\gamma = -7.06\delta + 14.12$$

(24)

$$\gamma = -4.194\delta + 9.6598$$

(25)

$$\gamma = -2.696\delta + 7.106$$

(26)

$$\gamma = -1.6556\delta + 5.045$$

(27)

The equations (23-27) are the derivatives of flow coefficients. Eq. (23), (24), (25), (26), (27) are yellow, purple, green, blue and red lines respectively in Chart 6 Gama is referred to slope of flow coefficient curves. Delta is already area ratio.

4. RESULTS

In this study, the optimized design parameters that are investigated can be obtain from optimization chart. Initial design of the check valve's flow coefficient was calculated as 9.36. The maximum flow coefficient was calculated as 11.44 from flow analysis. Thus, the maximum optimization ratio can be reach to 22.22% as relatively to the initial design. The flow resistance coefficient is an important value of valves. The initial design's flow resistance coefficient was calculated as 7.12 and the minimum flow resistance coefficient also calculated as 4.77. In this manner, the maximum optimization ratio can be reach 33% as relatively. As a result, the optimization ratios creates improvements that are not underestimate. In addition, thanks to the optimization diagram, it is possible to care about other design criteria. The designer can freely reach the required diameter values in order to provide the appropriate flow, taking into account other design criteria.

Consequently, the energy savings to be achieved by the flow optimization performed in this study, even when only cooling cycles are considered, are enormous. Therefore, when the energy methods produced by damaging the environment are considered, the damages are relatively reduced. For example, fossil fuels such as coal, natural gas etc. in widely used thermal power plants increase carbon emissions to produce electricity. In this respect, the importance of renewable and environmentally compatible energy methods is revealed. In addition, from an economic perspective, expenditures for energy needs are greatly reduced.

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Project Number: 1139B412000818

REFERENCES

Bahadori, A. (2014). Sizing of Valve and Control Valve. A. Bahadori, & Elsevier, *Natural Gas Processing Technology and Engineering Design*. Waltham: Gulf Professional Publishing.

- BSI. (2012, Ocak 31). Industrial valves - Test of flow resistance using water as test. *Industrial valves — Test of flow*. BSI Standards Publication.
- Çengel, Y., & Cimbala, J. M. (2006). *Fluid Mechanics Fundamentals And Applications*. New York: McGraw-Hill.
- Ferziger, J., & Peric, M. (2002). *Computational Methods For Fluid Dynamics*. Berlin: Springer-Verlag.
- Gürel, S. (2003). *Türk Tesisat Mühendisleri Derneği*. Mart 8, 2021 tarihinde ttmd: <https://www.ttmd.org.tr/PdfDosyaları/Dergi-Eki-26-1-1.pdf> adresinden alındı
- Skousen, P. L. (1998). *Valve Handbook*. New York: McGraw-Hill.

GENDER RECOGNITION WITH SONGS

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ABSTRACT

Voice is a behavioral biometric that conveys information about personal characteristics such as gender, ethnicity, and age. In this respect, human speech contains important paralinguistic information that can be used in many speech recognition applications. Detecting a person's gender (female or male) by voice is a very simple process because of the experience people have. However, it is a very challenging problem for computerized systems. The study is aimed at detecting gender with sound signals. The contributions of the study are (i) the determination of distinctive features of voice using the data set and (ii) the examination of various machine learning algorithms for gender detection by voice. In the study, a method using the Local Binary Pattern (LBP) algorithm and feature selection for gender recognition from the voice dataset has been proposed. The proposed method consists of two main steps. First of all, feature selection is made with the LBP algorithm. Then, these features are classified by the k-nearest neighbor (k-NN), and decision tree algorithms and gender determination is made. Experimental studies, a data set consisting of the songs of ten females and ten male singers who are famous in Turkish music in different music categories were used. Ten features were extracted from each 30-second a song using the LBP algorithm. The combined features were then classified using k-NN and decision tree algorithms, and gender determination was made. In experimental studies, 81% accuracy rate in decision trees and 85% accuracy rate in k-NN classifier was achieved in gender determination.

Keywords: Gender recognition with voice, LBP, k-NN, decision tree

1. INTRODUCTION

Voice is a behavioral biometric that conveys information about personal characteristics such as gender, ethnicity, and age. These unique features, also known as voice biometrics, are individual and unique as fingerprints, DNA, and eye retina [1]. Although Voice Gender Recognition (VGR) is an old subject, significant developments have been made in recent years with the use of computer systems [2]. VGR is a fairly easy procedure for humans. Because the human ear has an excellent mechanism to distinguish gender based on features such as the frequency and amplitude of the sound. However, it makes this situation a bit more complicated for computer systems due to noise in recording sound [3]. However, despite this complexity, audio signals are widely used in human-computer interaction, speaker-emotion recognition, automatic greeting, suppression of voices according to gender in instant conversations, electronic voice listening, security, and mobile banking applications [4].

The use of the speaker's pitch frequency characteristics is one of the key steps in gender recognition from audio signals [5]. Because the female voice has a greater frequency than the male voice. In the literature, machine learning (ML) models are preferred in the majority of VGR investigations, however deep learning (DL) techniques have also used in newer studies. Some studies and results in these areas are presented below.

Pahwa et al. [6] proposed a gender recognition model using data from 46 different speakers. In this proposed model, Mel coefficients of speech data are used as features. Then, these features performed gender recognition with 93.48% accuracy with Support Vector Machine (SVM) and Artificial Neural Network (ANN) classifiers. Jasuja et al. [6] They proposed a multilayer perceptron-based deep learning model for gender recognition from voice data. Firstly, for the proposed model, a data set of 3168 data was created by acoustic analysis from male and female voices recorded from many data sets. Then, after the proposed model was trained with different parameters, they performed gender recognition with 96% accuracy on the test dataset. Maka et al. [7] tried to analyze the effect of sounds in different acoustic environments on gender definition. For experimental studies, after background noise was removed from 630 speech data, 438 men and 192 women, feature extraction was performed with spectral variance. In addition, they achieved over 92% success in gender recognition with nonlinear smoothing to increase classification performance. Pribil et al. [8] proposed the Gaussian mixture model (GMM) algorithm for gender and age estimation. In the study, age estimation was made in 4 categories as child, young, adult, and old before speech signals. They then performed gender recognition with 90% accuracy. In another study, the researchers developed a two-level GMM classifier for age and gender recognition, providing gender recognition with an accuracy of 97.5% [9].

Maka et al. [7] tried to analyze the effect of sounds in different acoustic environments on gender definition. For experimental studies, after background noise was removed from 630 speech data, 438 men and 192 women, feature extraction was performed with spectral variance. In addition, they achieved over 92% success in gender recognition with nonlinear smoothing to increase classification performance. Pribil et al. [8] proposed the Gaussian mixture model (GMM) algorithm for gender and age estimation. In the study, age estimation was made in 4 categories as child, young, adult, and old before speech signals. They then performed gender recognition with 90% accuracy. In another study, the researchers developed a two-level GMM classifier for age and gender recognition, providing gender recognition with an accuracy of 97.5% [9].

In this study, gender recognition was performed from songs using the Local Binary Features (LBP) algorithm. In experimental studies, a dataset consisting of pieces belonging to ten males and ten female artists popular in Turkish music was used. After LBP feature extraction, gender recognition was performed with k-Nearest Neighbor (k-EYK) and decision tree classifiers. The results of the experimental study provided 85% accuracy of gender recognition in k-EYK classification.

The organization of the study is as follows: In section 2, information about the methods is given; in section 3, experimental studies, and in the final section, conclusions and recommendations are given.

2. MATERIAL AND METHODS

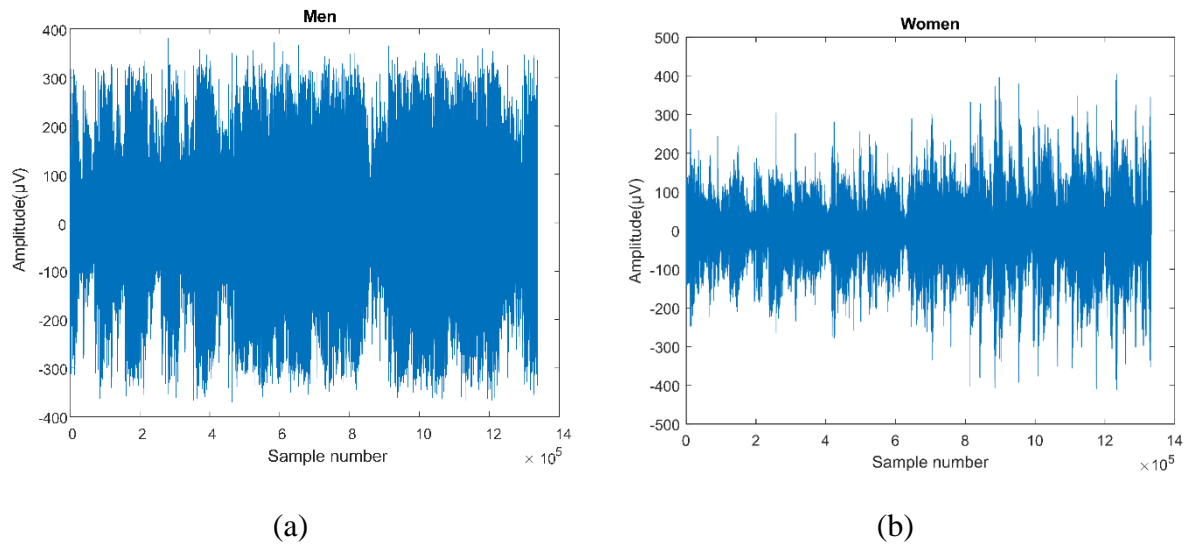
2.1. Dataset

The dataset includes the songs of famous Turkish music artists (such as S. Aksu, M. Senar, I. Tatlıses, A. Kaya, B. Manco, S. Ortac, etc.) in different music categories.

Table 1. Dataset

Singer (women)	Performed Song	Singer (men)	Performed Song
Hadise	<i>Aşk dediğin</i>	Ahmet Kaya	<i>Nerden bileceksiniz</i>
Müzeyyen Senar	<i>Dalgalandım da duruldum</i>	Bariş Manço	<i>Gamzedeyim</i>
Muazzez Abacı	<i>Vurgun</i>	Cem Adrian	<i>Kum gibi</i>
Neşe Karaböcek	<i>İntizar</i>	İbrahim Tatlıses	<i>Sarhoş</i>
Selda Bağcan	<i>Yürüyorum</i>	Kıraç	<i>Sevgilim</i>
Sezen Aksu	<i>Gülümse</i>	Musa Eroğlu	<i>Mihriban</i>
Sibel Can	<i>Padişah</i>	Mustafa Ceceli	<i>Emri Olur</i>
Yıldız Tilbe	<i>Seni andım bu gece</i>	Mustafa Sandal	<i>Aya benzer</i>
Zara	<i>Gönül dağı</i>	Neşat Ertaş	<i>Leylam</i>
Zerin Özer	<i>Son mektup</i>	Serdar Ortaç	<i>Şeytan</i>

Each song is arranged to be an average of 30 seconds in duration. The sampling frequency of the data set is 44100Hz. Musical pieces with musical instruments (instruments with high bass value for high-pitched artists) have been selected so that the musical instruments in the song chosen affect the artist's tone of voice. Figure 1 shows sample audio signals of male and female artists.

**Şekil 1.** Sample song signal a) Men, b) Women.

2.2. Local Binary Pattern

The Local Binary Pattern (LBP) operator was developed by Ojala et al. for tissue classification [12]. LBP is a non-parametric $n \times n$ kernel that summarizes the structure of a two-dimensional image. In short, it extracts local features by dividing an image into regions. It defines the pixel intensities between the pixel determined as the center of a 3×3 matrix (m_c, n_c) and the eight

surrounding pixels as a binary set [13,14]. The resulting 8-bit binary code set can also be expressed in decimal form, as seen in Figure 1. Center pixel values are determined by moving this process on the data according to the determined number of steps. Accordingly, the local binary code for the (m_c, n_c) location is defined as in Equation 1;

$$LBP(m_c, n_c) = \sum_{p=0}^8 s(i_p - k_c)2^p \tag{1}$$

Where k_c defines the gray value of the center pixel surrounded by (m_c, n_c) , and i_p represents the gray values of the 8 pixels surrounding the center. Also, the step function $f(s)$ is seen in Equation 2.

$$f(s) = \begin{cases} 1 & s \geq 0 \\ 0 & s < 0 \end{cases} \tag{2}$$

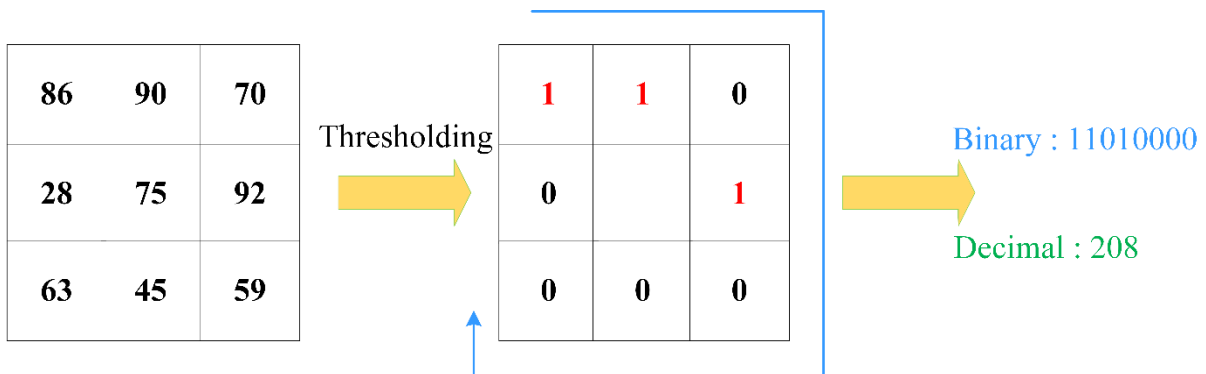


Figure 2. Local binary pattern operator

2.3. k- Nearest Neighbor

The nearest neighbor algorithm is one of the most straightforward and most used both classification and regression algorithms. The basic study of the algorithm decides according to the similarity measure of the data to be estimated with the existing data [15]. The decision process is determined by the k value. K is the element to be considered in the classification. The classification process is performed by calculating the distance between the k-value data and the test data. Functions such as Euclid, Manhattan, Minkowski, and Hamming are used as distance.

2.4. Decision Tree

The decision tree is a tree-based algorithm used in regression and classification problems. It is a widely used modeling method in machine learning, data mining, and statistics [16]. In this model, the observations about the event are represented by the branches and the target values of the event by the leaf, and a decision tree model is created to reach a conclusion about the event. It helps in determining the factors to be taken into account in the decision-making process and the relationship between these factors and outputs. In this way, it is possible to decide on the target function approximately. In practice, the decision process starts from the tree trunk and continues until it reaches a leaf. It can classify both numerical and categorical data. Algorithms such as C4.5, CART, and random forest are commonly used.

3. EXPERIMENTS RESULTS

Experimental studies were carried out with a dataset of popular songs. LBP was used as a feature extraction method to capture important information in the audio data signals of each artist in the data set. Feature extraction with LBP is explained step by step in Figure 3 via a sample song signal fragment.

A sequential pairwise comparison was made between the LBP operator center value and the neighbor value of the audio signal, as shown in Figure 3(a). Each sample of the sign was considered as $P/2$ sample neighbors before and after the sample center (PC). Briefly, four sample neighbors (P0, P1, P2, P3, PC, P4, P5, P6, P7) were determined before and after PC. Then, the amplitude values of each neighbor and the sample center were compared, as shown in Figure 3(b). In order to generate binary numbers as in Equations 1 and 2, all sample neighbors were thresholded with the sample center, and the image in Figure 3 (c) was obtained. Finally, the decimal value of the binary value was obtained as in Figure 3(d).

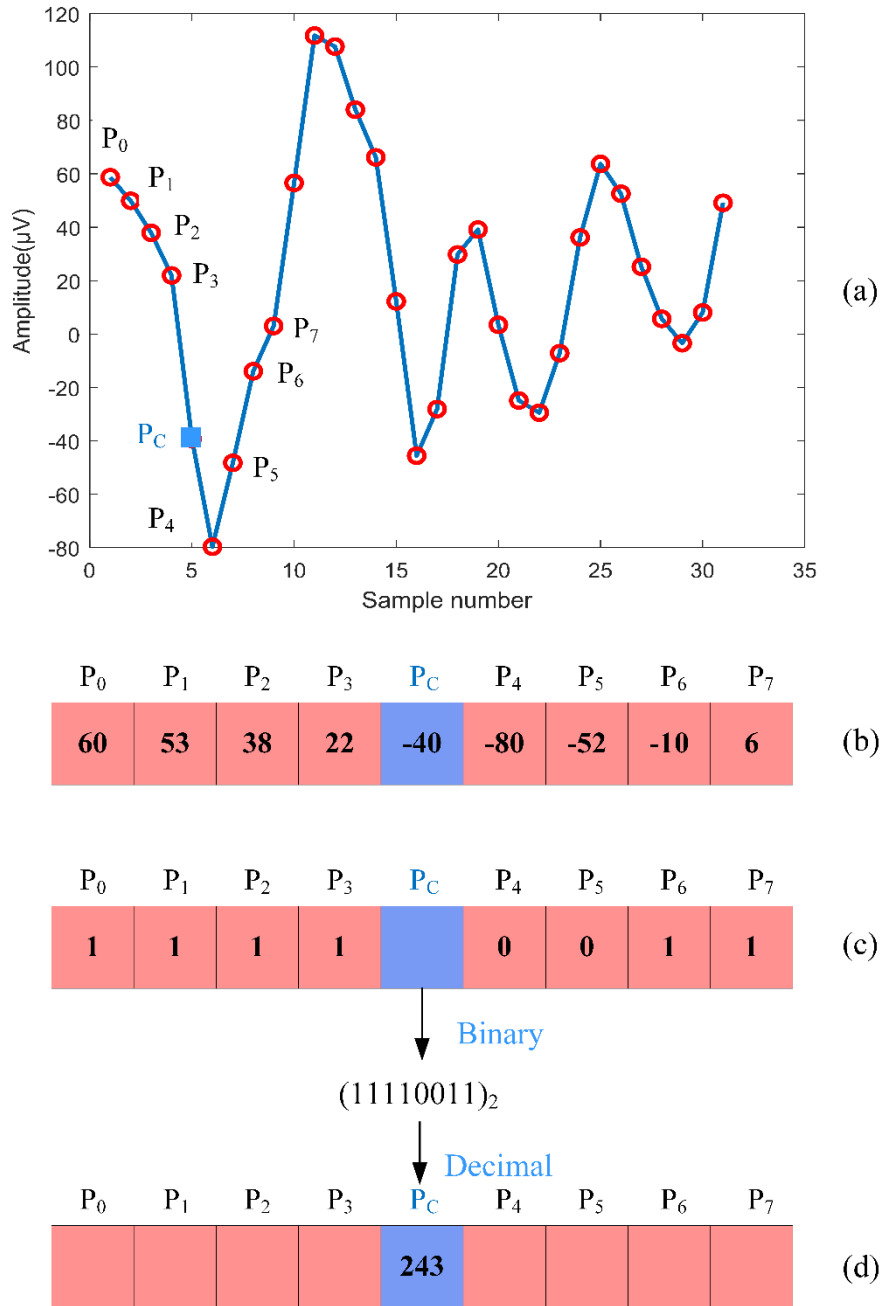


Figure 3. LBP implementation steps, (a) part of the sample audio signal, (b) sample values of the sub-signal, (c) thresholding by comparing neighboring samples with the central and 8-bit binary representation, and (d) decimal representation.

After feature extraction, the features obtained for gender recognition were applied to the k-NN and decision tree classifiers as inputs. At this stage, the 10-fold cross-validation technique, which is widely used in machine learning, is used for the best model selection in classification problems. In addition, to evaluate the classifier performances, accuracy (Acc), sensitivity (Sen), specificity (Spe), sharpness (Pre), and F1 performance criteria, which are widely used in the literature, were taken as references. Table 2 shows the classification results of the classifiers.

Table 2. Classification results of classifiers (%)

Classifier	Acc	Sen	Spe	Pre	F1
k-NN	85.0	81.0	89.0	88.04	84.38
Decision tree	81.0	83.0	79.0	79.81	81.37

As can be seen in Table 2, the highest accuracy was obtained in the k-NN classifier with 85%. An accuracy score of 81% was obtained in the decision trees. In other performance evaluation criteria, 83% decision trees for sensitivity, 89% for specificity, 88.04% for sharpness, and 84.38% for F1 were obtained in the k-NN classifier.

For a more detailed performance evaluation specific to classes, the confusion matrix of each classifier is given in Figure 4. In the confusion matrix in Figure 4, the sum of each column shows the estimated number of data for that category, while each row shows the actual values in the dataset.

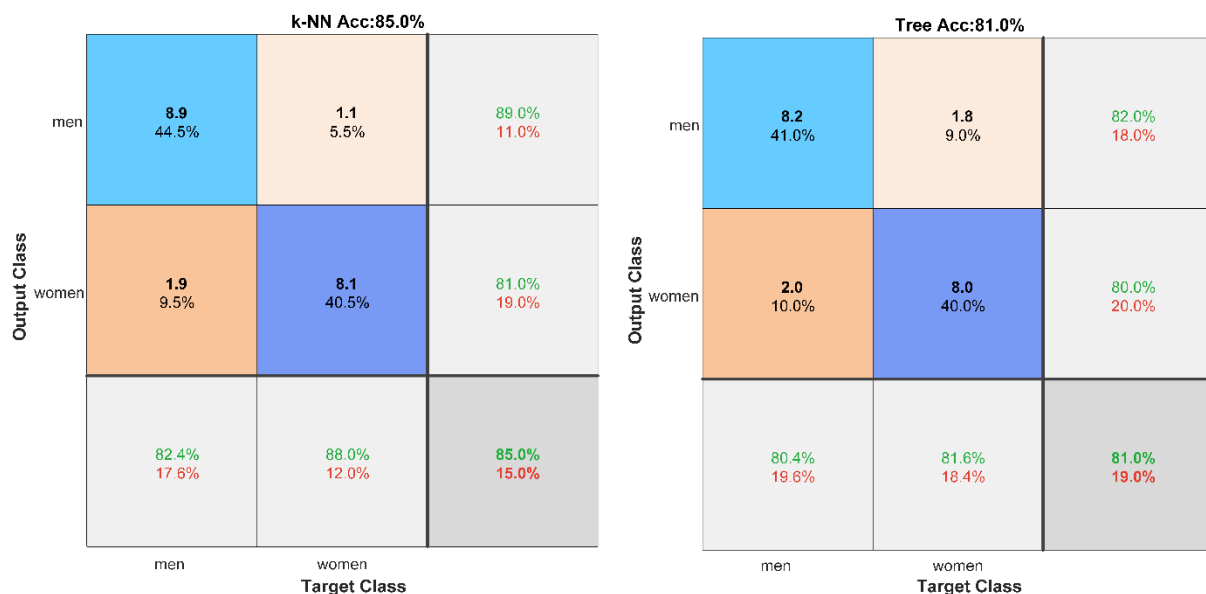


Figure 4. The confusion matrix of each classifier.

As seen in Figure 4, 89% male-class data and 81% female-class data were correctly classified by k-NN. On the other hand, it is seen that 11% of male-class data are incorrectly classified as female-class data, and 19% of female-class data are incorrectly classified as male-class data. In addition, 82% male-class data and 80% female-class data are correctly classified in the decision tree classifier. However, it is seen that 18% of male-class data are incorrectly classified as female-class data, and 20% of female-class data are incorrectly classified as male-class data. As a result, the confusion matrix values of each classifier in Figure 3 clearly show that the data labels of the dataset are highly predicted.

4. DISCUSSION AND CONCLUSION

In this study, a low-level tissue descriptor LBP method was proposed for gender recognition. The proposed method was used for feature extraction from audio signals. It was tested with

songs belonging to ten famous female and male artists in Turkish music for experimental studies. Experimental study results, gender recognition, was performed with an 85% accuracy score in the k-NN classifier and 81% accuracy in the decision tree classifier.

In future studies, we aim to explore a dataset of famous artists and different texture descriptors in the world.

REFERENCE

- [1]. Jahangir, R., Teh, Y. W., Nweke, H. F., Mujtaba, G., Al-Garadi, M. A., & Ali, I. (2021). Speaker Identification through Artificial Intelligence Techniques: A comprehensive Review and Research Challenges. *Expert Systems with Applications*, 114591.
- [2]. Li, M., Jung, C. S., & Han, K. J. (2010). Combining five acoustic level modeling methods for automatic speaker age and gender recognition. In *Eleventh Annual Conference of the International Speech Communication Association*.
- [3]. Ertam, F. (2019). An effective gender recognition approach using voice data via deeper LSTM networks. *Applied Acoustics*, 156, 351-358.
- [4]. Buyukyilmaz, M., & Cibikdiken, A. O. (2016, December). Voice gender recognition using deep learning. In *2016 International Conference on Modeling, Simulation and Optimization Technologies and Applications (MSOTA2016)* (pp. 409-411). Atlantis Press.
- [5]. Bishop, J., & Keating, P. (2012). Perception of pitch location within a speaker's range: Fundamental frequency, voice quality and speaker sex. *The Journal of the Acoustical Society of America*, 132(2), 1100-1112.
- [6]. Pahwa, A., & Aggarwal, G. (2016). Speech feature extraction for gender recognition. *International Journal of Image, Graphics and Signal Processing*, 8(9), 17.
- [7]. Maka, T., & Dziurzanski, P. (2014, April). An analysis of the influence of acoustical adverse conditions on speaker gender identification. In *XXII Annual Pacific Voice Conference (PVC)* (pp. 1-4). IEEE.
- [8]. Přibil, J., Přibilová, A., & Matoušek, J. (2016, July). GMM-based speaker gender and age classification after voice conversion. In *2016 First International Workshop on Sensing, Processing and Learning for Intelligent Machines (SPLINE)* (pp. 1-5). IEEE.
- [9]. Přibil, J., Přibilová, A., & Matoušek, J. (2017). GMM-based speaker age and gender classification in Czech and Slovak. *Journal of Electrical Engineering*, 68(1), 3-12.
- [10]. Jasuja, L., Rasool, A., & Hajela, G. (2020, September). Voice Gender Recognizer Recognition of Gender from Voice using Deep Neural Networks. In *2020 International Conference on Smart Electronics and Communication (ICOSEC)* (pp. 319-324). IEEE.
- [11]. Prasetio, M. D., Sekizaki, S., Hayashida, T., Susanto, A., Nishisaki, I., & Abdillah, M. (2019, October). Single Speaker Recognition Using Deep Belief Network Gender Classification Voices. In *2019 International Conference on Advanced Mechatronics, Intelligent Manufacture and Industrial Automation (ICAMIMIA)* (pp. 253-258). IEEE.
- [12]. Ojala, T., Pietikainen, M., & Maenpaa, T. (2002). Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. *IEEE Transactions on pattern analysis and machine intelligence*, 24(7), 971-987.

- [13]. Kheder, W. B., Matrouf, D., Ajili, M., & Bonastre, J. F. (2016). Local binary patterns as features for speaker recognition. In *Odyssey* (pp. 346-351).
- [14]. Kaya, Y., Uyar, M., Tekin, R., & Yıldırım, S. (2014). 1D-local binary pattern based feature extraction for classification of epileptic EEG signals. *Applied Mathematics and Computation*, 243, 209-219.
- [15]. Aslan, M., Akbulut, Y., Şengür, A., & Ince, M. C. (2017). Skeleton based efficient fall detection. *J. Fac. Eng. Archit. Gazi Univ*, 32(4) , 1025-1034
- [16]. Kantardzic, M. (2011). *Data mining: concepts, models, methods, and algorithms*. John Wiley & Sons.

ASAS¹ AN ENGINEERS' RECRUITMENT & COMMUNICATION SYSTEM

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ABSTRACT

Within the vision of 2030 for the Kingdom of Saudi Arabia, urban development is one of the most important basic pillars that the Kingdom needs in many fields, therefore the specialists and owners of funds sought to search for engineers and companies with competencies which is one of the most difficult steps faced. Therefore, in this work we provide an electronic system to connect between the engineers and the labor market. The system is developed as a virtual platform that required a life cycle consisting of many stages must be passed through to reach the final product. This cycle is referred to software development life cycle (SDLC). SDLC is a software engineering process which is used to design, develop, test, and publish programs. Each stage of the SDLC is designed to give the stakeholders control over their software development with predictable deliverables and visibility into budgets and deadlines. The aim of adopting the SDLC model is to produce high-quality programs at a lower cost in an efficient and productive manner [1] The project was starting by utilizing a Waterfall model in developing the system. This model is distinguished in many ways that facilitate the access to the final product within the specified time. The Waterfall methodology uses a sequential approach to program development, which is to describe, interpret, and systematically evaluate all aspects of a systematic information system development.

Consequently, the problem is concentrated in reaching experienced engineers to work on construction projects within the Kingdom of Saudi Arabia, from which these engineers can get the work quickly and desired, and thus work to integrate experienced engineers and newly graduated engineers into the labor market through an electronic system provided with many options and technologies that allow this.

Keywords: Real estate development, Engineering supervision, Saudi Arabia, Stakeholders, Architectural engineer, vision 2030, website, communication platform.

1. INTRODUCTION

The construction industry plays a fundamental role in the economic and social development of the Kingdom of Saudi Arabia, and with its multiple elements it represents a strategic center in development plans, as its share of the total investments for the annual development plan.

Urban development is considered one of the basic pillars on which the state depends on its emergence and prosperity, and thus working to integrate engineers into the labor market at the required speed is one of the tasks that we seek by providing a system capable of providing these capabilities, and thus work to increase the expertise of engineers by providing that platform electronic work to integrate these engineers into the labor market at the required speed.

As it known, the search for engineers and companies specialized in the field of construction is one of the obstacles that the money holders and citizens suffer when they need to build their buildings, therefore this research works through the system to provide advanced electronic means in the field of searching for engineers with high experience.

In an article by Al-Eqtisadia website, the article mentioned a list showing the number of female engineers in the kingdom, and we quote from the article: "The number of female engineers

¹ASAS is an Arabic word means indicating that the correct basis is the beginning of everything.

registered with the Saudi Council of Engineers reached 2,633, of whom 1,420 are Saudi, or 53.9 per cent, while the number of non-Saudi female engineers is 1,213, or 46 per cent. Engineer Abdel Nasser Al-Abd Al-Latif, a spokesperson for the authority, told Al-Eqtisadiah that the highest percentage of Saudi female engineers registered with the Saudi Council of Engineers specialized in the field of interior design, followed by architecture, and then architecture"[1].

2. MATERIALS AND METHODS

2.1. The Software Development Life Cycle

The system is a software that is developed in this research, it is used as a program needs life cycle consisting of many stages that we must pass through in order to reach the final product, and the path the researcher follow to end this life cycle may differ, but in all cases we launch This cycle is referred to as the software development life cycle, and it is called SDLC, so the software development life cycle is a software engineering process used to design, develop, test and publish programs. Each stage of the SDLC is designed to give companies control over their software development with predictable deliverables and visibility into budgets and deadlines. The aim of adopting the SDLC model is to produce high-quality programs at a lower cost in an efficient and productive manner [4].

Thus, there are many methodologies that can be used within the software life cycle, and the researcher will utilize the Waterfall model in developing our system, as this model is distinguished in many ways that facilitate our access to our final product within the specified time.

2.2. The Waterfall Methodology

The Waterfall methodology uses a sequential approach to program development, which is to describe, interpret, and systematically evaluate all aspects of a systematic information system development. The researcher decided within the system to use this methodology because it is considered an easy and simple methodology due to the ability to provide a full understanding of all requirements and deliveries. Also, using this methodology, verification is done at every stage of the waterfall model, ensuring early detection of errors / misunderstandings that the researcher may encounter during the development stage. Knowing that each stage of the waterfall has specific outputs are facilitate the process of analyzing the validity of the system outputs [4].

One of the advantages of using this model is that project requirements are completed early in the project development process. This allows our team to define the scope of the entire project and create a complete schedule. It improves resource utilization because tasks can be divided into parallel work or grouped to make use of resource skills [4].

2.3. The Unified Modeling Language UML

Unified Modeling Language is a standard language used to create layout design and documentation for any program. The UML is designed with the aim of helping software developers describe, visualize, create and document the technical work of the program. The UML is an important part of the development of any software system. Thus, the use of UML leads to the correct and successful implementation of the development of any software system, especially for large and complex programs in terms of tasks and functions provided by those applications and systems. One of the advantages of using UML is that it helps the project team express ideas, communicate between each other, And the ability to evaluate the stages that are being worked on, and verify the program model before the implementation phase [6].

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2.3. The Prototyping Methodology

The prototyping methodology is a method used for software development. It allows system developers in the process to build parts of the system's solutions, which aim to finish one phase before moving on to the next [5]. Prototype methods were applied while developing our system, to meet the requirements of the system, before moving on to the next stages.

2.4. The Planning Stage

In the planning stage, work is done to define the project problem and the goal of the project, which helps to better understand the system and its requirements. Project requirements were collected by taking an online questionnaire. The questionnaire was distributed to many engineers and stakeholders. Thus, through the first stage, which includes research, we found a great demand for dealing with the system that we are seeking to develop, and we found that many engineers and stakeholders suffer from great difficulties in seeking for work.

2.5. The Analysis Phase

In the analysis phase, our system-oriented UML diagrams are used. Many design programs help us at this stage, and one of those systems or applications is Draw.IO, which is dedicated to designing various standard UML diagrams. Thus, this system provides the ability to draw the different types of diagrams that we will use in drawing diagrams for our systems such as class, object, use case, component, deployment, composite structure, sequence, connection, graph, and activity diagram. Also, the database ER diagrams is drawn by using draw.io software.

2.6. The Software Prototyping

Software prototyping refers to the creation of system prototypes that serve to illustrate the product's functionality. Prototyping will help in testing and validating user requirements by obtaining their feedback after running the system prototype [7].

2.7. The Principles of Prototyping Software

There are many basic principles of prototyping software. The first principle is to divide the project into successive phases, some of which may overlap each other. The second principle is to focus on project planning, target dates, project budget, and implementation. The final principle is to control project time and duration by maintaining written documentation and approval of the user, management, and information technology after completion of each stage of the project and before starting the next [8]. Thus within this stage, we are designing the program's user interface without executing any functionality.

2.8. The Database Tables

The database tables were built and established relationships between them to ensure consistency between the program design and the database.

In this stage, the project plan is put into action and the work of the system is executed. Control and communication between our project team is maintained, as needed during implementation to ensure the correctness of the final product.

2.9. The Testing Phase

In the testing phase, our primary goal is to determine whether or not the final system we have arrived at meets the desires and requirements of our users. Thus, the test phase refers to testing the final product. After successful testing, the final product is created for users to start operating the product [8].

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2.10. The Maintenance Phase

The update and maintenance phase is a process through which the ability to provide updates to the system as well as the ability to provide business continuity to the system at full capacity when necessary. It is the last stage to improve the system in use if there is new. The additional requirements in the Figure illustrate the flow of the project development phases [8].

3. THE PROPOSED MODEL

The proposed model includes many stages that go through, and thus this model helps according to its own hierarchy, which guarantees not moving to the next stage before completing the previous stage, and here we can through this model progress towards the next steps and we are sure of the accuracy of the work that we do Thus, this model helps to facilitate work on large and advanced projects, and helps reduce the percentage of errors in work, and this helps to reduce the percentage of brotherhood at work during the development of our system.

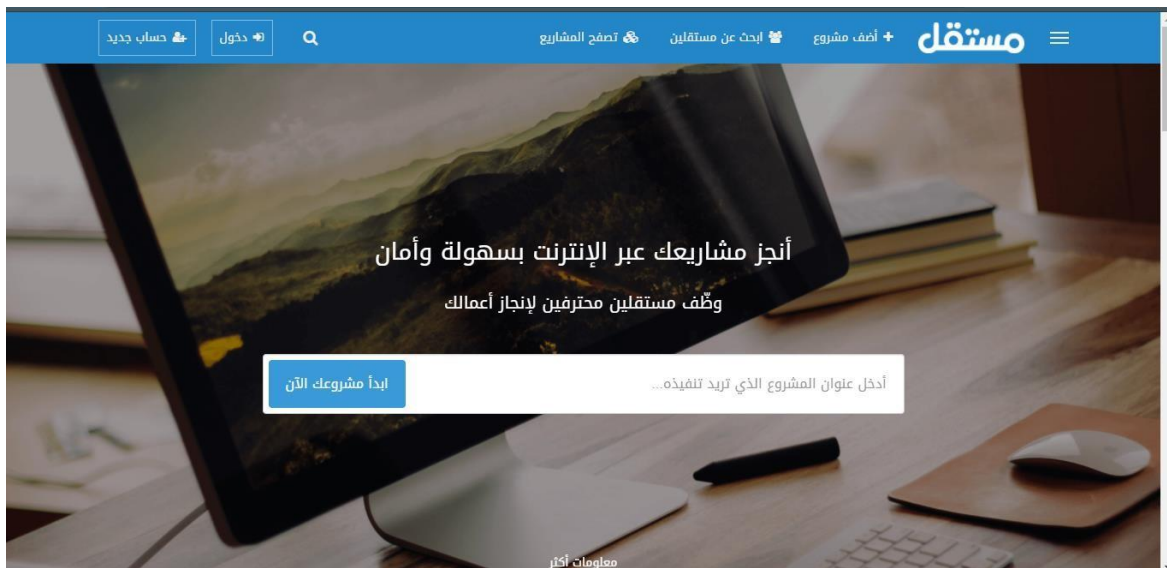
4. RESULTS AND DISCUSSION

There are many systems and websites of lust across the world, through which it is possible to search for work through the many options provided by these systems, and some of these systems follow an administrative policy different from other systems, but all of them are concerned with the concept of finding suitable work for those looking for it.

This research mentioned a list of those systems that are interested in the field of publishing works and following up their implementation by engineers or job seekers according to the following:

4.1. Mostaql Site:

Graph 1. HOME Page of Mostaql Site



- Where the mostaql platform relies on a huge number of services and features that make it unique from other sites that are similar to it, because money can be made through a wide range of options provided by the system, where many people who have experience in many general matters such as engineering, programming and design, as well as translation and content

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writing and other such fields, can earn money through this system. Thus, people with medium experience can benefit from this system and earn a lot of money [11].

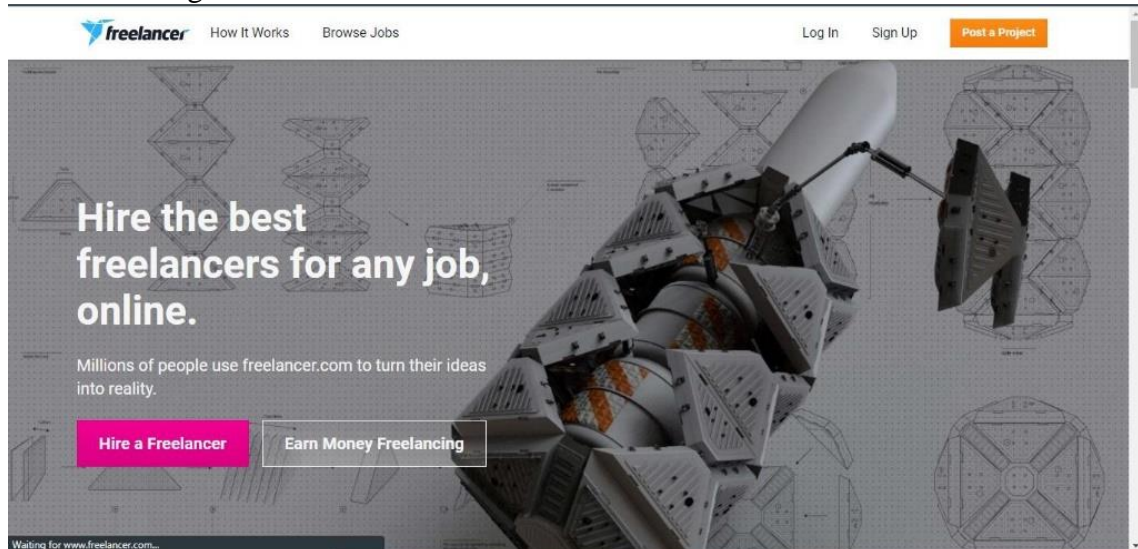
- As a person who has mastered some things in the field of accounting, law, drawing, poetry, translation, making video introductions, making Photoshop designs, or even programming, web design, can earn money through this site [11]

➤ **Disadvantages:**

- The site does not have a clever suggestion system for projects that are identical to people's wish.
- The site is not dedicated to a specific domain, rather it is open to all domains.
- It does not include the idea of smart notifications, which alert the user to the presence of a number of new projects.
- The site does not support the existence of a special forum for engineers within its system.

4.2. Freelancer System:

Graph 2. HOME Page of Freelancer Site



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- Freelancer is the largest and oldest freelance website. Through the FreeLancer site, any skill holder can register on the site, and then open the door to hundreds of projects that are waiting to be implemented in all fields. Also, through the Freelancer website, project owners can find professional cadres in all fields to complete their projects at the best possible level [10].

- FreeLancer is one of the freelance platforms specialized in large projects (but it includes all sizes of projects even small tasks), it provides a professional link all the project owners who have specific projects or tasks and want to implement them, and freelancers who have skills in certain fields and they want to profit from it [10].

➤ **Disadvantages:**

- The site is not dedicated to a specific field of architecture.
- The site does not support the existence of a special forum for engineers within its system.
- The site does not support the ability to interact between users within the system.

4.3. Shaghalni System



Graoh 3. HOME Page of Shaghalni Site

- Among the sites to search for jobs online, Shaghalni is one of the most recent and popular sites recently, what distinguishes Shaghalni is the ease of dealing with the site and the ease of dividing today's jobs so that jobs specializing in a specific field appear in one place that is easy to apply for [9].

- Where companies can, through this system, publish advertisements about their employment applications, and thus engineers and job seekers in various fields can access those advertisements and write to their companies [9].

➤ **Disadvantages:**

- The site does not support notifications within the system.
- The site is not dedicated to a specific domain, but rather to all fields.
- The site does not include a forum for all workers and engineers within the site.
- The site is not specifically intended for the field of architecture
- The site does not support the idea of smart notifications.

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- The site does not include the ability to intelligently post job application suggestions.

5. BENEFIT OF THE PROPOSED SOFTWARE:

Our system includes many features that distinguish it from other systems

- The features differentiate this system are concentrated, using artificial intelligence (the smart suggestion system or the recommender system is a special system adopted by many international companies and major Internet sites to increase their efficiency and benefit more from the user, and this system gives suggestions to the user so that they are among his own interests and have been concluded in a smart way), through which we can provide a list of employment requests appropriate to the desires that the engineer tends to, we are working to provide a smart experience that users can deal with simply and get a list of all employment options that suit their preferences, as well as our system is not general concerned with all areas, but the system is concerned with a specific area of construction and dealing with architects and companies that are looking for specialists with competencies in specific areas within the construction.
- The system also includes the idea of smart notifications, which sends alerts to architects within the system, where a list of all projects that meet the tendencies of the engineer appears, as these projects are recent within the system, and also includes the concept of notifications for companies, where the system is suggest a number of architects who can Dealing with this type of their requests, and therefore the company can also send a request to all the engineers who want them, as it includes viewing their advertisement.
- The system includes the ability to comment on the engineers' profile, so that before contracting with a specific engineer, companies can see a list of all comments that may be positive or negative about the engineer.
- The system includes the possibility of a forum in which the engineers can discuss, publish several publications, and obtain several comments related to a specific problem, and thus the system supports the possibility of providing a complete forum that

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Table 1. The Features Differentiate Between the Proposed System & other Systems

Features	Dedicated within the field of architecture	Intelligent recommendation system	Post a list of jobs	Comments	Forum to solve architects' problems	Smart notification system	Exclusive to the Kingdom of Saudi Arabia	Free
Our System	x	x	x	x	x	x	x	x
Mostaqil site			x	x				x
Freelancer system			x	x		x		
Shaghalni site			x	x				x

6. CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

As the researchers mentioned earlier, the importance that the main purpose of this research is to focus on the following points, which form the main axis, which are as follows:

1. Making it easier for investors to search for engineers with the expertise and features they need.
2. Making it easy for engineers to find work through our system, through which they can view all their experiences, projects, and evaluations.
3. Working on developing the idea of self-development for all engineers by demonstrating the need for competition between them by obtaining many advantages and certificates that work to increase the percentage of their selection by the owners of funds and investors.

7. ACKNOWLEDGMENTS

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REFERENCES

- [1]. عبد الحميد الأنصاري من الرياض. (25 مارس, 2018). 2633 مهندسة في المملكة .. 54 % سعوديات. تم الاسترداد من الاقتصادية: الأحد 25 مارس 2018
- [2]. Muslihat, D. (2018, march 2). *Agile Methodology: An Overview*. Retrieved from zenkit: <https://zenkit.com/en/blog/agile-methodology-an-overview/>
- [3]. *Architecture*. (n.d.). Retrieved from wikipedia: <https://en.wikipedia.org/wiki/Architecture>.
- [4]. BIBLIOGRAPHY \m JUL20 \l 1033 PETERSON, J. (2020, june 25). *Software Development Life Cycle: Finding a Model That Works*. Retrieved from whitesourcesoftware: <https://resources.whitesourcesoftware.com/blog-whitesource/sdlc-software-development-life-cycle>

¹ASAS is an Arabic word means indicating that the correct basis is the beginning of everything.

- [5]. BIBLIOGRAPHY \m She12 \l 1033 Sheetal Sharma, D. S. (2012). *Waterfall model Processes and Methodologies: A Conceptual Study*. International Journal on Computer Science and Engineering (IJCSE).
- [6]. BIBLIOGRAPHY \m Rad12 \l 1033 Radha Shankarmani, R. P. (2012). *Waterfall model: Benefits and Constraints*. International Journal of Computer Applications.
- [7]. BIBLIOGRAPHY \m Son13 \l 1033 Thakur, S. (2013). *Role of waterfall Methodology in Software Development*. International Journal of Computer Science and Mobile Computing.
- [8]. BIBLIOGRAPHY \m Far17\l 1033 Patel, F. M.-V.-M. (2017). *A Review on Recommender Systems*. Conference Paper .
- [9]. <https://shaghalni.com/>
- [10]. <https://www.freelancer.com/>
- [11]. <https://mostaql.com/>

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INVASIVE WEED OPTIMIZATION ALGORITHM FOR SOLVING MULTI-OBJECTIVE U-SHAPED DISASSEMBLY LINE BALANCING PROBLEM

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ABSTRACT

Rapid development of technology and highly demanding individuals promote products' diversification. Increasing number and rapid updates result in products becoming end-of-life (EOL) products early in their life cycles. Landfilling these products has a negative impact on the environment. More ecofriendly ways should be considered to protect the environment. Product recovery is an efficient way to deal with EOL products. Remanufacturing and reuse are examples of economically beneficial and environmentally friendly ways of product recovery. In remanufacturing, the first step is disassembly. Disassembly aims to physically separate EOL products into subassemblies or parts. The process of disassembly is carried out on a paced line linked with different workstations. Balancing the disassembly line is crucial. U-shaped disassembly line has advantages compared to the traditional straight-line disassembly line including increased work efficiency. Multiple objectives are considered in this paper to mimic real world disassembly. These objectives include optimizing the number of workstations, smoothness index, hazardous impact and demand fulfillment. Because of the NP-hard characteristic of the disassembly line balancing problem (DLBP), meta-heuristic algorithm is most suitable for solving large-scale real-life problems. Recently, a lot of attention has been paid towards employing nature inspired meta-heuristic algorithms to solve many optimization problems. Consequently, in this paper, a novel numerical stochastic optimization algorithm called invasive weed optimization (IWO) algorithm is proposed to find near-optimal solutions for the DLBP. IWO is inspired from colonizing weeds which is based on the natural selection (survival of the fittest). The performance of IWO algorithm is compared with several meta-heuristic algorithms. Results show that the proposed IWO algorithm can find near optimal solutions efficiently. In addition, the results demonstrate that the U-shaped layout has higher efficiency compared to the straight-line layout.

Keywords: Remanufacturing, Disassembly line balancing, U-shaped disassembly line, Invasive weed optimization (IWO).

1. INTRODUCTION

Technological advances and the desire to acquire the state-of-the-art products by individuals put pressure on the environment in terms of depletion of natural resources and the desertion of otherwise well-functioning products. It is hard to deny that economic development, directly or indirectly, is destroying the environment in which we live. This is especially true for electrical

and electronic products which are updated frequently and highly demanded by consumers to acquire the latest technology (Li and Janardhanan, 2021) which results in a lot of wastage (Wang et al., 2021). Shorter lifecycles and increasing demands together result in end-of-life (EOL) products earlier than essential. With the increase in EOL products, product recovery has become much more critical than ever before. Gungor and Gupta (1999) first highlighted important issues related to environmentally conscious manufacturing and product recovery (ECMPRO). Reuse, remanufacturing and recycling are efficient ways to deal with EOL products. These strategies call for disassembly which physically separates products into subassemblies or components using linked workstations (Akpinar, Ilgin, and Aktas, 2021). According to various considerations, there are many categories of disassembly. For example, disassembly can be complete or partial. Complete disassembly aims to disassemble all parts of an EOL product, whereas partial disassembly limits disassembly to only selected parts. Large scale disassembly is performed on a paced disassembly line. There are four basic types of disassembly lines, viz., straight-line, parallel, U-shaped, and two-sided. According to Ozceylan et al. (2019), majority of disassembly topics researched used straight-line configuration. However, the U-shaped configuration is more productive since operators can work on both sides of the line improving the work efficiency and flexibility. In order to optimize the disassembly objectives, balancing a disassembly line is critical. Disassembly line balancing problem (DLBP) was first proposed by Gungor and Gupta (1999) which can simply be described as the optimum assignment of disassembly tasks to workstations within the domain of predetermined constraints.

The rest of paper is structured as follows: The literature review is presented in section 2. Section 3 contains the mathematical model and the constraints. Section 4 shows detailed results and performance of numerous algorithms. Section 5 provides the conclusion and directions for future research.

2. LITERATURE REVIEW

As mentioned in the introduction, there are four types of disassembly lines. In this paper, U-shaped line is used to operate disassembly tasks. Considering uncertain structures of EOL products and non-deterministic task processing time, Agrawal and Tiwari (2008) first solved this problem on a U-shaped disassembly line with considerations of stochastic task times. Later, Avikal and Mishra (2012) and Avikal, Jain, and Mishra (2013) proposed heuristic algorithms for U-shaped disassembly lines which expanded the field of U-shaped DLBP. In recent years, Zhang et al. (2018) introduced a multi-objective ant colony genetic algorithm to solve the U-shaped DLBP with the considering of constructing high-quality initial feasible solutions. Li, Kucukkoc, and Zhang (2019) proposed an iterated local search method on a special situation of a U-shaped disassembly line. A discrete flower pollination algorithm with strong searching ability was introduced by Wang, Gao, and Li (2020) whose performance was tested on a U-shaped disassembly line. Results showed that this discrete flower pollination algorithm improved the performance of the disassembly line. A novel discrete cuckoo search (DCS) algorithm was implemented on U-shaped partial DLBP by Li and Janardhanan (2021). Yao and Gupta (2021) first used small world optimization algorithm (SWOA) on a U-shaped DLBP and Yao and Gupta (2021) also proposed a swarm-based algorithm called cat swarm algorithm (CSO) on the U-shaped layout. These two papers compared performances of these meta-heuristic algorithms with several other algorithms.

Disassembly line balancing problem belongs to the optimization field. Mathematical approaches, heuristic algorithms and meta-heuristic algorithms have been implemented on the DLBP since 1999. For small-sized DLBP, mathematical approaches and exact methods can find

optimal solution in a short time. But in real life practical remanufacturing cases, EOL products may have thousands of parts and therefore, mathematical and exact methods are not suitable. McGovern and Gupta (2007) proved that the DLBP is an NP-hard problem which is a milestone in DLBP research. From there, heuristic and meta-heuristic algorithms are continually introduced in DLBP literature such as genetic algorithm, ant colony algorithm, artificial bee colony algorithm, swarm-based algorithm and combinational algorithms. The proposed Invasive Weed Optimization (IWO) is a novel numerical stochastic optimization algorithm which is inspired from the colonization of invasive weeds. IWO has a strong ability of converging to optimal or near-optimal solutions by employing three steps: seeding, growth and competition (Xing and Gao, 2014).

In DLBP research, while there are many types of objectives, the two main types are profit-based and line-based objectives. In this paper, multiple objectives are considered, viz., minimizing number of workstations, minimizing total of idle times, removing hazardous part(s) early and removing high demand part(s) early. Here, since there is no primary objective, the pareto front concept is used to classify different near-optimal solutions.

To the best of authors' knowledge, invasive weed optimization (IWO) is proposed here for the first time to solve the disassembly line balancing problem and results show that the performance of IWO is superior to meta-heuristic algorithms such as genetic algorithm (GA) and artificial bee colony algorithm (ACO). This paper also compares the performance of U-shaped line and straight-line layout with same algorithm and same parameters. Results show that U-shaped layout indeed improves the performances of several objectives.

3. PROBLEM DEFINITION

Tasks are carried out on a U-shaped line and both sides of the line can be used to find optimal task sequence. The basic rule of DLBP is adjusting tasks sequence under cycle time constraint and precedence relationship in order to find the best solution. Assumptions are listed as follows:

- (1) Only one type of EOL product.
- (2) All tasks should be disassembled (complete disassembly).
- (3) Task processing times are considered as deterministic.
- (4) Total task processing times of each workstation should be less than or equal to the cycle time.
- (5) AND/OR graph is used to describe precedence relationship.
- (6) Sequence-dependent relationship is not considered in this paper.

3.1 Notation

N Number of tasks

i, j Task index, $i, j = 1, 2, \dots, N$

M Number of workstations

m Workstation index

t_i Processing time of task i

h_i binary variable, 1, if task i is hazardous; 0, otherwise

d_j demand value of task j

CT Cycle time

F_a Objective function, $a = 1,2,3,4$

Decision variables:

x_{im} 1, if task i is assigned at the front side of workstation m ; 0, otherwise

y_{jm} 1, if task j is assigned at the back side of workstation m ; 0, otherwise

s_i Position number of task i in sequence

3.2 Model formulation

$$\text{Min } F_1 = \sum_{m=1}^M ws_m \quad (1)$$

$$\text{Min } F_2 = \sum_{m=1}^M (CT - T_m)^2 \quad (2)$$

$$\text{Min } F_3 = \sum_{i=1}^N (s_i * h_i) \quad (3)$$

$$\text{Min } F_4 = \sum_{i=1}^N (s_i * d_i) \quad (4)$$

Four objectives are listed above. Equation (1) minimizes the total number of opened workstations. Equation (2) describes the minimization of total of idle times. Equation (3) aims to remove hazardous part(s) early. Equation (4) facilitates removal of high demand part(s) early. Constraints are listed as follows:

$$\sum_{m=1}^M (x_{im} + y_{im}) = 1 \quad (5)$$

$$\sum_{i=1}^N (x_{im} + y_{im}) \geq 1 \quad (6)$$

$$CT \geq T_m \quad (7)$$

$$x_{im}, y_{im} = \{0,1\} \forall i, m \quad (8)$$

Constraint (5) ensures that one task is assigned to only one side of one workstation. Constraint (6) shows that each workstation can operate on one or more tasks. Equation (7) is the cycle time constraint.

4. RESULTS

The proposed IWO was coded in MATLAB and tested on Apple M1. The case used in this paper is acquired from McGovern and Gupta (2006). The proposed IWO was independently run 20 times on U-shaped line and 20 times on straight-line disassembly line with the same parameter values. Also, the performance of IWO is compared with other algorithms like genetic algorithm (GA), ant colony optimization (ACO), improved ant colony optimization (IACO), improved artificial bee colony optimization (IABC), hybrid group neighborhood search algorithm (HGNS), small world optimization (SWO), and cat swarm optimization (CSO). Detailed performance data of various algorithms are taken from McGovern and Gupta (2006), Zhang et al. (2018), Zhu, Zhang, and Hu (2014), Zhu, Zhang, and Guan (2020), Yao and Gupta (2021), and Yao and Gupta (2021). Table 1 shows basic case information, viz., task processing times, hazardous indices and demand values. Table 2 shows result comparisons of two types of disassembly lines. As is clear from the table, both U-shaped line and straight-line disassembly line can find best value for minimization of workstations, but U-shaped line can find better value for minimization of idle times. Based on the average value of each objective, U-shaped line performs better than straight-line disassembly line.

Table 1. Case information

Task	Processing time	Hazardous index	Demand value
1	14	0	0
2	10	0	500
3	12	0	0
4	17	0	0
5	23	0	0
6	14	0	750
7	19	1	295
8	36	0	0
9	14	0	360
10	10	0	0

Table 2. Results of IWO performed on two disassembly line types

Line type	F_1	F_2	F_3	F_4	Task sequence
Straight-line	5	249	3	8295	6,5,7,4,1,9,8,10,2,3
	5	241	5	7445	6,9,5,10,7,4,8,1,2,3
	5	219	4	8260	5,6,9,7,4,1,8,10,2,3
	5	211	6	10320	5,10,6,4,9,7,8,1,2,3
U-shaped	5	207	5	8915	5,6,4,9,7,8,1,10,2,3
	5	211	5	8165	6,5,10,9,7,1,4,8,2,3
	5	219	3	9045	5,6,7,1,4,9,8,10,2,3
	5	219	4	8230	6,5,1,7,9,4,8,10,2,3

Table3. Performance comparison of 8 meta-heuristics

Objective	GA	ACO	IACO	HGNS	IABC	SWOA	CSO	IWO	SWOA(U)	CSO(U)	IWO(U)
F_1	5	5	5	5	5	5	5	5	5	5	5
F_2	211	211	211	219	211	211	211	211	207	207	207
F_3	4	4	4	4	4	4	5	4	4	5	5
F_4	9730	10090	9730	7510	9730	9480	8880	9480	8980	9695	8915

Table 3 lists result comparisons of different algorithms. The first two objectives are the primary objectives. From Table 3, we can see that IWO could find the minimum values of the number of workstations and the total of idle times. For the removal of highly demanded parts early, IWO found a lower average value than the preferred meta-heuristics, which establishes the superiority of IWO.

5. CONCLUSION

In this paper, IWO is proposed and implemented on DLBP for the first time. The results show that IWO has a great searching ability and it is suitable for solving the DLBP. Further, U-shaped disassembly line indeed improves performances compared to the straight-line layout. Future research can explore more on U-shaped, parallel and two-sided lines. In addition, special types

of disassembly issues such as sequence-dependent and partial disassembly will also be of interest to study. Novel optimization algorithms and combination algorithms can likewise be investigated.

REFERENCES

1. Agrawal, S. and Tiwari, M.K., 2008. A collaborative ant colony algorithm to stochastic mixed-model U-shaped disassembly line balancing and sequencing problem. *International Journal of Production Research*, 46(6), pp.1405-1429.
2. Akpınar, M.E., Ilgin, M.A. and Aktaş, H., 2021. Disassembly Line Balancing by Using Simulation Optimization. *Alphanumeric Journal*, 9(1), pp.63-84.
3. Avikal, S., Jain, R. and Mishra, P., 2013. A heuristic for U-shaped disassembly line balancing problems. *MIT International Journal of Mechanical Engineering*, 3(1), pp.51-56.
4. Avikal, S. and Mishra, P.K., 2012. A new U-shaped heuristic for disassembly line balancing problems. *PRATIBHA: International Journal of Science, Spirituality, Business and Technology*, 1(1), pp.21-27.
5. Gungor, A., & Gupta, S. M., 1999. Disassembly line balancing. *Proceedings of the 1999 Annual Meeting of the Northeast Decision Sciences Institute*, Newport, Rhode Island, March 24-26, pp.193-195.
6. Gungor, A. and Gupta, S.M., 1999. Issues in environmentally conscious manufacturing and product recovery: a survey. *Computers & Industrial Engineering*, 36(4), pp.811-853.
7. Li, Z. and Janardhanan, M.N., 2021. Modelling and solving profit-oriented U-shaped partial disassembly line balancing problem. *Expert Systems with Applications*, p.115431.
8. Li, Z., Kucukkoc, I. and Zhang, Z., 2019. Iterated local search method and mathematical model for sequence-dependent U-shaped disassembly line balancing problem. *Computers & Industrial Engineering*, 137, p.106056.
9. McGovern, S.M. and Gupta, S.M., 2006. Ant colony optimization for disassembly sequencing with multiple objectives. *The International Journal of Advanced Manufacturing Technology*, 30(5-6), pp.481-496.
10. McGovern, S.M. and Gupta, S.M., 2007. A balancing method and genetic algorithm for disassembly line balancing. *European Journal of Operational Research*, 179(3), pp.692-708.
11. Özceylan, E., Kalayci, C.B., Güngör, A. and Gupta, S.M., 2019. Disassembly line balancing problem: a review of the state of the art and future directions. *International Journal of Production Research*, 57(15-16), pp.4805-4827.
12. Wang, K., Gao, L. and Li, X., 2020. A multi-objective algorithm for U-shaped disassembly line balancing with partial destructive mode. *Neural Computing and Applications*, pp.1-22.
13. Wang, K., Li, X., Gao, L., Li, P. and Gupta, S.M., 2021. A genetic simulated annealing algorithm for parallel partial disassembly line balancing problem. *Applied Soft Computing*, 107, p.107404.
14. Xing, B. and Gao, W.J., 2014. Invasive weed optimization algorithm. In *Innovative*

- Computational Intelligence: A Rough Guide to 134 Clever Algorithms* (pp. 177-181). Springer, Cham.
15. Yao, P. and Gupta, S. M., 2021. Cat Swarm Optimization Algorithm for Solving Multi-Objective U-Shaped Disassembly Line Balancing Problem. *Proceedings of the International Conference on Remanufacturing*, March 24-25, pp. 222-230.
 16. Yao, P. and Gupta, S. M., 2021. Small World Optimization Algorithm for Solving Multi-Objective U-Shaped Disassembly Line Balancing Problem, *Proceedings of the 2021 Annual Meeting of the Northeast Decision Sciences Institute*, Virtual, March 26-27, 659-668.
 17. Zhang, Z., Wang, K., Zhu, L. and Cheng, W., 2018. Pareto Hybrid Ant Colony and Genetic Algorithm for Multi-Objective U-Shaped Disassembly Line Balancing Problem. *Journal of Southwest Jiaotong University*, 53(3), pp.628-637.
 18. Zhu, X., Zhang, Z., Zhu, X. and Hu, J., 2014. An ant colony optimization algorithm for multi-objective disassembly line balancing problem. *China Mechanical Engineering*, 25(8), p.1075.
 19. Zhu, L., Zhang, Z. and Guan, C., 2020. Multi-objective partial parallel disassembly line balancing problem using hybrid group neighbourhood search algorithm. *Journal of Manufacturing Systems*, 56, pp.252-269.

AN EMPIRICAL APPROACH FOR EXPLORING NON-SOCIAL LANGUAGE USE

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ABSTRACT

There are well known sex differences in language use; for example, women are considered more inclusive while men use more directives. These differences begin early in development, as girls acquire language faster than boys in general, use longer sentences, and have larger vocabularies earlier. Differences also appear in reports from sociolinguists who have identified how speech conveys social information. They document that topics of discussion, how they are discussed, and how others respond to the information they contain will reflect power, relationships, status, and so on. However, information sharing based only on text that is divorced from social context is novel, in that many of these social factors are removed – meaning that we can focus on sex differences in terms of how people conceptualise information rather than how it is shared and consequently determine whether developmental differences remain. Here we examine a simple task – how people generate Google queries for information. We asked 50 participants to report their search requests to Google for a list of provided topics. Our results indicate minimal sex differences yet highlight how some individuals have difficulty in forming satisfactory queries to obtain information. We discuss new methods that rely on innovative practices and that can be used to examine sex differences in areas such as sociolinguistics.

Keywords: Sex Differences, Information Retrieval, Language Use, Sociolinguistics

1. INTRODUCTION

According to the psychological literature pertaining to sex differences in cognition, it is well known that, on average, women and men exhibit significant differences in their use of language. In particular, women's verbal abilities exceed those of men in several domains, with differences arising early in childhood. These differences can be divided into general verbal ability, including spoken behaviour, and the more specific category of writing ability. Each of these domains will now be briefly reviewed.

Relative to men, women have advantages in a number of basic language-related skills. These advantages can be seen in the length and quality of utterances (e.g., women show standard grammatical structure and correct pronunciation of language sounds more frequently than men), the ease and speed of articulating words, the ability to generate complex words or strings of

words, the speed of retrieving words from memory, and the ability to discriminate basic language sounds (Block, Arnott, Quigley, & Lynch, 1989; Halpern, 1992; Halpern, 1997; Halpern & Wright, 1996; Hampson, 1990; Hunt, Lunneborg, & Lewis 1975; Hyde & Lynn 1988). As well, women are known to possess larger working vocabularies and speak more grammatically correct than men (Kimura, 1999).

Similar to general verbal behaviour, sex differences are also observed in writing ability. Women tend to read at higher levels, and are often better spellers than men (Kimura, 1999). Women are more fluent on tests of word generation when there are limitations, such as requiring the word contain or start with a particular letter (Kimura, 1999). It has been shown that female superiority in fluency, spelling and grammatical ability (e.g., the identification of grammatically incorrect sentence elements) begins during early childhood and remains throughout adolescence and adulthood (Kimura, 1999).

One method of measuring sex differences in writing ability is to examine scores on widely administered standardized tests. One such measure is The Differential Aptitude Test (DAT), which is composed of several sub-tests that measure abilities that are thought to be related to school performance. The DAT has been standardized using thousands of youths in order to be representative of the general population of the United States. Using this measure, grade 12 girls have been found to possess superior grammatical and spelling abilities (Hyde & Lynn, 1988) which appear to be stronger than in earlier grades, such as grade 8 (Feingold, 1988). However, it should be noted that many standardized tests, such as the Scholastic Achievement Test (SAT-V), show no difference in verbal ability. This lack of difference occurs because these tests are too complex (i.e., the associated items require many types of cognitive processes to make judgments; Geary, 1998).

It should be noted, though, that while there is a large and historic body of research documenting that women generally perform superiorly on language tasks compared to men, it has been the subject of recent debate. For example, given men's and women's brains exhibit similar characteristics (Joel & Fausto-Sterling, 2016), how could there be a difference in language? Further, a recent meta-analysis indicates the sex differences in performance on language-based cognitive tasks may be smaller than originally proposed (except for verbal fluency in essay writing; Hyde, 2016). Various reasons have been put forth to explain the discrepant findings, including individual differences in brain maturation for locations involved in language, publication bias in reported results, artificial tasks that are too far removed from ecologically valid measures of performance, to name a few (see Etchell et al., 2018, for a review).

It would also be incorrect to assume that women overall possess more advanced verbal abilities than men. In fact, adult women are not superior at the majority of verbal tasks per se. For example, women are not better than men on vocabulary-oriented tasks such as being asked to define presented words (Kimura, 1999). Instead, women are superior at tasks that specifically focus on the memory of verbal material and tasks of verbal fluency, such as listing words that begin with a specific letter, or end with a specific suffix. Fluency in this context does not refer

to the more popular connotation of ease with which one produces coherent sentences. Instead, fluency refers to one's ability in tasks where words or sentences must be produced that have particular constraints imposed, for example, under time limited conditions. It also refers to tasks such as generating words according to a specified theme (e.g., furniture, whereas many objects as possible must listed within a set time). This type of task is sometimes referred to as a divergent task since a variety of answers are acceptable (Kimura, 1999).

Exploration into these sorts of sex differences has a long history, such that the goal is typically to document quantifiable differences in the sexes' use of linguistic features. Sociolinguistics in relation to sex and gender differences adds an important dimension, where researchers turn toward understanding the social processes that lead to these linguistic developments (Bucholtz, 2002). Sex and gender differences also appear in reports from sociolinguists who have identified how speech conveys social information, including perceptions of dominance and power (Munira, Hossain, & Nessa, 2020). Sociolinguists document that topics of discussion, how they are discussed, and how others respond, with respect to how these concepts reflect power, relationships, status, and so on. Further, there is ongoing discussion regarding the theories about how these documented sex difference began, and the influence of culture, biology, and social structures, for example (see Munira, Hossain, & Nessa, 2020 for a review).

However, information sharing based only on text that is divorced from social context is novel, in that many of the social factors such as dominance and power are somewhat removed. Text-based information allows for a focus on sex differences in terms of how people conceptualise information rather than primarily on how it is shared. Therefore, a text-based analysis, especially when the text is *not* aimed at another person (and hence, would be social because it is interpersonal) but instead at a search engine, enables a clearer examination of sex differences in language, free from some of these considerations.

When using a web-search tool, such as Google, users express their information needs by entering terms (i.e., words) into a query interface. This task represents a constrained verbal task, similar to those outlined above. Users are constrained by their information need, which can be viewed as a specified theme. As well, users are restricted by any limitations provided by the query interface and the capabilities and algorithms of the search engine. Further, users are constrained by the necessity to create a query that returns needed information in a highly ranked document. Therefore, as queries are constrained by these factors, we predict a female advantage in query formation.

Specifically, as queries are a highly stylized form of written expression, we predict that there will be sex-based differences in the length, vocabulary, and effectiveness of generated queries. For these factors, we have developed four hypotheses, as follows:

1. Length: Women will tend to enter more terms, for a query, than men. As search tools are typically optimized for short queries, we predict sex-based differences in query length.

2. *Working vocabulary*: The number of unique terms will be higher for women than for men. Women, in constrained conditions, have access to a larger vocabulary than men and will consequently use a larger variety of unique query terms. Note that here a working vocabulary refers to the variety of terms that one uses and is not an indicator of the number of words that an individual actually knows.

3. *Vocabulary*: Women will tend to use less frequently occurring terms than will men, with respect to an appropriate language model. That is, in comparison to the average word use by a population, women are more likely to select less frequently used words due to possessing a larger vocabulary.

4. *Effectiveness*: When using Google, where search results are ordered using Google's PageRank algorithm, the queries of each sex will significantly differ in accuracy. We predict that women will obtain results with the needed information positioned higher in the response (i.e., closer to the beginning) than will men.

2. METHOD

2.1 Participants

We collected data from 50 participants: 25 men and 25 women (age in years $M = 22.68$, $SD = 3.87$). All were university students with experience using Google in the past month and all were native English speakers, thus removing any confound due to language fluency. We selected Google since it is the primary search tool used in North America and is well known to our students. We have used Google in studies for many years (e.g., Cox & Fisher, 2004) and have not encountered any issues with inexperience, lack of familiarity, or other confounding factors. Participation was voluntarily with each participant being compensated via selecting a treat from a basket carried by the experimenter. Examples of treats include candy bars, bags of chips, chewing gum, and fresh fruit.

2.2 Procedure

Participants were approached by one of the experimenters in a public area on campus, such as in a cafeteria or open workspace. Participants were seated alone and appeared to be studying or reading at the time of contact. They were asked if they would like to help with a survey on using Google, in exchange for a treat from the basket. Once they agreed, they were handed an envelope and the experimenter walked away, stating they would return in a few minutes. Inside the envelope was an informed consent letter, followed by a brief demographic survey to gather general descriptive information about the participants. The men and women did not differ significantly in terms of age, experience using Google, or self-assessed English language competency.

Participants were then given a survey with 15 imaginary scenarios describing situations in which the participant needed to find information. To obtain this information, participants had to create a Google query by filling in, on paper, the query entry box that normally appears on the main Google screen. We used a paper-based approach as we wished to avoid any

confounds created by Google's query predictor. That is, Google suggests possible completions for partly finished queries based on recent trends and statistical probability.

The scenarios were designed to examine a broad range of issues, three of which are now discussed. First, two of the queries allowed for examination of visual to verbal translation by using photographs. In one, participants had to identify the meaning associated with a picture of a straw goat while the other required the identification of a leaf presented as a photograph. Note that while tools such as Google Lens are now available such that users may take a photograph in lieu of writing a query, we wanted to determine how participants would capture and linguistically describe these images.

Second, four of the queries are focussed on sex/gender-role content. Two were aimed at stereotypically masculine content regarding hockey, and two were aimed at stereotypically feminine content regarding cooking. We selected these topics as, when generating words belonging to non-phonemic categories (e.g., types of furniture, also called ideational fluency), sex differences can exist and depend on the categories. For example, when asked for lists of round things or metal things men may obtain better scores (Harshman, Hampson, & Berenbaum, 1983) whereas if the categories are red things or white things women perform better (Kimura, 1994). In tasks where it is not possible to provide immediate verbal labels, there appears to be no sex difference (e.g., irregular nonsense shapes reveal no sex difference in recall; Mann, Sasanuma, Sakuma, & Masaki, 1990), although there are contradictory results. We pursued this idea using stereotypically sex/gender linked query content as perhaps men are more proficient than women (as measured by length, vocabulary, and effectiveness) at generating queries for the items pertaining to hockey, whereas women are more proficient (using the same metrics) than men at generating queries for items pertaining to cooking.

Third, the queries varied with respect to their level of complexity which allowed for variable creativity in word selection and vocabulary usage. For example, an individual responded quite simply for a query about Walt Disney World, but had more difficulty in obtaining suitable terms for finding recipes for peanut-free cookies. It should also be noted that all the scenarios are approximately the same length to avoid any confounding effects from the amount of provided information. Participants were thanked after completing the surveys and debriefed.

The completed survey queries were entered into Google by the researchers and the results were analysed. For the first 10 documents in the returned solutions, an independent judge evaluated each document as either 'correct' (i.e., provides the information needed by the scenario) or 'incorrect' (i.e., does not contain the needed information). We then generated two effectiveness scores: position and precision. A position score, from 10 (i.e., needed information is in the highest ranked document) down to 0 (e.g., needed information is not found in any of the 10 highest ranked documents), was calculated by subtracting the position of the first relevant document from 11. For example, if the first document containing the sought information is the second of the 10 returned by Google, the position score is 9 (e.g., $11 - 2 = 9$). The precision score was calculated by counting the number of relevant documents occurring in the first 10

ranked documents. This score is referred to as ‘p@10’ in information retrieval research, such as that published at the annual Text Retrieval Conference held by the US National Institute of Standards and Technology. Given these two scores, we compared the effectiveness search queries by men and women.

2.3 Results

Hypothesis 1 was not supported; women did not form significantly longer queries than men with the dependent variable of mean number of words used, collapsed across the 15 queries (Men $M = 5.07$, $SD = .95$; Women $M = 5.02$, $SD = .89$, two-tailed independent samples $t(48) = .23$, $p = ns$). Note that we set $p < .05$ *a priori* as indicating significance, and all tests were two-tailed. To further explore this hypothesis, we compared the number of characters in men’s and women’s queries. Again, there was no significant difference: Men $M = 27.27$, $SD = 3.76$; Women $M = 27.81$, $SD = 4.53$, $t(48) = .47$, $p = ns$.

Hypothesis 2 was that women use more unique terms than men. We consider a term to be unique if it is only used once in the aggregate collection of query terms for all 50 participants. For all queries by all participants, a total of 3723 terms were used (including multiple occurrences), with 683 of these being unique. Taking the proportion of the total unique words and attributing by sex, there was no significant sex difference, $z = 1.35$, $p = ns$. Men used 354 unique terms and women used 329 unique terms.

We also hypothesised that women use more ‘rare’ terms than men. To test Hypothesis 3, we needed a relevant language model that accurately identifies a term’s frequency of use. Rather than use a generalised model, we used an educationally-focused model created using 500 000 web pages randomly selected from .edu websites. As our participants were university students, we used a model generated using content from university websites. Terms taken from men’s queries occurred 84 995 980 times while those used in women’s queries occurred 72 807 013 times. As men’s and women’s queries did not differ in length, these occurrence counts are generated from approximately the same number of words, thus providing some indication that Hypothesis 3 is supported. We did not have full access to the language model and so we were unable to perform a deeper statistical analysis.

To explore our final hypothesis, that women will create more effective queries (i.e., have a higher position) than men, we entered the queries into Google and examined the first 10 results. Recall that position score is the inverse of the first correct document’s location within the first 10 total documents (10 being first, 1 being tenth, and 0 indicating that no document was correct) meaning that a larger number indicates a better position. The mean location of the first correct response showed significant difference, such that queries by men were more frequently positioned higher than those of women: Men $M = 8.27$, $SD = .95$; Women $M = 7.62$, $SD = 1.15$, $t(48) = 2.16$, $p = .036$. However, the hypothesis is not supported as men’s queries were significantly better at locating a higher-ranked correct solution in the query response than were women’s queries, in direct opposition to our hypothesis. Further, we examined the mean precision of the 10 responses for each query (i.e., P@10 - the percentage of the first 10 judged

as correct). There was no significant difference; Men $M = .59$, $SD = .09$; Women $M = .56$, $SD = .10$, $t(48) = 1.20$, $p = ns$.

3. DISCUSSION

While we were not able to support our hypotheses, the study is important because it provides a new tool for those interested in sociolinguistics to explore language in a context that is de-personalized with respect to a receiver. It also enables those exploring systematic differences in language use according to sex to investigate how effective people are at communicating their information needs. Participants stated that they had trouble explaining the photographs in words and were concerned that they had provided enough information for Google to find what they were looking for. Indeed, this issue is likely why Google Lens and, to some extent, Google Images were created. Further, the method from the current study would be applicable in a variety of settings, such as to explore language development in youth who are accommodating to a new cultural group, those who have difficulty in accurately identifying their information needs succinctly, and so on.

However, this method is not without drawbacks. We believe the lack of difference in query length is because Google is optimized for short queries such that there is no advantage in writing longer ones. However, this factor is changing due to Google's use of 'semantic search' which attempts to use semantic concepts (i.e., the interpreted meaning of the query) to provide more accurate results. The algorithms for semantic search, as were older systems based on term-vector ranking algorithms, are more accurate when longer queries with more information content are used. It should be noted that other researchers have reported (e.g., Clarke & Cormack, 2000) that the average query length is 2 to 3 terms. We believe our longer query lengths are due to the fact that participants knew their queries were going to be evaluated and thus put in greater effort when forming them. It could also be caused by participants having to 'get it right' on the first attempt, rather than refining their search as they received feedback from Google. We discuss this matter more shortly.

Our results for term frequency and uniqueness are biased in that participants focused highly on terms found in task descriptions. For example, when we asked participants to find information about Walt Disney World, almost every query contained the terms Walt, Disney, and World. Our attempt to control the search topics by providing descriptions of information needs biased our participants by providing them with terms that matched the information needs. Instead of using a text-based question, we propose that using images or situations to present the information need and asking for descriptions of the information need are necessary to really determine participants' thought-processes regarding the shaping of a query. In future studies, we feel it is necessary to provide the search topics in a more natural way rather than as written textual descriptions. It would also be potentially useful to have people attempt to describe, using a talk-aloud procedure, their decisions regarding what words to use or exclude.

Our finding that men are more effective at finding information than women may have been caused by several factors. First, there is evidence that women perform less effectively on

computing tasks when they are being observed (Robinson-Stavely & Cooper, 1990). As an experimenter was nearby during the data collection, this factor is quite likely to have influenced results. Secondly, we observed a bias among the participant's area of study and found that 10 of the men were in mathematics, computing, physics, or engineering as opposed to 4 of the women. As a greater percentage of the men are involved in highly technical disciplines with considerable computer use, they may have an advantage in terms of skills training. This explanation seems unlikely though, given students show a high acceptance for Google search and find it both easy to use and useful (Lavidas et al., 2020).

We did not perform an outlier analysis or discard any data, potentially causing us to use some suspect data. A couple of participants did not provide effective queries for reasons that we did not ascertain. That is, some of them failed to produce results and in some instances were missing (i.e., no query provided), contained extremely poor spelling, or used symbols (e.g., '+' for 'and') that changed the query effectiveness.

Our task was static in nature and evaluated participant's initial queries. For some tasks, participants may not attempt to "get it right" on the first query and use an iterative approach to collect information to produce stronger and more accurate queries. Our method did not account for any refinement of queries and only evaluated a participant's first attempt. As a consequence, our data may not fully evaluate an individual's ability to obtain information as we have ignored the process and concentrated on the initial query.

As found by Harshman, Hampson, and Berenbaum (1983) and Kimura (1994) we observed that men tended to do minimally better on the sports scenarios while women did slightly better on those involving cooking or baking. When analysed statistically, 3 of the 4 queries that we expected to show a sex bias were not significant and are omitted for brevity. However, the fourth query, which was on hockey, did show an expected bias for men with the mean location for the first correct response being significantly higher; Men $M=9.20$, $SD=2.77$; Women $M=6.68$, $SD=4.69$, $t(48)=2.31$, $p=.025$. This finding offers some support for a sex bias due to topic and warrants further investigation.

We believe that this initial experiment provides insight into some sex differences in language use for query formation. With a stronger, more accessible, language model, more naturalistic tasks, and evaluation of refined, follow-up queries, we anticipate that these differences can be more fully explained and investigated. However, the true value of this research is in providing sociolinguists with an empirical approach for exploring language use that is generally divorced from interpersonal contexts.

REFERENCES

1. Block, R., Arnott, D., Quigley, B., & Lynch, W. (1989). Unilateral nostril breathing influences lateralized cognitive performance. *Brain and Cognition*, 9, 181-190.
2. Bucholtz, M. (2002). From 'sex differences' to gender variation in sociolinguistics. In D. E. Johnson & T. Sanchez (Eds.), *Papers from NWAV 30. University of Pennsylvania Working Papers in Linguistics*, 8(2), 33-45.

3. Cox, A., & Fisher, M. (2004). Expectation as a mediator of user satisfaction. In proceedings *WWW 2004 Workshop on Web Search Effectiveness: The User Perspective*. New York, NY.
4. Clarke, C., & Cormack, G. (2000). Shortest-substring retrieval and ranking. *ACM Transactions on Information Systems*, 18, 44-78.
5. Etchell, A., Adhikari, A., Weinberg, L. S., Choo, A. L., Garnett, E. O., Chow, H. M., & Chang, S. E. (2018). A systematic literature review of sex differences in childhood language and brain development. *Neuropsychologia*, 114, 19-31.
6. Feingold, A. (1988). Cognitive gender differences are disappearing. *American Psychologist*, 43, 95-103.
7. Geary, D. (1998). *Male, Female: The Evolution of Human Sex Differences*. Washington, DC: American Psychology Association Press.
8. Halpern, D. (1992). *Sex Differences in Cognitive Abilities*, 2nd Edition. Hillsdale, NJ: Lawrence Erlbaum Associates.
9. Halpern, D. (1997). Sex differences in intelligence and their implications for education. *American Psychologist*, 52, 1091-1102.
10. Halpern, D., & Wright, T. (1996). A process-oriented model of cognitive sex differences. *Learning and Individual Differences*, 8, 3-24.
11. Hampson, E. (1990). Estrogen-related variations in human spatial and articulatory-motor skills. *Psychoneuroendocrinology*, 15, 97-111.
12. Harmon, D., & Vorhees, E. (2004). In proceedings *The Thirteenth Text Retrieval Conference, National Institute of Standards*, Gaithersburg, MA.
13. Harshman, R., Hampson, E., & Berenbaum, S. (1983). Individual differences in cognitive abilities and brain organization, part I: Sex and handedness differences in ability. *Canadian Journal of Psychology*, 37, 144-192.
14. Hunt, E., Lunneborg, C., & Lewis, J. (1975). What does it mean to be high verbal? *Cognitive Psychology*, 7, 194-227.
15. Hyde, J. S. (2016). Sex and cognition: gender and cognitive functions. *Current Opinion in Neurobiology*, 38, 53-56.
16. Hyde, J., & Lynn, M. (1988). Gender differences in verbal ability: A meta-analysis, *Psychological Bulletin*, 104, 53-69.
17. Joel, D., & Fausto-Sterling, A. (2016). Beyond sex differences: new approaches for thinking about variation in brain structure and function. *Philosophical Transactions of the Royal Society, Series B Biological Sciences*, 371(1688), p. 20150451.
18. Kimura, D. (1994). Body asymmetry and intellectual pattern. *Personality and Individual Differences*, 17, 53-60.
19. Kimura, D. (1999). *Sex and Cognition*. Cambridge, MA: MIT Press.
20. Lavidas, K., Achriani, A., Athanassopoulos, S., Messinis, J., & Kotsiantis, S. (2020). University students' intention to use search engines for research purposes: A structural equation modeling approach. *Education and Information Technologies*, 25, 2463-2479.
21. Mann, V., Sasanuma, S., Sakuma, N., & Masaki, S. (1990). Sex differences in cognitive abilities: A cross-cultural perspective. *Neuropsychologia*, 28, 1063-1077.
22. Munira, S., Hossain, A., & Nessa, M. (2020). Gender and sex based differences in lexical directions: A study on language theories. *Advances in Applied Sociology*, 10(4). DOI: 10.4236/aasoci.2020.104007
23. Robinson-Staveley, K., & Cooper, J. (1990). Mere presence, gender, and reactions to computers: studying human-computer interaction in the social context. *Journal of Experimental Social Psychology*, 26, 168-183.

THE GENETIC CHARACTERISTICS OF CANINE DISTEMPER VIRUS ISOLATED FROM INFECTED DOGS AT CAN THO CITY IN THE MEKONG DELTA VIETNAM

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SUMMARY

The study was carried out from April to December 2020 to evaluate the endemicity and determine the genetic characteristics of Canine Distemper virus (CDV). A survey on 1,120 dogs raised in Can Tho city revealed that 150 dogs showed clinical symptoms of Canine Distemper. Canine Distemper was determined to base on the test kit of Rapid Test Immuno supplied by Asan company (Korea). Of 150 dogs examined with the test kit, there were that 68 dogs were positive for *Canine Distemper Virus* (CDV). In which, dogs < 6 month-ages were infected with CDV at the highest rate (68,00%) and there was a significant difference in comparison with other age groups ($P < 0,05$). There were 50% of male and 41,86% female dogs infected CDV. The exotic dogs were infected with CDV higher than domestic dogs, and it significantly differed with other age-groups ($P < 0,05$). Clinical symptoms such as anorectic, moodiness, fever, sneezing, conjunctivitis appeared at 100%. The vaccinated dogs were infected with CDV at a lower rate than the dogs, that were not vaccinated or not enough vaccination, with 6.25%, 80%, and 69.57% respectively. The study on genetic characteristics of 7 representative Distemper virus strains isolated from the infected dogs was conducted via sequencing the H gene. The sequence of nucleotides, amino acids among these strains and the field/vaccine strains published on the GenBank were compared. The results showed that these virus strains could be the same origin and circulated frequently in the study area with a high similarity level (99.82–99.96%). Moreover, the similarity levels on nucleotides of the isolated strains with the other strains on the GenBank were 93.26–99.56%, and with the vaccine strains on the GenBank were 96.72–97.08%. The Distemper virus strains isolated from the infected dogs in this study belonged to the genotype Asia 1, circulating commonly in Viet Nam and Asian countries. This study contributes the basis information for adjusting and selecting the appropriate vaccines against Distemper disease in Viet Nam.

Keywords: Dogs, Distemper virus, H gene, genotype Asia 1, Can Tho city.

1. INTRODUCTION

Canine distemper virus (CDV) is the etiological agent of a multisystemic infection that affects different species of carnivores. Canine distemper virus belongs to the genus Morbillivirus, family

Paramixoviridae, that includes measles virus, phocine distemper virus and rinderpest virus. Morbilliviruses have enveloped virions and a negative-sense, single stranded RNA genome. Viruses have a nucleocapsid structure containing a single strand of unsegmented RNA consisting of about 1,600 nucleotides encoding six structural and one nonstructural proteins (Diallo, 1990; Murphy et al., 1999). Although considered to have only one serotype, there are differences in antigenic structure among CDV strains. Mutations have been reported to occur in viral structural proteins such as H, F, and N. Of these, H and F proteins are considered to be major viral antigens, stimulate the host immune response, and have genetic/antigen diversity of the Carré virus. Based on the nucleotide sequence of the gene coding for the H protein, there are 7 major virus types isolated from different geographical areas: America-1 (including most vaccine strains), America-2 (stored in Vietnam), circulating in North America), Asia-1 and Asia-2 (circulating in Asia), Europe (circulating in Europe), Arctic (circulating in the Arctic and Europe), and Africa (circulating in Africa.) (Bolt et al., 1997; Iwatsuki et al., 1997; Pardo et al., 2005; Martella et al., 2007; Gallo et al., 2007; Woma et al., 2010; Zhao et al., 2010 ; Gamiz et al., 2011).

In Vietnam, a number of studies on the genetic characteristics of the strains of Carré virus circulating in infected dogs in the field have shown that there is a very high similarity between these strains and those recorded in the world (Vo Tan et al. Dai and Duong Tan Dat, 2016). In addition, Tran Van Nen and ctv. (2017) identified some genetic characteristics of Carré virus isolated in some northern provinces of Vietnam belonging to 3 genotypes Asia 1, Asia 2 and Classic. However, in the Mekong Delta, studies on the genetic characteristics of Carré virus in dogs are still limited. Therefore, this study was carried out to identify and compare the genetic characteristics of Carré virus strains isolated in sick dogs at the Veterinary Clinic, Can Tho University; as well as the basis for research on preventive vaccines in the region. The RNA encodes six structural proteins: two membrane glycoproteins, the fusion (F) and the hemagglutinin (H), the envelope-associated matrix (M) protein, the phosphoprotein (P), the large polymerase (L) and the nucleocapsid (N) (Gabiella Elia, 2006)

So far, we believe no reports exist of CDV in Mekong Delta Vietnam. Therefore, in this study, contributes the basis information for adjusting and selecting the appropriate vaccines against Distemper disease in Viet Nam and for further purposes vaccine studies.

2. MATERIALS AND METHODS

The study was carried out from April to December 2020 in Can Tho city, Vietnam

2.1. Animals and sample collection Canine distemper virus-positive samples

Of 1,120 examined dogs in Can Tho city, by history and clinical examination, 150 dogs showed clinical symptoms of Canine Distemper, such as fever, purulent ocular and nasal discharge, tonsillitis, bronchitis, gastroenteritis or neurological disturbance.

Conjunctival swabs were collected from 150 dogs to determine Canine Distemper Virus antigen (CDV) with Rapid Test Immuno CDV Ag by Korean Asan Company. These cases positive dogs for *Canine Distemper Virus* (CDV) Rapid test were noted some characteristics such as breed, sex, age and vaccination schedule.

Molecular study

Extraction of total RNA and cDNA synthesis

A total of 7 clear positive dogs via *Canine Distemper Virus* (CDV) Rapid test were collected the tracheal exudates and blood. They were labeled as CT01, CT03, CT04, CY06, CT07, CT08, CT09 . These virus strains represent strains isolated from domestic (CT01, CT06, CT08) and foreign (CT03, CT04, CT07, CT09) dogs from three to six years of age. Viruses were extracted RNA according to the instructions for use of the QIAamp Viral RNA Mini kit (Qiagen, Germany); RNA samples were stored at -70°C. Amplification of the entire H gene region of CDV by RT - PCR reaction; the primer sequences are presented in Table 1.

Table 1. Nucleotide sequences of primers that amplify the H gene (Gamiz et al., 2011)

Primer name	Oligonucleotid Squence (5'-3')	Psition	Estimated Size Product
DHI-F	TGGTTCACAAGATGGTATTC	8.005	613 bp
DHI-R	CAACACCACTAAATTGGACT	8.617	

The thermal cycle for RT-PCR reaction was as follows: reverse transcription: 45°C for 45 minutes; pre-denaturation stage: 94°C for 5 minutes; 30 cycles: 94°C for 30 seconds, 51 °C for 30 seconds, 72 °C for 30 seconds; and 72 °C for 10 minutes (Gamiz et al., 2011). Ingredients for one RT – PCR reaction: 10 µL Go taq® green master mix 2X (Promega, USA); 1 µL MgCl₂ (25 mM); 0.5 µL M – MLV (Moloney Murine Leukemia Virus); 0.5 µL forward primer; 0.5 µL reverse primer; 4 µL of extracted RNA sample and 8.5 µL of purified water. The RT - PCR product was sent to the laboratory of Phu Sa Biochemistry Co., Ltd. (Can Tho) for sequencing H gene region.

2.2 Statistics

Survey of related factors to CDV including ages, breeds and gender and vaccination schedule CDV by χ^2 test of Minitab 16.0

Accessing GenBank to collect and determine the nucleotide similarity of the published CDV gene sequences with the gene fragment obtained in the study through the Blast program on GenBank. Phylogenetic origin based on H gene sequences from virus strains obtained by MEGA (Molecular Evolutionary Genetics Analysis) software version 7.0. Using the Maximum likelihood test method with a bootstrap value of 1,000 repetitions.

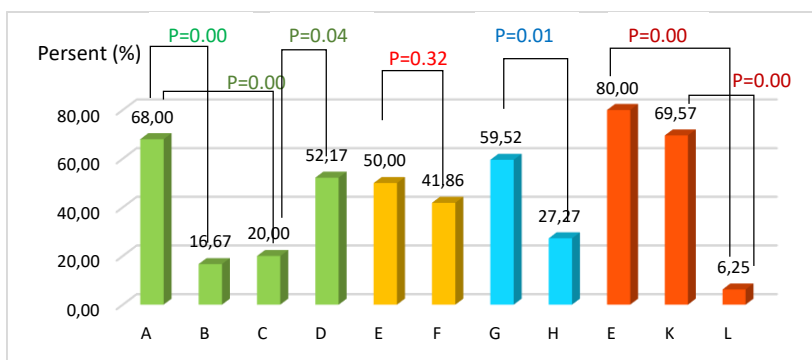
3. RESULTS

3.1 Canine distemper in dogs at cantho city

A survey on 1,120 dogs raised in Can Tho city revealed that 150 dogs showed clinical symptoms of Canine Distemper. Canine Distemper was determined to base on the test kit of Rapid Test Immumo supplied by Asan company (Korea). Of 150 dogs examined with the test kit, there were that 68 dogs were positive for *Canine Distemper Virus* (CDV)

Fig 1 shows that the highest infected CDV rate were dogs at < 6 months old (68%) which is statistically significant with other groups with $p < 0.05$. Dogs over 5 years old had a rate 52.17%. Dogs older than 5 years old are old age, so the frequency of exposure to pathogens increases and the risk of infection is higher. The Dogs were vaccinated prevention were lower ratio the dogs .The dogs were not vaccinated and vaccinated but not enough doses were high infected CDV ratio respectively 80% and 69.57% (Fig 1) because of Lack of complete or partial immunity against CDV may be responsible for the variant clinical signs of CD in dogs due pathophysiology mechanisms associated with the disease occurrence (M. Geetha, 2019).

Canine distemper viral infection in dogs presents with multiple clinical courses and outcome of CDV infection ranges from complete recovery to persistent infection leading to death depending on the age and immune status of the infected animals (Martella et al.,2008). Clinical signs of CD are often unapparent or initially mild during initial phase of fever is characterized by mucopurulent oculonasal discharges, conjunctivitis, respiratory distress, anorexia, vomiting, diarrhea and dehydration, and cutaneous rash (Appel et al.,1982). The findings of the above author is well in accordance with the clinical signs of CD affected dogs in this study including purulent ocular discharge (Fig. 2), abdominal pustules (Fig. 3) and purulent nasal discharge (Fig.4).



A: Age ≤ 6 months, B: 6 months < Age ≤ 2 years, C: 2 years < Age ≤ 5 years, D: Age > 5 years, E: male, F: female, G: Exotic group dogs, H: Domestic dogs, I: No vaccination K: Insufficient dose vaccination' L: Vaccination

Figure 1: The bar chart show the prevalence of CDV dogs based on breeds, ages, gender, and vaccination chedual

Table 2. Frequency of clinical symptoms in CDV infected dogs

Clinical symstom	Amount (Dogs)	Percent (%)
fever, sneezing, eges conjunctivitis, cough, internal runny nose	68	100.00
Skin nodules	25	36.76

Keratosis hyperkeratosis of paw pad and nose skin	28	41.18
Neurological symptoms	28	36.76

Canine distemper viral infection in dogs presents with multiple clinical courses and outcome of CDV infection ranges from complete recovery to persistent infection leading to death depending on the age and immune status of the infected animals (Martella et al.,2008). Clinical signs of CD are often unapparent or initially mild during initial phase of fever is characterized by mucopurulent oculonasal discharges, conjunctivitis, respiratory distress, anorexia, vomiting, diarrhea and dehydration, and cutaneous rash (Appel et al.,1982). The findings of the above author is well in accordance with the clinical signs of CD affected dogs in this study including purulent ocular discharge (Fig. 2), abdominal pustules (Fig. 3) and purulent nasal discharge (Fig. 4). Hyper keratinization of foot pad



Fig 2. Purulent ocular discharge in a dog with CDV infection



Fig3. Purulent nasal discharge - Canine distemper in dog



Fig 4. Hyper keratinization of foot pad

3.2 Results of comparing the similarity of nucleotide and amino acid sequences between the strains of CDV at the Cantho city and the published strains

The H gene sequences of 7 strains of Carré virus were sequenced with a length of 1,839 nucleotides. The results of comparing the H gene sequences between the Carré virus strains that cause disease in dogs in Cantho city with the strains of GenBank showed that there was a very high similarity rate (from 93.17% to 99.96%) (Table 2.).

Table 2. Similarities in nucleotide sequences between CDV strains isolated at Cantho and reference strains on GenBank

Bảng 1: Sự tương đồng về trình tự nucleotide của gene H giữa những chủng virus nghiên cứu và một số chủng khác trên GenBank

Stains	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2	99,96																			
3	99,96	99,96																		
4	99,96	99,96	99,96																	
5	99,82	99,86	99,86	99,86																
6	99,89	99,86	99,86	99,86	99,71															
7	99,89	99,86	99,86	99,86	99,71	99,71														
8	93,26	93,31	93,31	93,31	93,48	93,17	93,17													
9	96,03	96,07	96,07	96,07	96,24	95,91	95,91	94,35												
10	96,84	96,88	96,88	96,88	97,04	96,72	96,72	94,74	98,25											
11	96,88	96,92	96,92	96,92	97,08	96,76	96,76	94,79	98,29	99,82										
12	96,84	96,88	96,88	96,88	97,04	96,72	96,72	94,75	98,25	99,78	99,96									
13	94,65	94,69	94,69	94,69	94,86	94,52	94,52	93,32	95,70	96,55	96,52	96,48								
14	95,36	95,40	95,40	95,40	95,57	95,23	95,23	94,06	96,34	97,27	97,31	97,27	95,82							
15	95,45	95,49	95,49	95,49	95,65	95,36	95,36	93,99	96,27	97,08	97,12	97,08	95,54	96,39						
16	93,47	93,51	93,51	93,51	93,69	93,46	93,46	97,55	94,42	94,94	94,98	94,94	93,61	94,43	94,18					
17	93,67	93,71	93,71	93,71	93,88	93,58	93,58	99,30	94,79	95,17	95,22	95,17	93,76	94,50	94,43	98,02				
18	95,68	95,72	95,72	95,72	95,88	95,55	95,55	93,68	96,96	97,64	97,67	97,64	95,33	95,91	95,75	93,92	94,08			
19	95,56	95,60	95,60	95,60	95,76	95,51	95,51	93,93	96,92	97,68	97,72	97,68	95,42	95,99	95,84	94,17	94,37	96,50		
20	99,31	99,34	99,34	99,34	99,49	99,20	99,20	93,36	96,19	97,08	97,12	97,08	95,03	95,69	95,78	93,65	93,76	95,92	95,88	
21	99,38	99,42	99,42	99,42	99,56	99,27	99,27	93,35	96,07	96,80	96,84	96,80	94,65	95,40	95,41	93,51	93,75	95,63	95,51	99,27

- (1) CT01; (2) CT03; (3) CT04; (4) CT06; (5) CT07; (6) CT08; (7) CT09; (8) CDV/AB472690/Vietnam/2016; (9) CDV/Z54166/The Netherland/1996; (10) CDV/FJ461702/South Africa/2010; (11) CDV/EF095750/Hungary/2016; (12) CDV/FJ705238/Taiwan/2010; (13) CDV/AB040767/Japan/2002; (14) CDV/DQ226087/Italy/2006; (15) CDV/EJ461715/South Africa/2010; (16) CDV/HM063009/Kazakhstan/2010; (17) CDV/AF378705/USA/2012; (18) CDV/FJ416339/Germany/2016; (19) CDV/Q226168/Italy/2006; (20) CDV/JX681125/China/2013; (21) CDV/LC159587/Vietnam/2019

The isolates of CDV strains were almost completely similar to each other, with the rate from 99.82–99.96%. This shows that the isolated strains of CDV that cause disease in dogs may have the same origin, and are common in the study area. In addition, the similarity of nucleotides between the studied strains and other strains on GenBank was 93.26-99.56% and the vaccine strains above

GenBank is 96.72–97.08%. This result shows that the isolated virus is also highly similar to the strains used to make the vaccine; Therefore, if vaccinated with vaccines produced from these virus strains (CDV/FJ461702/SouthAfrica/2010; CDV/EF095750/Hungary/2016; CDV/FJ705238/Taiwan/2010) will increase the protection effect for dogs in the study area. Research results of Tran Van Nen et al. (2017) also recorded a high degree of similarity between isolated strains of Carré virus (90.05 – 99.61%), and similarity with virus strains in the published vaccine (89.99 – 99.34). %. The analysis results of Vo Tan Dai and Duong Tan Dat (2016) also show that the nucleotide similarity of the CDV samples in the field is very high (99.30 - 100%), and similar to the virus strain in the field. vaccines (96.10 - 96.60%). Guo et al. (2013) also recorded the nucleotide sequence in the H gene between the Carré virus strain in China compared with other strains in the world with the similarity rate ranging from 85.40-99.80%.

Table 3. Similarities in amino acid sequences between CDV strains isolated at Cantho city and reference strains on GenBank

Bảng 3. Sự tương đồng về trình tự amino acid của gene H giữa những chủng virus nghiên cứu và một số chủng khác trên GenBank

Stains	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2	99,96																			
3	99,96	100																		
4	99,96	99,96	100																	
5	99,82	99,86	99,86	99,86																
6	99,89	99,86	99,86	99,86	99,71															
7	99,89	99,86	99,86	99,86	99,71	100														
8	93,26	93,31	93,31	93,31	93,48	93,17	93,17													
9	96,03	96,07	96,07	96,07	96,24	95,91	95,91	94,35												
10	96,84	96,88	96,88	96,88	97,04	96,72	96,72	94,74	98,25											
11	96,88	96,92	96,92	96,92	97,08	96,76	96,76	94,79	98,29	99,82										
12	96,84	96,88	96,88	96,88	97,04	96,72	96,72	94,75	98,25	99,78	99,96									
13	94,65	94,69	94,69	94,69	94,86	94,52	94,52	93,32	95,70	96,55	96,52	96,48								
14	95,36	95,40	95,40	95,40	95,57	95,23	95,23	94,06	96,34	97,27	97,31	97,27	95,82							
15	95,45	95,49	95,49	95,49	95,65	95,36	95,36	93,99	96,27	97,08	97,12	97,08	95,54	96,39						
16	93,47	93,51	93,51	93,51	93,69	93,46	93,46	97,55	94,42	94,94	94,98	94,94	93,61	94,43	94,18					
17	93,67	93,71	93,71	93,71	93,88	93,58	93,58	99,30	94,79	95,17	95,22	95,17	93,76	94,50	94,43	98,02				
18	95,68	95,72	95,72	95,72	95,88	95,55	95,55	93,68	96,96	97,64	97,67	97,64	95,33	95,91	95,75	93,92	94,08			
19	95,56	95,60	95,60	95,60	95,76	95,51	95,51	93,93	96,92	97,68	97,72	97,68	95,42	95,99	95,84	94,17	94,37	96,50		
20	99,31	99,34	99,34	99,34	99,49	99,20	99,20	93,36	96,19	97,08	97,12	97,08	95,03	95,69	95,78	93,65	93,76	95,92	95,88	
21	99,38	99,42	99,42	99,42	99,56	99,27	99,27	93,35	96,07	96,80	96,84	96,80	94,65	95,40	95,41	93,51	93,75	95,63	95,51	99,27

(1) CT01; (2) CT03; (3) CT04; (4) CT06; (5) CT07; (6) CT08; (7) CT09; (8) CDV/AB472690/Vietnam/2016; (9) CDV/Z54166/The Netherland/1996; (10) CDV/FJ461702/South Africa/2010; (11) CDV/EF095750/Hungary/2016; (12) CDV/FJ705238/Taiwan/2010; (13) CDV/AB040767/Japan/2002; (14) CDV/DQ226087/Italy/2006; (15) CDV/FJ61765/South Africa/2010; (16) CDV/HM063009/Kazakhstan/2010; (17) CDV/AF378705/USA/2012; (18) CDV/AF378705/USA/2012; (19) CDV/FJ416339/Germany/2016; (20) CDV/DQ228166/Italy/2006; (21) CDV/JX681125/China/2013; (22) CDV/LC159587/Vietnam/2019

Due to the high similarity in nucleotide sequences on the H gene between the isolated CDV strains and the reference strains, these viruses also have high degree of similarity in amino acid sequences on the H gene from 93.17 –100% (Table 3). The amino acid similarity between the studied strains and other strains on GenBank was 99.03–99.56% and the vaccine strains on GenBank were 96.72–97.08%. According to research by Tran Van Nen et al. (2017), the analyzed CDV strains have the amino acid similarity in the H gene at the rate of 89.38 - 99.50%, the amino acid similarity in the H gene between the studied virus strain and the H gene. The rate of vaccine virus strains is 89.39-99.17%. The results of the study by Swati et al. (2015) also showed that the similarity of amino acid sequence in the H gene of CDV strain in India reached a high rate of 96.30 - 97.00%; At the same time, the amino acid similarity between these strains and the vaccine strains Convac, Ondersteport, and CDV3 was 92.10%, 92.90%, and 94.80%, respectively.

3.3 Genetic relationship between studied CDV strains and CDV strains circulating in Vietnam and the world

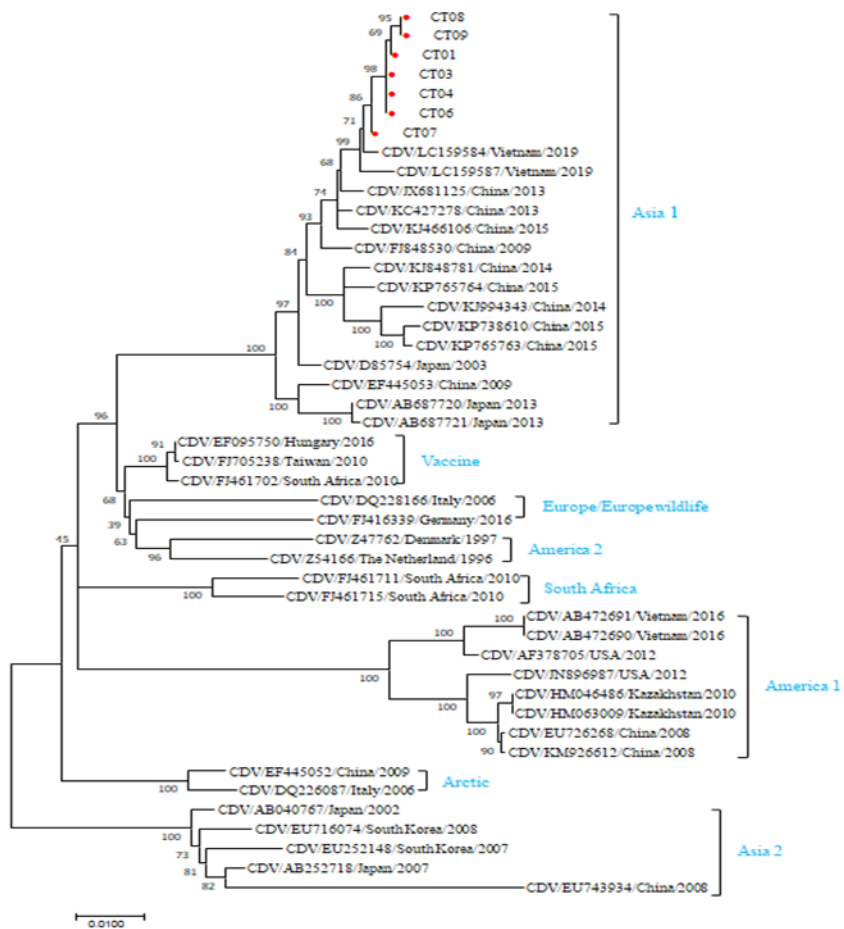


Figure 5. Genetic relationships between Carré virus strains isolated in dogs at Cantho city (CT01, CT03, CT04, CT06, CT07, CT08, CT09) and strains published on Genbank

The analysis results of the studied virus strains belong to the same branch of the studied virus strains belong to the same of genotype Asia 1 and are quite similar to strains originating from China and Japan. At the same time, the results of origin analysis are based on nucleotide differences in the H gene segment of 7 researched CDV strains, 7 studied virus strains are different from the phylogenetic branch of reference strains in the world belonging to genotypes. such as: Europe, America, America 1, Africa, Arctic, and Asia 2. Within the same group, the virus strains were divided into subgroups according to the individual dogs collected. The CDV/Dog/CT/07/2020 strain is located in a different branch from the other 6 studied virus strains, with 86% similarity. The vaccine virus strains are in the same other clade and belong to the vaccine subgroup. Despite the high similarity in nucleotide and amino acid sequences, the CDV strains isolated at Cantho exhibited city distinct subtypes. This shows that there are many strains of CDV circulating in

Vietnam; Therefore, it is important to choose the appropriate vaccine to use. The results of this study are similar to those of Lan et al. (2005, 2006, 2009), Tan et al. (2011), Tran Van Nen et al. (2017). They showed that virus isolates in Japan, China and Asia are circulating 2 main genotypes, Asia 1 and Asia 2. Another study by Guo et al. (2013) also showed that the CDV strains that cause disease in pandas and wild dogs in China belong to genotype Asia 1. The research results of Vo Tan Dai and Duong Tan Dat (2016) also show that real CDV strains are true. Soils collected at veterinary clinics in Ho Chi Minh City all belonged to genotype Asia 1. Although, CDV was first detected in Vietnam in 1950, but in 2009, the CDV strain in Vietnam was identified with genotype America 1 (Lan et al., 2009). However, the results of Dung et al. (2017) showed that the CDV strain collected at Cantho city in Ho Chi Minh City belongs to genotype Asia 1 and is similar to the strains circulating in other Asian countries (Taiwan, China), Korea, Japan, Thailand) and different from previous studies in Vietnam. Therefore, the results of this study have practical significance in the adjustment and selection of suitable virus strains to import vaccines; or make vaccines from domestic strains of the virus causing Carré disease to prevent the disease.

4. CONCLUSION

CDV strains isolated at Cantho city may have the same origin due to their very high similarity (99.82–99.96%), and high similarity to each other. with field viruses and viruses in vaccine preparations have been published on GenBank. At the same time, these isolated virus strains belonging to genotype Asia 1 are widely circulated in Vietnam and other Asian countries. There are many subtypes of CDV in Vietnam; Therefore, the selection of vaccines suitable for the field in the prevention of diseases in dogs should be concerned. The results of this study can contribute to the basis of research on selection or preparation of a vaccine against Carré disease in Vietnam.

REFERENCES

1. Appel, M. J. G. (1987): Canine distemper virus. (eds.): Virus Infections of Carnivores, Elsevier Science Publishers B. V., New York. Pp. 133–159.
2. Bolt G., Jensen T.D., Gottschalck E., Arctander P., Appel M.J., Buckland R., Moller M. B., 1997. Genetic diversity of the attachment (H) protein gene of current isolates of canine distemper virus. *J. Gen. Virol.* 78:367-372.
3. Diallo A., 1990. Morbillivirus group: genome organisation and proteins. *Veterinary Microbiology.* 23(1-4): 155-163.
4. Dung V.N., Suzuki J., Minami S., Yonemitsu K., Nagata N., Kuwata R., Shimoda H., Vu C.K., Truong T.Q., Maeda K., 2017. Isolation and phylogenetic analysis of canine distemper virus among domestic dogs in Vietnam. *J. Vet. Med. Sci.* 79(1): 123-127.
5. Gallo C.M., Remorini P., Periolo O., Iglesias M., Mattion N., Torre J.L., 2007. Detection by RT-PCR and genetic characterization of canine distemper virus from vaccinated and non-vaccinated dogs in Argentina. *Vet. Microbiol.* 125: 341-349.
6. Gamiz C., Martella V., Ulloa R., Fajardo R., Quijano-Hernandez I., Martinez S., 2011. Identification of a new genotype of Canine Distemper Virus circulating in America. *Vet. Res. Commun.* 35: 381-390.

7. Guo L., Yang S.L., Wang C.D., Hou R., Chen S.J., Yang X.N., Liu J., Pan H.B., Hao Z.X., Zhang M.L., Cao S.J., Yan Q.G., 2013. Phylogenetic analysis of the haemagglutinin gene of canine distemper virus strains detected from giant panda and raccoon dogs in China. *Virology Journal*. 10(109) (10:109 <http://www.virologyj.com/content/10/1/109>).
8. Iwatsuki K., Miyashita N., Yoshida E., Gemma T., Shin Y.S., Mori T., Hirayama N., Kai C., Mikami T., 1997. Molecular and phylogenetic analyses of the haemagglutinin (H) proteins of field isolates of canine distemper virus from naturally infected dogs. *J. Gen. Virol.* 78: 373-380.
9. Lan N.T., Yamaguchi R., Furuya Y., Inomata A., Ngamkala S., Naganobu K., Kai K., Mochizuki M., Kobayashi Y., Uchida K., Tateyama S., 2005. Pathogenesis and phylogenetic analyses of Canine Distemper Virus strain 007Lm, a new isolate in dogs. *Veterinary microbiology*. 110(3): 197-207.
10. Lan N.T., Yamaguchi R., Inomata A., Furuya Y., Uchida K., Sugano S., Tateyama S., 2006. Comparative analyses of Canine Distemper Viral isolates from clinical cases of Canine Distemper in vaccinated dogs. *Veterinary microbiology*. 115(1): 32-42.
11. Lan N.T., Yamaguchi R., Hirai T., Kai K., Morishita K., 2009. Relationship between growth behavior in vero cells and the molecular characteristics of recent isolated classified in the Asia 1 and 2 groups of Canine Distemper Virus. *J. Vet. Med. Sci.* 71(4): 457-461.
12. Martella V., Elia G., Lucente M.S., Decaro N., Lorusso E., Banyai K., Moller M.B., Lan N.T., Yamaguchi R., Cirone F., Carmichael L.E., Buonavoglia C., 2007. Genotyping canine distemper virus (CDV) by a hemi-nested multiplex PCR provides a rapid approach for investigation of CDV outbreaks. *Vet. Microbiol.* 16: 32-42.
13. Murphy F.A., Gibbs E.P.J., Horzinek M.C., Studdert M.J., 1999. *Veterinary virology*. Academic Press. USA.
14. Pardo I.D., Johnson G.C., Kleiboeker S.B., 2005. Phylogenetic characterization of canine distemper viruses detected in naturally infected dogs in North America. *J. Clin. Microbiol.* 43:5.009-5.017.
15. Swati D.D., Uppal S.K., Verma R., 2015. Isolation and phylogenetic characterization of Canine distemper virus from India. *Virus. Dis.* 26(3): 133–140.
16. Tan B., Wen Y.J., Wang F.X., Zhang S.Q., Wang X.D., Hu J.X., Shi X.C., Yang B.C., Chen L.Z., Cheng S.P., Wu H., 2011. Pathogenesis and phylogenetic analyses of Canine Distemper Virus strain ZJ7 isolate from domestic dogs in China. *Virol. J.* 16(8) (doi: 10.1186/1743-422X-8-520).
17. Trần Văn Nền, Nguyễn Thị Lan, Nguyễn Văn Thanh, Lương Quốc Hưng, 2017. Nghiên cứu một số đặc điểm sinh học phân tử của virus Ca rê phân lập được tại một số tỉnh phía Bắc Việt Nam. *Tạp chí Khoa học Nông nghiệp Việt Nam*. 15(1): 44-57.
18. Võ Tấn Đại, Dương Tấn Đạt, 2016. So sánh hiệu quả chẩn đoán bệnh Care trên chó bằng phương pháp xét nghiệm nhanh và kỹ thuật RT – PCR, phân tích một đoạn gen Hemagglutinin của virus gây bệnh. *Tạp chí Khoa học kỹ thuật Thú y*. 23(8): 29-36.

19. Woma T.Y., Vuuren M.V., Bosman A.M., Quan M., Oosthuizen M., 2010. Phylogenetic analysis of the haemagglutinin gene of current wild-type canine distemper viruses from South Africa: Lineage Africa. *Vet. Microbiol.* 143:126-132.
20. Zhao J.J., Yan X.J., Chai X.L., Martella V., Luo G.L., Zhang H.L., Gao H., Liu Y.X., Bai X., Zhang L., Chen T., Xu L., Zhao C.F., Wang F.X., Shao X.Q., Wu W., Cheng S.P., 2010. Phylogenetic analysis of the haemagglutinin gene of Canine distemper virus strains detected from breeding foxes, raccoon dogs and minks in China. *Vet. Microbiol.* 140: 34-42.

USING SMART AGRICULTURE TECHNIQUES FOR IMPROVING CROP PRODUCTION

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ABSTRACT

As the population is growing day-by-day, the living area of the people is also increasing. The space used for spending their livelihoods has been extending. As a result, the land used for agriculture is shrinking slowly. This situation is emphasizing pressure on agriculture techniques. We have to use such a technique that can increase productivity. Along with the Smart agriculture techniques, we also have to protect the crop from destruction. Crop destruction causes a huge amount of crops to be destroyed every year. As a result, IoT solutions can assist us in effectively protecting our crops from harm. In this research paper, we have proposed a model using new smart agricultural techniques that are transforming the face of traditional farming by improving and protecting it from intimidations such as locust, animal and fire, while also making it more cost-effective for farmers. Crop protection techniques using IoT can lead us to increase the net productivity of Agriculture.

Keywords: Crop protection, IoT Techniques, Smart Agriculture, Locust & Animal attacks, Crop destruction

1. INTRODUCTION

As the population grows, so does the amount of space available for individuals to live. The area in which they spend their living spaces has been growing. As a result, agricultural land is gradually diminishing. This condition is putting further strain on agricultural systems. We need to employ an approach that will boost productivity. We must also preserve the crop from destruction, in addition to using smart agriculture practices. Crop devastation results in the loss of a large number of crops each year. Crop damage is one of the major issues preventing people from meeting their food needs. From 2017 to 2019, India sustained severe crop damage on 18.176 million hectares (mha), or nearly 8.5 percent of the total gross cultivated area, due to floods, according to data provided by the government in the Lok Sabha on February 11, 2021. In this data, only one factor for destruction is shown. Other things that cause crop destruction include animals, insects, pests, fire, and so forth[1]. Humans find it difficult to resist all of these influences. As a result, IoT technologies can help us secure our crops more efficiently. High population growth influences the requirement for more communities on the land. Such a situation implies that agricultural land is likely to be constructed as a result of substantial conversion to new land uses, such as settlement or another more profitable land use. Furthermore, population pressure on the land throughout this period has the potential to impair agricultural productivity[2]. In the future, the Internet of Things (IoT) will serve as the cornerstone for Smart Computing. A crucial factor is the transfer of existing technology from the home to the workplace into "next-generation

computing." The "Internet of Things" is a key component of global research, notably in the field of enhanced wireless communication. Today, IoT is building the groundwork for numerous goods, such as smart healthcare, smart housing, smart schools, and technology that have an impact on people in and out of the market. Agriculture is the most researched aspect of the Internet of Things[3][4]. This research contains a comprehensive set of data that will assist IoT-based researchers and agricultural engineers in achieving the necessary level of food security. The rest of this article is organized in the same way. The overview and problem statement is discussed in Section 2. The suggested frameworks as well as their components are described in Section 3. Section 4 discusses experimental data analysis and results. Finally, Section 5 brings the process to a conclusion.

2. OVERVIEW AND PROBLEM STATEMENT

Animal attacks on crops are a regular and serious problem that results in significant losses. Local animals such as buffaloes, pigs, goats, birds, and fire have damaged farm crops in multiple cases[5]. So, this research is based on solving the problem of these attacks to some extent using IoT Techniques.

India is an agriculture-based country, with agriculture employing more than half of the population. In 2020, a locust invasion was there in almost 10 states of India as shown in Figure 1. Rajasthan, Punjab, Gujarat, Uttar Pradesh, Madhya Pradesh, Maharashtra, Bihar, Chhattisgarh, Haryana and Uttarakhand were the affected states. Initially, the Government of Rajasthan reported crop destruction of 33% or more due to locust attack in 2235 hectares in Bikaner, 140 hectares in Hanumangarh, and 1027 hectares in Sri Ganganagar in May 2020; however, according to a revised report, the earlier submitted data was related to the initial stage of crop sown in Kharif season, and this area of crop loss has been re-classified. Due to locust invasion this year, the state governments of Haryana, Madhya Pradesh, Maharashtra, Uttar Pradesh, and Uttarakhand have estimated crop damage of less than 33% in 6520 ha, 4400 ha, 806 ha, 488 ha, and 267 ha, respectively[6].

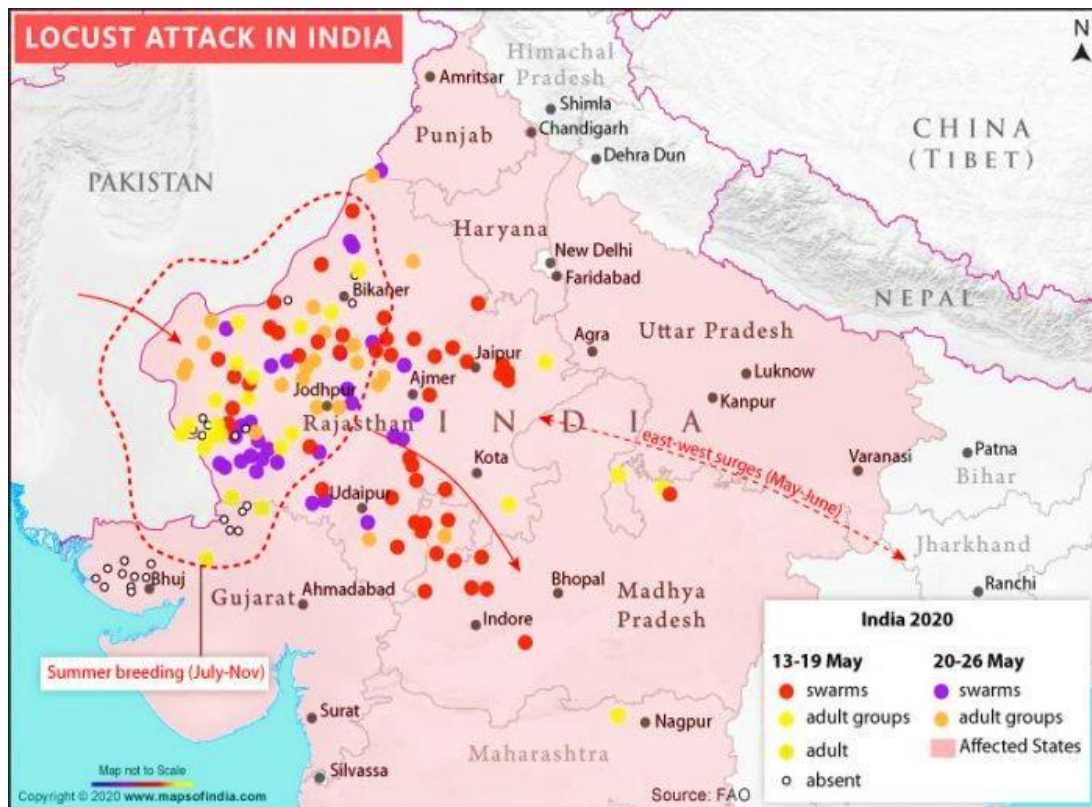


Figure 1. Locust attack in India, 2020-21 (source: www.mapsofindia.com)

Human-wildlife conflict has always been a major concern in Bhutan, with about 60% of the country's 765,000 people reliant on agriculture and animal production. In the Yangthang village of Bhutan Wild boars had eaten about 40% of the potatoes grown by most of the farmers. According to the Ministry of Agriculture and Forests, wild animals ruining crops and killing livestock is a prevalent problem across the country (MoAF). According to the 2017 State of the Nation survey, 70 percent of farmers reported wildlife destroying crops and 12 percent reported livestock losses due to wildlife attacks. Agriculture experts warn that in recent decades, the rising incidence of wild animal attacks has put farming communities in trouble. Farmers spend around four to five months a year securing their crops during the night.

The main objectives of this research are as follows:

- To reduce the crop destruction done by Animals.
- To reduce the crop destruction done by locusts/pests.
- To prevent crop destruction in the field by fire.

For fulfilling these objectives, we have proposed a model that can be implemented for protecting the farmer's crop from destruction during the night also. No guard will be needed for guarding the farm day and night. Also, this model will produce a frequency to repel animals.

3. PROPOSED MODEL

Local animals such as buffaloes, pigs, goats, birds, and fire have damaged farm crops in multiple times. This results in significant losses for producers. Farmers are unable to encircle entire fields with barricades or stand on the field for 24 hours to secure it [7]. As a result, we've proposed an automated system to defend crops from animals and fire. This Proposed System would transform the classic inactive scarecrow into a smart, adaptable scarecrow that can not only scare away birds but also repel wild animals and guard against fire.

Working Principle

A classic scarecrow sculpture will be updated and enhanced in this suggested model by integrating sensors and Repeller Devices that can identify animals in the range of farmer's crop field, as well as a fire sensor and alarm that can notice the fire in the cropland and raise the alert. We're utilizing a GSM module to connect these sensors' output signals to the farmer's phone, so that if there's any movement detected inside the farm while the farmer is away, a message may be delivered to him[8].

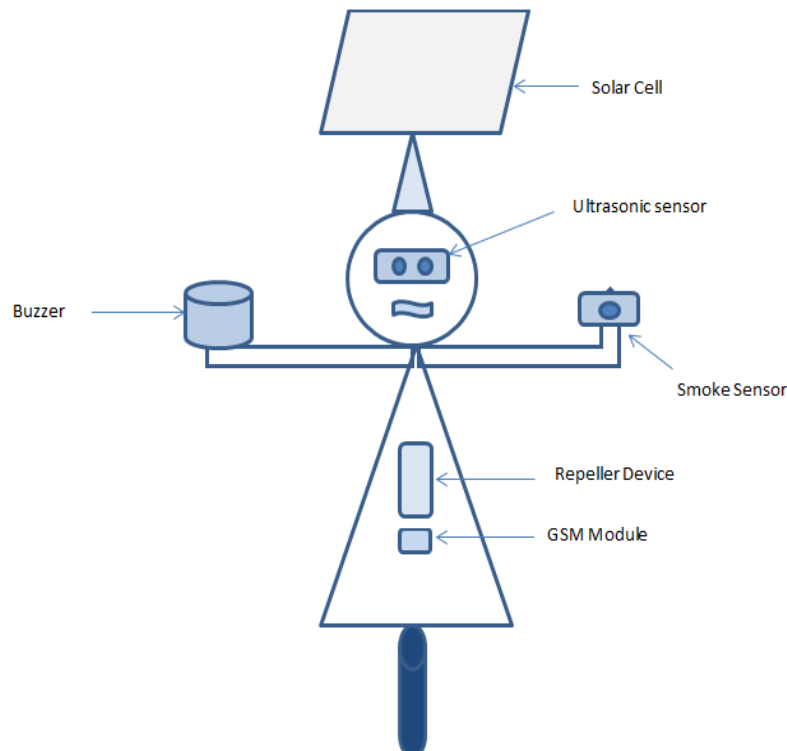


Figure 2. Proposed model in shape of traditional scarecrow

Algorithm For Animals attack prevention

Start

- When an animal reaches the sensor range's farmland area, the Arduino UNO receives data from the Ultrasonic sensor.
- The output pin will be activated as soon as the Ultrasonic sensor detects any animal and also detect the animal's height.
- At the output pin, the Repeller gadget will begin making alarm sounds of various high frequencies dependent on tiny, medium, or large animals.

- Simultaneously the GSM Module sends a message to the farmer's registered mobile phone.

End

4. DATA AND RESULTS

The basic working principle of this model are based on Ultrasonic frequencies to repel Animals from Cropland especially when the farmer is not in the ground. Ultrasonic devices work by releasing short-wavelength, high-frequency sound waves that are too loud for the human ear to hear (generally accepted to be frequencies more than 20 kHz). Due to physiological constraints of the cochlea, humans are normally unable to hear sounds louder than 20 kHz, while there is considerable variation between people, especially at such high frequencies. Bats, dogs, and rats, for example, can perceive well into the ultrasonic range[9]. Figure 3 below shows the Repeller Frequency for various Animals.

Repeller Frequency for Animals:

Animals	frequency range (Hz)
Pig	45-45,000 Hz
Ferret	16-44,000 Hz
Raccoon	100-40,000 Hz
Risso's dolphin	8,000-100,000 Hz
Jamaican fruit bat	2,800-131,000 Hz
Rabbit	360-42,000 Hz
Human	31-17,000 Hz
Guinea pig	54-50,000 Hz
Rat	500-64,000 Hz
Dogs	up to 40,000 Hz
Cats	100-60,000 Hz
Bats	1,000-100,000 Hz
Mouse	2,300-85,000 Hz

G gerbil	100-60,000 Hz
Manatee	400-46,000 Hz
Birds	
Pigeon	?-5,800 Hz
Chicken	125-2,000 Hz
Canary	250-8,000 Hz
Cockatiel	250-8,000 Hz
Parakeet	200-8,500 Hz
Penguin	100-15,000 Hz
Owl	200-12,000 Hz
Insects	
Noctuid moth	1,000-240,000 Hz
Grasshopper	100-50,000 Hz

Figure 3. Various Repeller Frequencies for various types of Species

Now, Figure 4, Figure 5 and Figure 6 are showing the simulation experiment of proposed model using RED LED at output PIN instead of frequency generator.

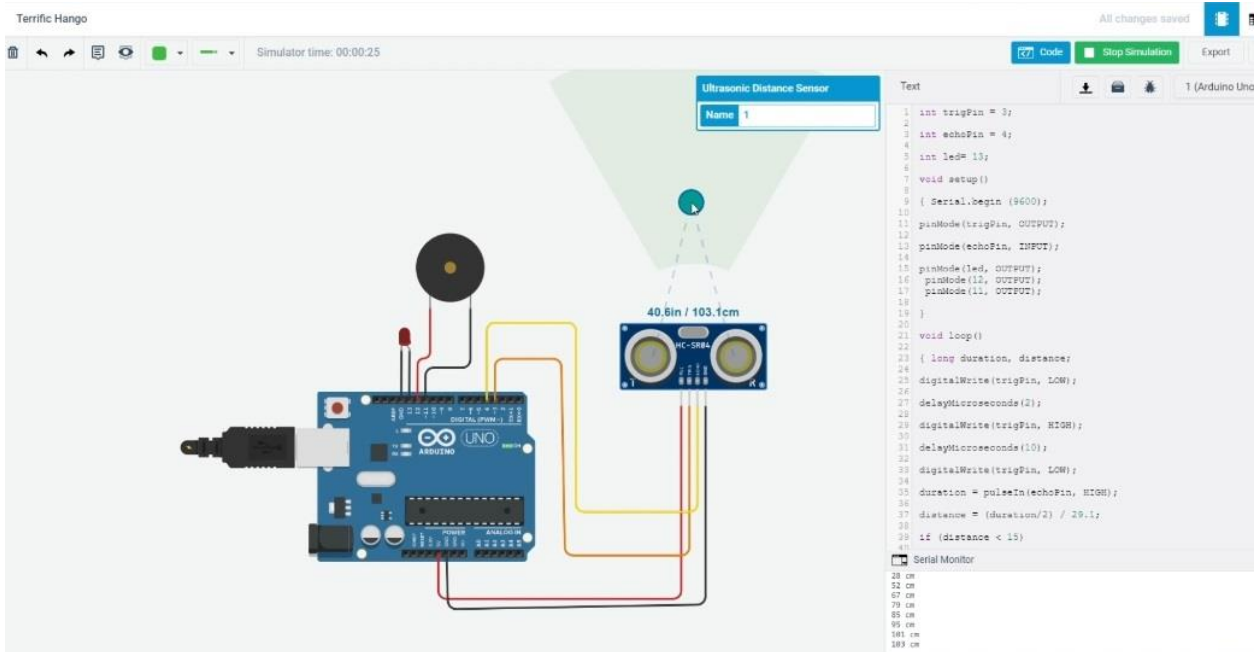


Figure 4. Object beyond the field area range (LED OFF)

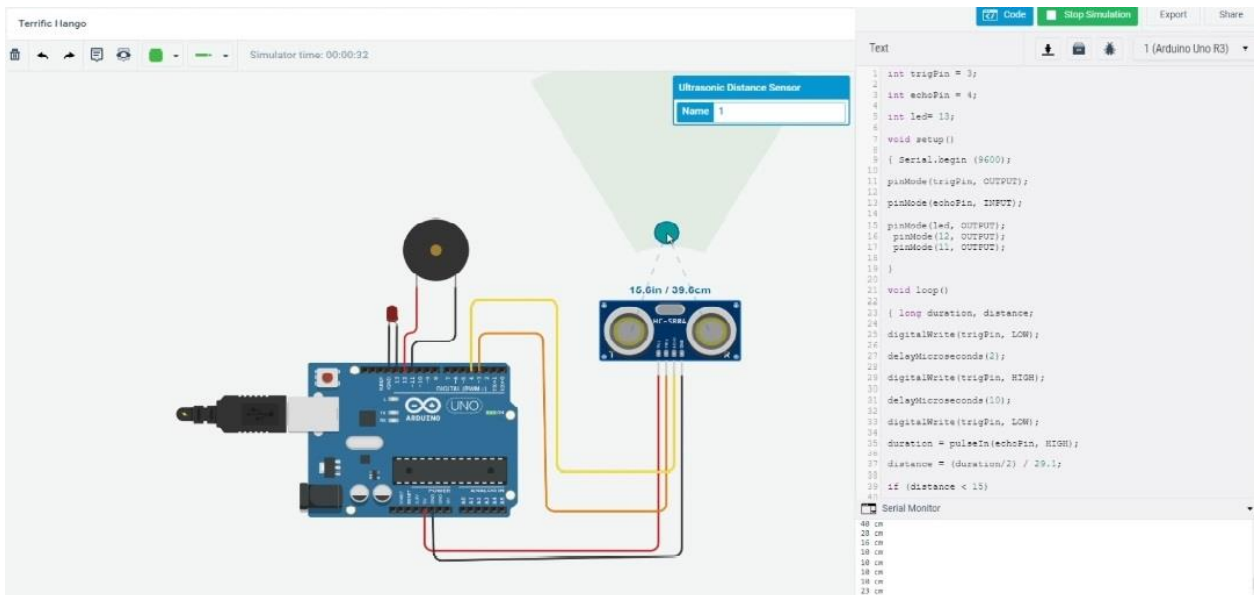


Figure 5. Object at the boundary of field (LED OFF)

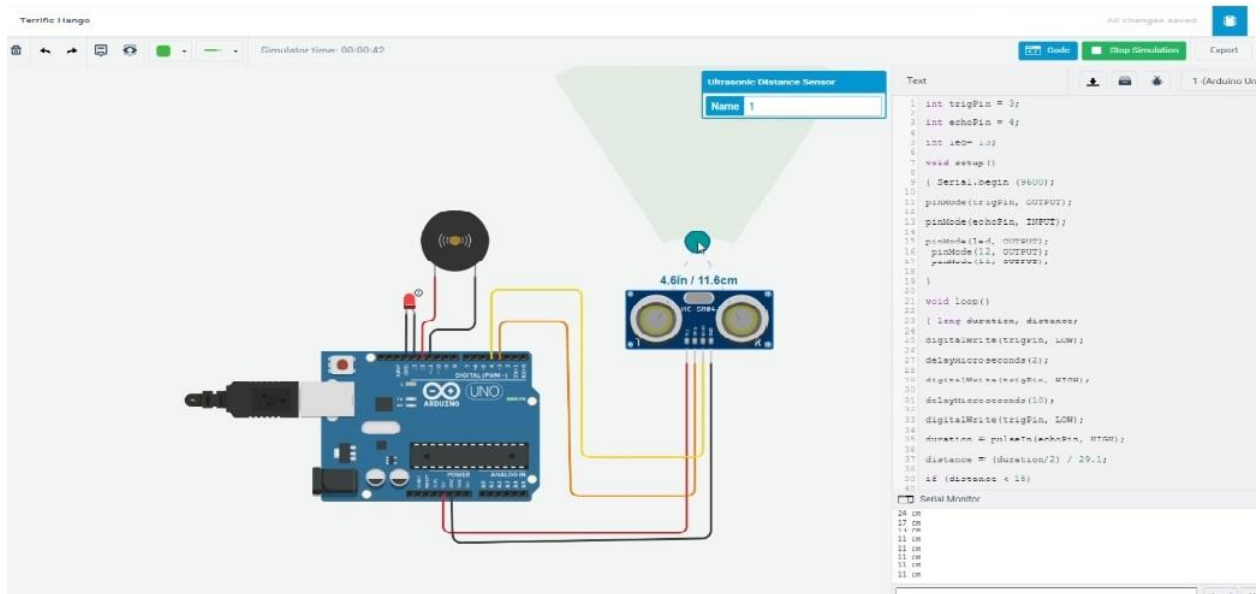


Figure 6. Object inside the Field Range (LED ON)

Thus, the above simulation of the experiment shows the working of the proposed model. In the above figure, it is clearly shown that no response is there from ARDUINO until the object comes inside the field. Red LED is ON in the experiment only when the object comes inside the field. Thus, LED can be replaced by a frequency generator repeller device to generate frequency as the animal comes inside the field.

So, the main advantages of this proposed model are:

- 24X7 guarding of the crop-field by this system.
- Detection of animal, bird or any intruder to the field.
- No need to kill Animals as in many countries killing animals is a punishable offense. Animals can be repelled away by frightening from the frequency generated.
- Automatic fire detection and automatic switching on the motor for extinguishing the fire.

5. CONCLUSION

We can conclude at the end of this research the proposed model is designed for the protection of crops from animals. So that farmers should not invest their income in guarding the crops of field. This model will act as a guard from animals due to its technical application and from birds due to its physical structure like a scarecrow in the field. Agricultural farms would have to use cutting-edge technology to gain the competitive advantage needed to meet the population's growing demands. Agricultural IoT (Internet of Things) applications can help the industry improve operational efficiency, cut costs, reduce waste, and improve yield quality[10]. Smart agriculture based on the Internet of Things is a system that uses sensors to monitor watering activities and regulate crop protection in the agricultural field. Farmers can monitor the state of their farms from any location. The fundamental goal of the suggested approach is to protect crops in any circumstance and to assist farmers in controlling their land from anywhere.

REFERENCES

- [1] M. A. Haque, S. Haque, D. Sonal, K. Kumar, and E. Shakeb, “Security Enhancement for IoT Enabled Agriculture,” *Mater. Today Proc.*, Feb. 2021, doi: 10.1016/j.matpr.2020.12.452.
- [2] R. F. Putri, M. Naufal, M. Nandini, D. S. Dwiputra, S. Wibirama, and J. T. S. Sumantyo, “IOP Conference Series: Earth and Environmental Science The Impact of Population Pressure on Agricultural Land towards Food Sufficiency (Case in West Kalimantan Province, Indonesia) The Impact of Population Pressure on Agricultural Land towards Food Suffic,” doi: 10.1088/1755-1315/256/1/012050.
- [3] M. G. P. M. Samarasinghe, “Use of IOT for Smart Security Management in Agriculture,” no. 978, pp. 65–73, 2019.
- [4] S. David, R. S. Anand, and M. Sagayam, “Enhancing AI based evaluation for smart cultivation and crop testing using agro-datasets,” *J. Artif. Intell. Syst.*, vol. 2, no. 1, pp. 149–167, 2020.
- [5] B. V. Raju, “An IOT based Low Cost Agriculture Field Monitoring System.”
- [6] “Damage to Crops due to Locust Attack - India | ReliefWeb.” <https://reliefweb.int/report/india/damage-crops-due-locust-attack> (accessed Jul. 04, 2021).
- [7] M. Parashar, *Candidate Declaration “Iot Based Smart Agriculture Monitoring System,”* no. 151042. .
- [8] S. Haque, D. Sonal, and K. Kumar, “Materials Today : Proceedings Security Enhancement for IoT enabled Agriculture ScienceDirect Security Enhancement for IoT enabled Agriculture.”
- [9] P. Nair, K. Nithiyanthan, and P. Dhinakar, “Design and development of variable frequency ultrasonic pest repeller,” *J. Adv. Res. Dyn. Control Syst.*, vol. 9, no. Special Issue 12, pp. 22–34, 2017.
- [10] B. Ragavi, L. Pavithra, P. Sandhiyadevi, G. K. Mohanapriya, and S. Harikirubha, “Smart Agriculture with AI Sensor by Using Agrobot,” in *2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC)*, 2020, pp. 1–4.

OSTEOPOROSIS AND HIGH SCHOOL EDUCATION

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ABSTRACT

In this paper, it is discussed how lifestyle during the teenage years can affect genetic predisposition towards the development of osteoporosis. The inclusion of this topic in the high school curriculum would reinforce students' health education. It would contribute towards building healthy dietary habits among adolescents and preventing osteoporosis in later stages of their lives. Furthermore, it would present a practical purpose of the knowledge gained in Chemistry and Biology classes.

In this article, an overview is presented of the physiological role of some biogenic elements and radicals, which determine bone structure and are part of the Chemistry and Biology high school curricula. Discussed are the causes of the formation of free radicals in the body, which cause the emergence of oxidative stress - one of the factors which change the concentration of the bioelements calcium, phosphorus, magnesium, copper, and zinc in the body, and speed up the development of osteoporosis. Implemented is the idea of natural antioxidants - substances which deactivate free radicals and decrease oxidative stress.

Key words: osteoporosis, bioelements, radicals, oxidative stress, education

INTRODUCTION

Osteoporosis is a highly prevalent disease with serious psychological and economic consequences for the affected individual, their family and society at large. Its development has a tendency towards becoming an epidemic, due to the ageing population and lack of health strategies for early screening in many countries, including Bulgaria. The frequency of this socially significant disease and its complications is high – over 200 million people worldwide [1]. In the European Union, annual expenditures for osteoporotic fractures aggregate 37 billion euro [2], and in Bulgaria – over 30 million euro [3]. Femoral neck bone mineral density and 10-year absolute fracture risk in a national representative sample of Bulgarian women aged 50 years and older. Osteoporosis also affects men over the age of 50 years old, due to the oncoming testosterone deficit. Every fifth man over 50 suffers an osteoporotic fracture [4].

Despite the presence of a plethora of effective medications available, a disorder of bone health leads to deterioration of the quality of life. Hence, it is of higher importance to explore opportunities for osteoporosis prevention, rather than its treatment modalities [5].

Statistics show that the higher the peak bone mass accumulated is during puberty, the lower the risk is of losing bone density during the period of hormonal deficit. Puberty is the period during which bone density grows the fastest. With appropriate nutrition and physical activity, bone density can reach a high enough value, so that its inevitable reduction with the decline in sex hormone synthesis does not reach the critical level of osteoporosis. Hence, osteoporosis

prevention must start with school education – with giving young people enough knowledge about the disease, which would convince them to build a healthy lifestyle. Knowing the factors for prevention of the development of osteoporosis should be founded in the chemistry, biology and physical education curriculums.

Metabolic disruptions of bone homeostasis start during adolescence. Regulation of this process requires balanced levels of biogenic elements and vitamins, which provide the body with the ability to cope with oxidative stress.

Our review of high school chemistry and biology textbooks shows that most of the chemical elements studies during Chemistry and environmental protection classes during secondary school are biogenic elements, which are part of bone formation. However, not enough information is provided about their biological functions, causes of their insufficiency in the human body, as well as the nutritional sources, which can maintain their normal levels [6 ÷ 15].

The information provided in textbooks about free radicals is in a similar situation. During organic chemistry classes, student learn about what is a free radical and how active it is, and the mechanism of reactions of chain-radical replacement. However, it is not discussed how these active particles form inside the cells and deconstruct them when there is a lack of antioxidants to neutralize them. Hence, with time, various diseases start developing, including osteoporosis. It is necessary for information about ways to increase the body's antioxidant activity to be added to high school curriculums.

Students need to be provided with similar topics, which would guarantee a certain level of medical literacy. This type of information is not only useful for building nutritional habits, but also for provoking practical interest in the subject.

The inefficient system for teaching physical education to secondary education students is one of the main causes of hypodynamics among young people, and their inability to reach a stable bone structure. The data from studying children and adolescents in Bulgaria point to 50.93% of students in secondary education are highly immobile and form a serious risk contingent for the development of osteoporosis in the future. Changes are necessary in this subject as well. A module about bone health and the ways for osteoporosis prophylactic from childhood age needs to be included in the curriculum, which would provide a suitable school and out-of-school sport environment for the early prevention of osteoporosis. Sports exercises need to be included which would be entertaining for students, as well as motivational explanations for their usefulness.

In this article, we have suggested ideas for the enrichment of educational materials in the chemistry, biology and physical education curriculums during the high school course, with knowledge on the nature of the disease, as well as the factors for the building of a stable bone system.

Ideas for the enrichment of the educational contents

Osteoporosis

Osteoporosis is a progressive disease of the skeleton, caused by an imbalance between bone resorption and formation. It is characterized by low bone density and an impaired bone structure. Bones become porous and brittle. Bone loss is asymptomatic until the first fracture, typically that of a thoracic or lumbar vertebra or the neck of the femur [2]. Every person's metabolism is affected by ageing, however, not everyone is affected by osteoporosis.

Factors for the prevention of osteoporosis

In this article, ideas for the enrichment of the educational contents of the Chemistry Biology and Physical education high school curriculums with knowledge of the nature of the disease, as well as the factors for building a stable bone structure, are suggested.

Genetic predisposition for osteoporosis

To a large extent, the likelihood for the development of this disease is determined by the genetic predisposition to osteoporosis, which children inherit from their parents. Bone structure is highly dependent on the condition of the vitamin D receptors, oestrogen receptors and the various collagen receptors. It has been established that the presence of fractures in mothers and sisters increases the risk of osteoporosis fractures on average by 2.02 times [16].

Healthy lifestyle suppresses genetic predisposition

Bone mass grows during puberty until age 16-18 in women and 18-20 in men. Bone density slowly continues to grow until age 30. That is when peak bone mass or PBM is reached – the maximum bone density reached at the end of the skeletal maturation. This is followed by a period of maintaining of the level reached until age 35-40, after which the processes of bone decomposition become dominant, leading to a loss of bone mass. The level of PBM is the most important factor for determining the risk of osteoporosis during later stages of life. It has been established that the increase of PBM by 10% lowers the risk of hip fractures later in life by 30%. The accumulated bone tissue during ages 11-13 in girls is almost equal to the bone loss over 30 years after reaching menopause [17].

Physical activity and the role of exercises

Childhood and adolescence are a particularly important period for the accumulation of bone mass through exercises. It has been established that young kids participating in energetic physical activity for 1h a day have significantly healthier bones than their less-active peers.

Bones as a live tissue react to exercises. Two types of exercises are important for the formation and maintaining of bone mass and density:

1. Strength exercises with light and medium weights, during which the resistance of the musculoskeletal system to the gravitational forces improves muscle mass and strengthens the bones.
2. Proprioceptive exercises for the improvement of gait, balance, and coordination of movements through neuromuscular matching. They enhance the inner sense of the location of individual parts of the body, as well as the force applied to them to set them in motion. They are appropriate for fall-prone individuals.

Harmful habits

Results from “Global study of tobacco smoking among young people – Bulgaria, 2002”, carried out among 2164 students (1020 boys and 1147 girls) ages 13-16 points to 69.1% of the surveyed individuals having attempted smoking, the majority before age 10.

The harmful habits of tobacco smoking and alcohol use since childhood and adolescence are a serious risk factor for suboptimal peak bone mass and osteoporosis later in life.

Inorganic ions and vitamins

The levels of vitamins and biogenic elements, enzyme cofactors in the calcium-phosphorus exchange are also important for good bone structure. Studies confirm changes in their serum concentrations with the development of the disease [18]. As a result of human metabolism, the body loses these essential elements. A deficit is a prerequisite for deterioration of bone metabolism. In order for maintaining them in referential levels, biogenic elements need to be imported daily with food in a certain amount.

Calcium

Calcium is a major macronutrient in the body of an adult, 99% of it being a building element for bones and teeth, and 1% is found in other cells and extracellular fluid. It is found in two forms within the body – ionized and bound. The two fractions are in a fragile balance, dependent on blood pH. Ionised calcium is a more informative parameter for the physiological calcium activity and the degree of osteoporosis. During acidosis, the degree of dissociation and the proportion of ionized calcium increases, and decreases during alkalosis.

In blood plasma, approximately 50% of the total calcium content is ionised, 40% is bound to proteins, and only about 10% is included in the composition of inorganic complexes. The balance of this microelement in the body depends on its resorption in the intestines, the blood-bone exchange, and its excretion in urine. Normally, 2.5 to 4.36 mmol / L are excreted in the urine. The content of calcium in the blood is controlled by parathyroid hormone, the hormone calcitonin and the active form of vitamin D, calcitriol. When serum calcium is low, the parathyroid glands secrete parathyroid hormone, which corrects the level by extracting calcium from the bones. The hormone calcitonin secreted by parafollicular cells (C-cells) of the thyroid gland and calcitriol have the opposite effect to that of the parathyroid hormone: they reduce serum calcium by injecting it into the bones. In this manner, these hormones regulate the metabolism of calcium and phosphorus and determine the levels of calcium in the bones. In hyperparathyroidism, most often from an adenoma of the parathyroid gland and in bone metastases, bone resorption is achieved - the breakdown of bone tissue by osteoclasts. The calcium released from the bone tissue passes into the blood - a state of hypercalcemia. Bones become vulnerable to fractures, kidney stone disease may develop from the accumulation of calcium in the kidneys [18].

The recommended daily intake of Ca varies with age from 800 mg / day to 1300 mg / day. It is highest in the increased period of bone mass accumulation in students from 9 to 18 years of age. Adequate calcium intake during childhood and adolescence is necessary to ensure maximum PBM at this age. Inadequate intake leads to a risk of impaired bone development.

The recommended daily intake of Ca is also high over the age of 50, 1200 mg / day, in order to reduce the rate of bone resorption and the risk of osteoporosis [19].

Magnesium

Magnesium is an intracellular cation. About 2/3 of it is in the bones and the other 1/3 is in the muscles and soft tissues. Only 1% of magnesium is found in the blood. In the body of an adult, about 70% of magnesium ions are in the free state, and 30% are associated with proteins (mainly albumin), phosphates and other compounds. It enters the body via food, is filtered through the glomeruli (arterial capillaries of the kidneys), is normally significantly absorbed in the proximal tubule and is almost completely excreted by the kidneys. This process, as well as the absorption of calcium ions, is regulated by parathyroid hormone.

Magnesium ions are cofactors of many enzyme systems and are important for the normal course of catabolic processes. Magnesium is associated with the density and structure of bone tissue due to its participation in the secretion of parathyroid hormone, i.e. in the metabolism of calcium and phosphorus. A deficiency leads to a change in the metabolism of calcium and phosphorus, which is associated with bone disorders. On the other hand, an abnormal increase in blood serum is indicative of acute and chronic liver disease [20]. The recommended daily intake of magnesium is 310 mg / day for under-19s and 320 mg / day for older adults [19].

Phosphorus

88% of the phosphorus contained in the body is localized in the bones in the form of calcium phosphate. In the blood, phosphorus is in the form of soluble phosphates and phosphoric acid, associated with organic compounds.

The ratio of phosphorus to calcium is approximately 6:10. Increased concentration of phosphorus leads to a decrease in the concentration of calcium. This mechanism of interaction is due to the influence of parahormone and vitamin D. Hypophosphatemia occurs in rickets and hyperparathyroidism.

The recommended daily intake of phosphorus for men, women and pregnant women is 700 mg / day. Eating a variety of legumes, nuts, whole grains and vegetables helps to meet daily phosphorus needs [19].

Zinc

Zinc is an important factor for bone health. It is a cofactor of a number of enzymes involved in bone metabolism and collagen degradation. 29% of the zinc content in the body is found in the bone matrix.

Studies in patients with reduced bone density show deviations in plasma zinc concentrations compared to controls [18]. This is a reason to recommend its addition to the diet of patients with low bone density [21, 22]. Daily intake of zinc is mandatory because there is no mechanism for its accumulation in the body [23]. The recommended daily intake of zinc is: for 4 - 8 years of age 5 mg / day; for 9 - 13 years of age 8 mg / day; for 14 - 18 years of age is 11 mg / day for men and 9 mg / day for women; over 18 years of age is 11 mg / day for men and 8 mg / day for women [19].

The main food sources of zinc are animal products, the richest being muscle meat, organ meat, and seafood. The zinc content of animal feed varies from 0.02 mg per 100 g of egg white, 1 mg per 100 g of white chicken to 75 mg per 100 g of Atlantic oysters.

Iron

Disorders of iron metabolism are associated with bone marrow diseases.

Food-grade iron is absorbed in the duodenum and small intestine as Fe^{2+} . About 1 mg of iron is ingested per day. In the intestinal mucosa, Fe^{2+} binds to transport substances, oxidizes to Fe^{3+} and thus binds to transferrin in the blood.

The recommended daily intake of iron is 15 mg / day for 14-18 year-olds, 18 mg / day up to 50 years old, and in older age - 8 mg / day [24].

The iron found in meat and fish is highly digestible – it is absorbed two or three times more intensively than iron found in products of plant origin. Animal- and seafood-derived Fe is not only better absorbed, but also contributes to the absorption of plant Fe. Increased consumption of tea and coffee can reduce the absorption of iron - by 60% and 50% respectively. The tannins in these drinks bind iron in difficult-to-digest compounds [19].

Copper

Copper is an essential trace element and a cofactor in a number of enzyme systems, including bones. It participates in the synthesis of collagen - a component of connective tissue. Cuproenzymes in the body act as antioxidants and protect cells from free radical damage.

Copper deficiency is rare due to its content in foods of plant origin, due to the treatment of agricultural land with copper preparations. Despite the high prevalence of the element, studies in patients with reduced bone density showed an increase in plasma copper concentrations compared to controls [18].

Optimal dietary ratios

Establishing the optimal dietary ratios of trace elements and vitamins in food, as well as their proper application, is crucial for the prevention and treatment of osteoporosis. For example, it is believed that the lack of magnesium for bone mineralization may be among the most important factors affecting the progression of this disease. However, the excessive intake of magnesium supplements can undoubtedly lead to diarrhea, neurological and cardiac toxicity [22, 24]. The recommended weight ratio of Ca:Mg is 4:1 or lower. Excessive intake of calcium and phosphorus impairs the adsorption of zinc by the mechanism of competition of divalent ions for the tubules of cell membranes at a weight ratio of Ca:Zn = 20:1.

The reference values of the listed essential elements in blood serum approved in a clinical laboratory are found in the table below [19]:

Ca	2,12÷2,62 $\mu\text{mol/l}$
Ca ²⁺	1,1÷1,3 $\mu\text{mol/l}$
Mg	0,7÷1,2 $\mu\text{mol/l}$
Mg ²⁺	0,33÷0,57 $\mu\text{mol/l}$
P	0,84÷1,45 $\mu\text{mol/l}$
Fe(ферозин), жени	10,7÷23,4 $\mu\text{mol/l}$
Cu, жени	13,2÷24,3 $\mu\text{mol/l}$
Zn	12÷2,4 $\mu\text{mol/l}$

Maintaining optimal element status is a factor in maintaining bone homeostasis enzymes.

Oxidative stress, antioxidants and osteoporosis

An impaired element status leads to oxidative stress in the body, which further disrupts calcium-phosphorus metabolism.

Oxidative stress is a condition in which the amount of active species of oxygen (radicals and volatile molecules that release radicals) is greater than that of antioxidants. Its level is determined by the ratio between the levels of active oxygen species and antioxidants. Oxidative stress is the cause of aging and the pathogenesis of many diseases, including osteoporosis.

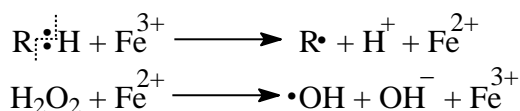
Free radicals are independently-existing particles (atoms, ions, molecules or parts of molecules) that have one or more unpaired electrons [25]. They are highly reactive and, when they meet the molecules in the cells, they tear off particles with a single electron, with which they pair. Another free radical is formed, which attacks and destroys another cell, and creates another radical. This chain of radical reactions breaks when two radicals meet and bind into a molecule.

Sources of free radicals in the body [25]:

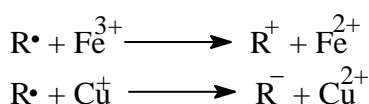
- endogenous - from cellular metabolism and physiological and pathophysiological processes in the body: in auto-oxidation, infections, oxidative enzymes, reduced metabolism; from the respiratory chain; from oxyhemoglobin.

- exogenous - from external physical or chemical effects such as radiation, ionizing radiation, UV light, ultrasound, high-intensity microwave energy, heat treatment of food, burns, mechanical effects and injuries, high oxygen partial pressure, active chemical components of the atmosphere (ozone), industrial pollutants, chemicals used in agriculture (herbicides), air pollution (nitrogen oxide, sulfur dioxide), drugs, heavy metal ions, cigarette smoke, alcohol, recreational drugs.

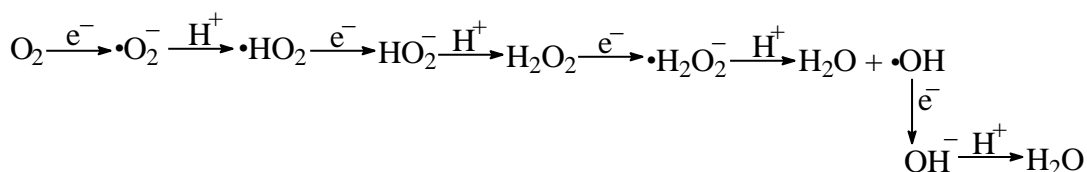
One of the ways of generation of free radicals in the body is single-electron transfer. One example of such occurrence of free radicals in the body is the process of changing the degree of oxidation of iron in living systems:



Free radicals in the body can be oxidized to cations or reduced to anions by metal ions with variable valence of Cu, Cr, Mn, Fe, which are cofactors of various enzymes:



The absorption of oxygen in the body produces various O-containing radicals and the complete absorption of O₂ is associated with a fourfold course of single-electron and single-proton transfers, H⁺:



Reactive oxygen species (ROS) [26]

ROS are highly reactive radical and non-radical oxygen species that can further interact with other molecules and generate more aggressive ROS. Examples are the following:

3O₂ triple oxygen, commonly referred to as O₂

1O₂ singlet oxygen

•O₂ superoxide radical (radical-anion)

•OH hydroxyl radical

H₂O₂ hydrogen peroxide (not radical)

•O₂H hydroperoxyl radical

ROO• organic peroxide radicals

ROOH hydroperoxide

ROS also includes active non-radicals such as hypochlorous acid, HOCl and ozone O₃. Most of the reactive forms of oxygen are formed homogeneously and continuously as intermediates of cellular metabolism, are involved in the chain and autocatalytic processes of oxidation of alcohols, acids, fats and others. Therefore, the formation and action of free radicals in the individual is a natural process.

Antioxidants

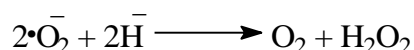
Antioxidants "capture" a free radical and transport it to an enzyme that combines two free radicals together and neutralizes them. Antioxidant levels and activity can be crucial in protecting the body from oxidative damage [27].

Natural antioxidants are thiol and non-thiol compounds (such as polyphenols), found mainly in various plants.

They can be endogenous and exogenous.

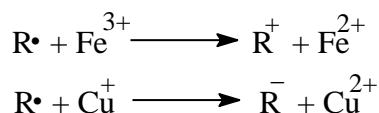
Exogenous antioxidants in blood plasma are uric acid, the tripeptide glutathione (GSH), vitamin C (ascorbic acid), vitamin A, α -tocopherol and others [26].

Endogenous antioxidants are the enzymes superoxide dismutase, SOD and catalase. Their substrates are the superoxide radical and hydrogen peroxide [28, 29, 30]. For example, these metalloenzymes catalyze the dismutation of two superoxide radicals to O_2 and H_2O_2 :



The level and activity of these antioxidant enzymes on the levels of oxidative stress in disease states is determined by the serum and plasma concentrations of the essential trace elements [31].

Metal cations with variable valence of Fe, Cu, Zn and Mn are antioxidants because they oxidize free radicals to cations or reduce them to anions [32, 33]:



Metals can also act as antioxidants by inhibiting enzyme systems [32, 34].

In scientific observations, the influence of the levels of trace elements is reported only in pathological cases, as in healthy individuals the changes in the microelement concentrations are insignificant [31].

Oxidative stress causes an imbalance between osteoclasts and osteoblasts and bone remodeling with low skeletal bone mass.

A useful strategy against osteoporosis is to increase the antioxidant capacity of plasma by introducing antioxidants with food that inhibit osteoclast activity. Effective physiological antioxidants for the prevention and treatment of osteoporosis are vitamin E, vitamin C, β -carotene in higher doses. Vitamin A and some flavonoids are also used as pharmacological antioxidants.

In 2015, the antioxidant role of adding vitamins D3, K1 and B6 in the diet of postmenopausal women was confirmed. [26]. After one year of taking the supplements, a decrease in the biomarkers of oxidative stress and a significant increase in bone density were reported.

Consumption of foods rich in antioxidants and appropriate nutrients is a useful strategy in the prevention of osteoporosis. Implementing healthy eating habits at a young age is a task for high school education.

CONCLUSION

Osteoporosis is a socially significant disease with serious psychological and economic consequences for the affected individuals, their families, and society at large. It is epidemiological in nature [35] and the factors for its formation begin in adolescence. It is

associated with metabolic disorders of bone homeostasis. Regulating this process requires balanced levels of nutrients and vitamins, which provide the body with the ability to cope with oxidative stress.

Prevention of osteoporosis should begin in childhood, because acquiring bone mass during stages of growth is a determining factor for the development of osteoporosis at a later age. The greater the peak bone mass reached in adulthood, the lower the loss of bone density in the period of hormonal deficiency will be. Therefore, the foundations of prevention must be laid in childhood and it should continue to be carried out throughout life.

Funding and implementing prevention programs targeted at the young demographic is an investment for the future and would reduce economic losses due to disability resulting from osteoporosis.

The state institutions and the educational system for the formation and development of the individual's competencies for a healthy lifestyle have an important role in this process. Knowledge of risk factors and negative consequences are key to achieving satisfactory health status and should find a place in the curricula of chemistry, biology, physical education and sports.

The proposed information can be used selectively depending on the abilities of the students. In this form it provides an opportunity to realize interdisciplinary links and to reveal the causal link between lifestyle during school years and the state of the skeletal system in the later stages of life.

BIBLIOGRAPHY

1. Reginster, J.Y. & Burlet, N. Osteoporosis: A still increasing prevalence, *Bone*, 38 (2), 4–9, 2006.
2. Петранова Ц., Шейтанов Й., Шейтанов И. *Остеопороза*. Изд. Къща Шено, Варна, 2016.
3. Borissova AM., Rashkov R, Shinkov A, Boyanov M., Popivanov P., Temelkova N., Vlahov J., Gavrilova M. Femoral neck bone mineral density and 10-year absolute fracture risk in a national representative sample of Bulgarian women aged 50 years and older. *Archives Osteoporos*, 6, 189-95, 2011.
4. Несторова Р., Петранова Ц., Коларов З., Рашков Р., Стоилов Р., Монов М., Шейтанов И., Petranova Tz., Kolarov Z, Rashkov R, Stoilov R, Monov M, Sheytanov I, Rusimov V. Да обърнем внимание на остеопорозата при мъжете. *GP News*. Vol.11, 43-50, 2014.
5. Национална програма за превенция на остеопорозата в България 2006 – 2010 г.
6. Ангелов П., В. Ишев, П. Попов. *Биология и здравно образование, 9. клас*. Просвета, С., 2001.
7. Димитров, О., М. Кожухарова, Т. Аргирова, В. Богоев, И. Минков, Г. Кименов, М. Славова. *Биология и здравно образование, 9. клас*. Булвест 2000, С., 2008.
8. Димитров, О., М. Кожухарова, Т. Аргирова, В. Богоев, И. Минков, Г. Кименов, М. Славова. *Биология и здравно образование, профилирана подготовка, 9. клас*. Булвест 2000, С., 2001.
9. Павлова, М., Е. Бояджиева, В. Иванова, М. Кирова, Н. Микова. *Химия и опазване на околната среда, 9. клас*. Педагог 6, С., 2002.
10. Ангелов П., В. Ишев, П. Попов. *Биология и здравно образование, 9. клас*. Просвета, С., 2001.

11. Димитров, О., М. Кожухарова, Т. Аргирова, В. Богоев, И. Минков, Г. Кименов, М. Славова. *Биология и здравно образование, 9. клас*. Булвест 2000, С., 2008.
12. Димитров, О., М. Кожухарова, Т. Аргирова, В. Богоев, И. Минков, Г. Кименов, М. Славова. *Биология и здравно образование, профилирана подготовка, 9. клас*. Булвест 2000, С., 2001.
13. Павлова, М., Е. Бояджиева, В. Иванова, М. Кирова, Н. Микова. *Химия и опазване на околната среда, 9. клас*. Педагог 6, С., 2002.
14. Шишньова, М., Р. Димков, М. Оджакова, М. Враджалиява, Л. Банчева. *Биология и здравно образование за 9. клас, профилирана подготовка*. Анубис, С., 2002.
15. Bliznakov, G., L. Boyanova, A. Sokolova, P. Ribarska. *Chemistry and Environmental Protection 9.grade*. Anubis, S., 2002.
16. Боянов М. *Клинична ренгенова денситометрия и количествен ултразвук на костите*. Централна медицинска библиотека, МУ-София, 2006, 25-38.
17. Shea, B., Bonaiuti, D., Iovine, R., Negrini, S., Robinson, V., Kemper, H. C., Wells, G., Tugwell, P., Cranney, A. Cochrane review on exercise for preventing and treating osteoporosis in postmenopausal women. *Europa Medicophysica*, 40(3), 199-209, 2004.
18. Томова, Р., Асенова, С., Атанасова, В., Тzoneva, К., Slavova, М. ВСС 52, 3, 76-80, 2020.
19. Томова Р., Цачев К., Боянова Л. Биогенни елементи: Биологични функции, причини за дефицит и хранителни източници. *Chemistry*, 19 (3), 2010.
20. Шишков Т., Кръстев З. *Лабораторните резултати в диагностичния процес*. Издателство Медицина и физкултура, София, 1987 г.
21. Sadeghi, N., Mohammad, R.O., Behrooz, J., Mannan, H., Masoomeh, B., Abdolazim, B., Fatemeh, S., Sahereh, S. The relationship between bone health and plasma zinc, copper lead and cadmium concentration in osteoporotic women. *Journal of Environmental Health Science & Engeneering*, 12, 125-133, 2014.
22. Mahdavi-Roshan, M., Ebrahimi, M.&Ebrahimi, A. Copper, magnesium, zinc and calcium status in osteopenic and osteoporotic post-menopausal women. *Clinical Cases in Mineral and Bone Metabolism*, 12(1), 18-21, 2015.
23. King, J.C., Cousins, R.J. Zinc. In.: Shils, M.E., Shike, M., Ross, A.C., Caballero, B., Cousins, R.J. (Eds.). *Modern Nutrition in Health and Disease*. Lippincott Williams & Wilkins, Baltimore, 2005.
24. Miret, S., Simpson, R.J. & McKie, A.T. Physiology and Molecular Biology of Dietary Iron Absorption. *Annual Rev. Nutrition*, 23, 283-301, 2003.
25. Цветков Н., П. Бочев. *Свободно-радикални увреждания и перспективи на антиоксидантната терапия и лечение*. Изд. ВМИ-Плевен, 1995.
26. Mazzanti, L., Battino, M., Nanetti, L., Raffaelli, F., Alidori, A., Sforza, G., Carle, F., Quagliarini, V., Cester, N., Vignini, A. Effect of 1-year dietary supplementation with vitaminized olive oil on markers of bone turnover and oxidative stress in healthy post-menopausal women. *Endocrine*, 50(2), 326-334, 2015.
27. Bouayed, J., Bohn, T. Exogenous antioxidants—double-edged swords in cellular redox state: health beneficial effects at physiologic doses versus deleterious effects at high doses *Oxid. Med. Cell Long*, 3, 228-237, 2010.

28. Nelson, S.K, Bose, S.K., Grunwald, G.K., Myhill, P., McCord, J.M. The induction of human superoxide dismutase and catalase in vivo: a fundamentally new approach to antioxidant therapy *Free Rad. Biol. Med.*, 40, 341-347, 2006.
29. Zanini D., Schmatz, R., Pelinson, L.P., Pimentel, V.C., Da Costa, P., Cardoso, A.M., & Oliveira, L. Ectoenzymes and cholinesterase activity and biomarkers of oxidative stress in patients with lung cancer. *Mol. Cell. Biochem.*, 374, 137-148, 2013.
30. Kodydkova, J., Vavrova, L., Stankova, B., Macasek, J., Krechler, T. & Zak, A. (2013). Antioxidant status and oxidative stress markers in pancreatic cancer and chronic pancreatitis. *Pancreas*, 42, 614-621.
31. Zabłocka-Słowińska, K., Płaczkowska, S., Prescha, A., Pawelczyk, K., Porebska, I., Kosacka M., Pawlic-Sobecka, L. & Grajeta, H. Serum and whole blood Zn, Cu and Mn profiles and their relation to redox status in lung cancer patients. *J. Trace Elem. Med. Biol.*, 45, 78-84, 2018.
32. Aguirre, J.D., Culotta, V.C. Battles with iron: manganese in oxidative stress protection. *J. Biol. Chem.*, 287, 13541-13548, 2012.
33. Theophanides, T., Anastassopoulou, J. Anastassopoulou, copper and carcinogenesis. *Rev. Oncol/Hematol.*, 42, 57-64, 2002.
34. Prasad, A.S. (2016). Zinc: an antioxidant and anti-inflammatory agent: role of zinc in degenerative disorders of aging. *J. Trace Elem. Med. Biol.*, 28, 2014, 364-371, 1995.
35. Abrahamsen, B., van Staa, T., Ariely, R., Olson, M., Cooper C. Excess mortality following hip fractures: a systematic epidemiological review. *Osteoporosis International*, 20 (10), 1633-1650, 2009.

EFFECT OF SUPPLEMENTING PROTEASE ENZYME TO JAPANESE QUAIL (*Coturnix coturnix japonica*) DIETS ON GROWTH PERFORMANCE AND CARCASS TRAITS

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ABSTRACT

The effect of protease enzyme supplementation in the diet of Japanese quails were determined on the growth performance and carcass traits from 1-35 days of age. In a completely randomized design involving three replicate pens of 36 a day-old quails assigned to each of four treatments. The treatment diets were: (1) Control (Con) contained a basal diet without additive; (2) P120 contained the basal diet plus 120mg protease/kg of feed; (3) P125 contained the basal diet plus 125mg protease/kg of feed; and (4) P150 contained the basal diet plus 150mg protease/kg of feed. There was a slightly increasing trend in body weight (BW) and body weight gain with supplementation of 125 and 150 mg protease in the diet during the growing period ($p>0.05$). Moreover, the feed conversion ratio (FCR) of the protease supplementation groups were more efficient ($p<0.05$) throughout the 22-35 days of experimental period. The P125 treatment increased carcass weight, thigh meat weight, thigh meat yield and gizzard significantly ($P<0.05$) compared with the control group at 35 days of age. It is possible suggested that supplementation of 125mg protease/kg feed to improve the growth performance and carcass traits of Japanese quails.

Keywords: Protease enzyme, production performance, carcass traits

1. INTRODUCTION

The goal of poultry industry has been to obtain faster their growth in minimal time (Longo et al., 2007). Therefore, optimising poultry performance is one of the major challenges encountered by poultry producers and nutritionists (Sandercock et al. 2001; de Souza et al. 2016). In order to attain optimum animal performance, diets should be supplemented with proteins to ensure both an adequate level of total proteins and an optimum ratio of amino acids for the development stages of the birds (Dosković et al. 2013). However, Nir et al. (1993) cited that birds are known to produce proteolytic enzymes that are important for protein utilization, a substantial amount of dietary protein has been observed to pass the gastro-intestinal tract without being completely digested (Wang and Parsons 1998; Lemme et al. 2004). Moreover, soybean is one of the vegetable protein sources used during feed formulations by feed manufacturing industries because of its high protein content and a relatively well-balanced amino acid profile (Cromwell et al. 1999). But researchers have proved that soybean meal diet contains numerous anti-nutritional factors, such as protease inhibitors and lectins, and it has been proved that the addition of exogenous enzymes in corn and soybean meal is justified and feasible (Yang et al., 2010). Thus, feed additives as enzymes has been adding in the poultry diet to break down the anti-nutritional compounds in feed and then increase nutrient digestibility (Bedford and Partridge. 2001). The use of exogenous enzyme blends such as carbohydrases, phytase, and protease is well-established and widely accepted to improve digestibility of nutrient elements (Cowieson and Ravindran, 2008; Mahmood et al. 2017). Protease can improve protein hydrolysis in the presence of anti-nutritional factors such as lectins or trypsin inhibitors (Huo et al., 1993; Ghazi et al., 2002) and protease supplementation may improve crude protein and energy digestibility (Angel et al. 2011; Fru-Nji et al. 2011).

Quails were first imported to Vietnam in 1997 and widespread-reared under high-input, intensive production systems due to their superior qualities over other poultry birds such as faster growth rates, early sexual maturity, short generation intervals and low space requirements (Puspamitra et al. 2014; Mnisi et al. 2017). Many the inclusion of exogenous intestinal proteases to improve protein utilization have also been proposed on chicken and duck and only fewer studies is still under investigation for widespread application in laying and adult quail diets use of single proteases. This study investigated the effects of adding protease enzymes on growth performance and carcass traits on Japanese quails from 1-35 days old.

2. MATERIALS AND METHODS

2.1. Animals and management

The experiment was conducted at the experimental farm located on Thuan An, Binh Minh, Vinh Long province, Vietnam. The Japanese quails started at 1 day old and ended at 35 days old were used in this experiment, all quails were similar body weight and raised in the opened house system and were vaccinated all common diseases followed the vaccination procedure guide. The poultry house was oriented east to north and the dimensions of each cage were 100x50x40cm. At a day of age, the quails were randomly allocated to the treatments with three replicates of 36 quails per treatment. During the experimental period, Japanese quail chicks were fed ad-libitum during the growing period and water was available for free access.

Enzyme protease product (commercial named Jefe Protease®), a dried fine powder, was purchased from Jefe Company, Canada. The commercial feeds contained mainly corn, soybean meal, fish meal were formulated into two continuous phase feedings of 1-14 and 15-35 days of age to match the bird nutrient requirements. The CP diets contained 23, and 20% corresponding to ME 2,850 and 2,750 kcal/kg of each stage, respectively.

2.2. Experimental design and data collection

A total of 432 Japanese quails to randomly allocate into 4 dietary treatments and three replicates with 36 quails per each. The control fed only a basic diet and other different levels of protease (120, 125, and 150 mg/kg feed) named P120, P125 and P150, respectively.

The body weight of birds were recorded at 1, 21 and 35 days old. Feed offered and feed refused were weighed daily for calculation of feed intake and feed conversion ratio. The growth performance parameters such as body weight gain, feed intake and feed conversion ratio were determined according to the procedures of McDonald et al. (2011).

At the 35 days of age, a total of 10 birds x 4 treatments was randomly selected and transported from farm to the lab of Cantho university, Cantho City, Vietnam. Quails were given a short rest before slaughtering to minimize stress. Before bleeding, birds were weighed to record their live weight. After that, birds were scalded at 54°C, defeathered and manually eviscerated. Carcass traits were evaluated. After defeathering, eviscerating and removal of the head and paws, carcass weight was determined. The breast and thigh muscles, liver, heart and gizzard of each birds were dissected and weighed. Dressing corresponded to the ratio between dressed weight (DW) and live weight at slaughter (LW), and was calculated according to the following formula: Dressing (%) = DW/LW*100. Parts yield (breast, thigh, liver, heart and gizzard) was calculated as the ratio between the part weight and carcass weight, according to the formula: Part yield (%) = PY/ DW*100 (PY is the representative value of each part).

2.3. Statistical analysis

All recorded data were analyzed by using the GLM procedure of Minitab version 16.0, the Tukey test was used to compare mean differences among treatments at $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Growth performance of Japanese quail chicks

Results showed that dietary treatments did not significantly affect body weight, body weight gain, feed intake and feed conversion ratio of birds ($P > 0.05$). However, the feed conversion ratio was significant difference among treatments at 22-35 days old of quails, highest on control and lowest on P125 ($P < 0.05$). This improved growth performance of quail chicks, observed in the present study, due to dietary enzyme supplementation is mainly attributable to the increased nutrient digestibility of the feedstuff. In fact that protease has proteolytic activity on the dietary plant protein components (corn and soyabean meal) and thus increasing the digestibility of protein and availability of amino acids required for protein biosynthesis and other metabolic demands. Such protein sources are known to contain some antinutritional compounds (such as protease inhibitors and lectins) which have a depressive effect on protein digestion and utilization (Thorpe and Beal, 2001). Inclusion of the protease in quail diets did not improve in terms of body weight, weight gain and feed intake in compared with the control. These findings were in line with those of Chimote et al. (2009) investigated the effect of dietary enzyme supplementation on growth performance of Japanese quail feed conversion efficiency of quail but feed intake was not affected and Marsman et al. (1997) who observed no effect on weight gain and feed conversion ratio of chicks fed exogenous protease-treated soy-based diets.

Table 1. Growth performance of the Japanese quails 1-35 days old

Variables (g/bird)	Dietary Treatments				SEM	P
	Contro 1	P12 0	P125 6	P150 8		
Body weight 1days, g	7.53	7.62	7.60	7.89	0.103	NS
Body weight 21days, g	104.68	98.2	102.6	102.6	3.418	NS
Body weight 35days, g	148.7	158.4	162.5	158.8	6.305	NS
Body weight gain 1-21days, g	97.15	90.59	95.00	94.77	3.399	NS
Body weight gain 22-35days, g	44.04	60.14	59.93	56.09	5.169	NS
Body weight gain 1-35days, g	141.2	150.7	154.9	154.8	6.145	NS
Feed intake 1-21days, g/day	9.12	8.58	8.60	8.72	0.215	NS
Feed intake 22-35days, g/day	15.15	14.18	13.15	14.22	0.896	NS
Feed intake 1-35days, g/day	11.98	11.27	10.44	10.96	0.678	NS

Feed conversion ratio 1-21days	1.98	1.99	1.90	1.93	0.108	NS
Feed conversion ratio 22-35days	4.81 ^a	3.44 ^a _b	3.07 ^b	3.59 ^{ab}	0.348	0.035
Feed conversion ratio 1-35days	2.96	2.64	2.36	2.48	0.171	NS

a,b mean on the same row with different superscripts are significantly difference at $P < 0.05$

3.2 Carcass traits of the Japanese quails

The effects of dietary supplementation of protease on carcass traits of Japanese quails are shown in Table 2. There were significantly different among treatments on live weight, dressed weight, thigh weight, thigh weight percentage and gizzard, highest values on P125 and P150 and lowest on control. In disagreement to the present results, Khan et al. (2006) indicated that dietary enzyme supplementation to broiler chicks improved dressing percentage but reduced the relative weights of gizzard. However, Chimote et al. (2009) reported that dietary enzyme supplementation had a positive effect on carcass traits of Japanese quail.

Table 2. Carcass traits of the Japanese quails at 35 days old

Variables	Dietary Treatments				SEM	P
	Contro l	P120	P125	P150		
Live weight, g	136.50 ^b	148.00 ^a _b	156.2 ⁰ _a	150.4 ⁰ _{ab}	3.725	0.006
Dressed weight, g	81.64 ^b	83.23 ^{ab}	94.64 ^a	89.21 ^a _b	3.108	0.021
Dressing, %	59.54	56.43	60.62	59.35	1.576	NS
Breast meat, g	25.59	27.08	29.91	28.11	1.259	NS
Breast meat, %	31.15	32.64	31.64	31.60	1.065	NS
Thigh meat, g	13.01 ^b	14.69 ^{ab}	16.87 ^a	16.87 ^a	0.596	0.000
Thigh meat, %	15.97 ^b	17.81 ^{ab}	17.84 ^a _b	18.96 ^a	0.589	0.010
Heart, g	1.02	0.96	1.18	0.96	0.069	NS
Heart, g	1.24	1.17	1.26	1.07	0.068	NS
Gizzard, g	2.91 ^{ab}	2.66 ^b	3.25 ^a	3.39 ^{ab}	0.187	0.038
Gizzard, %	3.64	3.30	3.44	3.78	0.246	NS
Liver, g	2.92	2.66	2.92	2.83	0.131	NS
Liver, %	3.63	3.24	3.09	3.17	0.156	NS

a,b mean on the same row with different superscripts are significantly difference at $P < 0.05$

4. CONCLUSION

Dietary supplementation of 125mg protease/kg feed may improve the growth performance and carcass traits of the Japanese quails.

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REFERENCES

1. Angel, C., Saylor, W., Vieira, S., Ward, N. (2011). Effects of a monocomponent protease on performance and protein utilization in 7- to 22-day-old broiler chickens. *Poult Sci.* 90:2281–2286.
2. Bedford, M.R. and Partridge G.G. (2001). *Enzymes in Farm Animal Nutrition*. CAB International Publishing, Wiltshire, UK., ISBN-13: 9780851993935, Pages: 406.
3. Chimote, M.J., Barmase B.S., Raut A.S., Dhok A.P. and Kuralkar S.V. (2009). Effect of supplementation of probiotic and enzymes on performance of Japanese quails. *Vet. World*, 2: 219-220.
4. Cowieson, A.J. and Ravindran, V. (2008). Effect of exogenous enzymes in maize-based diets varying in nutrient density for young broilers: growth performance and digestibility of energy, minerals and amino acids. *Br Poult Sci.*; 49(1):37-44.
5. Cromwell, G.L., Calvert, C.C., Cline, T.R., Crenshaw, J.D., Crenshaw, T.D., Easter, R.A., Ewan, R.C., Hamilton, C.R., Hill, G.M., and Lewis, A.J. (1999). Variability among sources and laboratories in nutrient analyses of corn and soybean meal. NCR-42 Committee on Swine Nutrition. North Central Regional-42.. *J Anim Sci.* 77:3262–3273. doi: 10.2527/1999.77123262x
6. de Souza, L.F.A., Espinha, L.P., de Almeida, E.A., Lunedo, R., Furlan, R.L., and Macari, M. (2016). How heat stress (continuous or cyclical) interferes with nutrient digestibility, energy and nitrogen balances and performance in broilers. *Livest Sci.* 192:39–43.
7. Fru-Nji, F., Klunter, A.M., Fischer, M., and Pontoppidan, K. (2011). A feed serine protease improves broiler performance and increases protein and energy digestibility. *J Poult Sci.* 48:239–246.
8. Ghazi, S., Rooke, J.A., Galbraith, H. and Bedford, M.R. (2002). The potential for the improvement of the nutritive value of soya-beanmeal by different proteases in broiler chicks and broiler cockerels. *British Poultry Science* 43: 70-77.
9. Huo, G.C., Fowler, V.R., Inbarr, J. and Bedford, M.R. (1993). The use of enzymes to denature antinutritive factors in soybean. *Proceedings of the Second International Workshop on Antinutritional Factors in Legume Seed*, Wageningen, Netherlands, pp. 60.
10. Khan, S.H., Sardar R. and Siddique B. (2006). Influence of enzymes on performance of broilers fed sunflower-corn based diets. *Pak. Vet. J.*, 26: 109-114.
11. Lemme, A., Ravindran, V., and Bryden, W.L. (2004). Ileal digestibility of amino acids in feed ingredients for broilers. *World Poult Sci J.* 60:423–438. doi: 10.1079/WPS200426
12. Longo, F.A. Menten, J.F.M., Pedroso, A.A., Figueiredo, A.N., Racanicci, A.M.C. and Sorbara, J.O.B. (2007). Performance and Carcass Composition of Broilers Fed Different

- Carbohydrate and Protein Sources in the Prestarter Phase. *Journal of Applied Poultry Research* 16: 171-177.
13. Mahmood, T., Mirza, M., and Nawaz, H. (2017). Effect of supplementing exogenous protease in low protein poultry by-product meal based diets on growth performance and nutrient digestibility in broilers. *Anim Feed Sci Technol.*;228:23–31.
 14. Marsman, G.J., Gruppen, H., Van der Poel, A.F., Kwakkel, R.P., Verstegen, M.W., and Voragen, A.G. (1997). The effect of thermal processing and enzyme treatments of soybean meal on growth performance, ileal nutrient digestibilities, and chyme characteristics in broiler chicks. *Poult Sci.* 76:864–872. doi: 10.1093/ps/76.6.864
 15. McDonald, P., Greenhalgh, J.F.D., Morgan, C.A., Edwards, R.A., Sinclair, L.A. and Wilkinson, R.G. (2011). *Animal nutrition*. 7th Edi. Essex, UK: Pearson Education Limited.
 16. Mnisi, C.M., Matshogo, T.B., Van Niekerk, R.F., and Mlambo, V. (2017). Growth performance, haematological and serum biochemical parameters and meat quality characteristics of male Japanese quails fed a *Lippia javanica*-based diet. *S Afr J Anim Sci.* 47:661–671. doi: 10.4314/sajas.v47i5.9
 17. Nir, I., Nitsan, Z., and Mahagna, M. (1993). Comparative growth and development of the digestive organs and of some enzymes in broiler and egg type chicks after hatching. *Brit Poult Sci.* 34:523–532. doi: 10.1080/00071669308417607
 18. Puspamitra, S., Mohanty, P.K., and Mallik, B.K. (2014). Haematological analyses of Japanese quail (*Coturnix coturnix japonica*) at different stages of growth. *Int Res J Biol Sci.* 3:51–53.
 19. Sandercock, D.A., Hunter, R.R., Nute, G.R., Mitchell, M.A., and Hocking, P.M. (2001). Acute heat stress-induced alterations in blood acid-base status and skeletal muscle membrane integrity in broiler chickens at two ages: implications for meat quality. *Poult Sci.* 80:418–425.
 20. Thorpe, J. and J.D. Beal, (2001). Vegetable Protein Meal and the Effects of Enzymes. In: *Enzymes in Farm Animal Nutrition*, Bedford, M.R. and G.G. Partridge (Eds.). Chapter 6, CAB International Publishing, Wiltshire, UK., ISBN-13: 9780851993935, pp: 125-143.
 21. Wang, X., and Parsons, C.M. (1998). Effect of raw material source, processing systems, and processing temperatures on amino acid digestibility of meat and bone meals. *Poult Sci.* 77:834–841. doi: 10.1093/ps/77.6.834.

3D MESH MATCHING USING SURFACE DESCRIPTOR AND INTEGER LINEAR PROGRAMMING

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ABSTRACT

The widespread of 3D shapes nowadays, gained it huge importance in several fields like computer vision, engineering, image processing, and many others. Its main challenge is the representation of these shapes and projecting them into canonical features referred to as descriptors. The necessity of them appears in different tasks like classification, retrieval, and matching, where they considered as the main step in what follows. Moreover, the matching problem is the core of all other tasks. This is why in this paper we propose a graph matching problem to find a one-to-one correspondence between models, it's obviously known as the NP-hard problem. So, a novel compact feature vector to represent our 3D models is extracted, combining several geometric representative curvatures, it's simple in complexity computational, yet powerful discriminating in the sense of affine transformations. The 3D surface is modeled as an undirected weighted graph, with the Gaussian kernel as a weight function. Integer Linear Programming is used in order to segment our meshes into regions, where we maximized the modularity between vertices, these regions are represented by a single

point each, named as key-points, interest points. This ends up for a graph matching problem between the models, treated as a combinatorial optimization problem. We tend to minimize the cost function between the graphs obtaining a one-to-one correspondence. Our experimental results on a wide variety of meshes demonstrate the feasibility of our proposed approach, the robustness of our method regarding affine transformations like rotation, scaling, translation...), as well as for different poses models, some quantitative results, and classification with retrieval objects are shown.

Keywords: 3D matching, feature descriptors, integer linear programming, graph-theory, clustering

1. INTRODUCTION

Matching and similarity between 3D shapes is a fundamental task whether for shape segmentation, classification, retrieval, and all of these with many others are important procedure in different areas like computer vision, biomedical modeling, mechanical engineering. At the same time, the widespread of 3D data brings the need to develop algorithms in order to match, classify as well recognizing it. Unlike images and range scans, 3D models do not depend on the configuration of cameras, light sources, or surrounding objects (e.g., mirrors). As a result, they do not contain reflections, shadows, occlusions, projections, or partial objects, which greatly simplifies finding matches between objects of the same type.

Descriptors whether local, or global ones, should capture most significant features of the shape in order to represent it in a well manner. Many approaches were proposed to capture the details of shapes, some lack the capacity in terms of huge memory required, others may be variant towards affine transformations, etc... And since this step is a crucial one for the dependence of other steps on it, in our work we proposed an efficient way to describe the 3D model, by modeling its surface as a weighted graph using the Gaussian function, followed by combining precise curvatures formulating compact feature vector. To follow on, we use Louvain clustering method implemented by [1] in order to segment our mesh into regions. These regions are set to be our subgraphs, and they are matched through linear sum assignment problem [13].

The rest of the paper is organized as follows. Section 2, shows some literature reviews on the recent work. Section 3, presents the full framework starting by the surface modeling, followed by regions segmentation ending this section by the 3D matching problem. In section 4, we shows our experimental results and the robustness of our proposition. The work is concluded in section 5.

2. RELATED WORKS

Shape descriptors obtained locally, on each vertex becomes an important step behind matching, retrieval, classification, segmentation of 3D models. Local shape descriptors speed up the process by lowering the objects into a little features that are responsible for matching. In [6] an overview shows how computing curvature plays a vital role in representing a shape. Similarly, many other papers deal with the importance of curvatures, authors in [15] works with curvature maps as a feature extraction for face recognition, as well showing the priority of using local feature on global ones. H'roua et. al in [7] present in their paper an overview of 3D object recognition, as well the representative states of the art methods. According to [10] shape descriptors must obey some requirements in order to classify this descriptor as a good descriptor, so researchers tend to ensure the quality of their descriptor depending on, not limited to, discriminating power regarding similarity measures, invariant under transformations,

compact in order to minimize the storage though optimality in search dimensionality, as well insensitive to noise and topological deformations.

New contributions on level of multi-scale descriptors are trending nowadays, where in this paper [2] they show how extracting features in multi-scale summarizes the shapes of differently sized neighborhoods. The descriptor considers a local neighborhood around a central point with a roughly circular area specified by radial distance. While authors in [4] define multi-scale descriptor map by merging single scale descriptor maps calculated with different Delaunay neighboring level. Our work which is nearly similar to this work, without a multi-scale level, where our descriptor maps at single level shows nearly familiar to the ground truth results.

The work in [4] tends to project height maps with patches in order to obtain Zernike moments on the corresponding images obtained, while in our approach, being concise towards the speed of getting our descriptor maps.

In the recent years, scientific researchers model the matching problem as a combinatorial optimization problem, and since graphs are the most appropriate data representation, the problems are treated as graph matching problem. Several approaches arise to solve the problem, algorithm to image segmentation using two different kinds of local neighborhoods in constructing the graph is done in [5], the algorithm uses a greedy approach and gives a well notable results. Establishing a meaningful correspondence between shapes is often difficult, in [16] authors shows a review on the available methods and algorithms detailed for the appropriate correspondence depending on applications. Sahillioğlu, Y. et. Al in their paper [14] propose a dense shape correspondence method which is computationally efficient. They minimize the isometric distortion directly in the 3D Euclidean space. A drawback for their work is the symmetry problem, which is inherent to all isometry-based correspondence algorithms. 3D shapes matching methods as Riemannian [17] or conformal [9] geometries have proposed to use a local optimization technique to minimize the non-convex energy. One way to solve the matching problem is to match maximum relational sub graph matching among the set of feature regions that represent an object as done in [4]. To overcome several issues arise from the previous we tend to propose a framework that extract simple, yet powerful, well representative shape descriptors, that are concise to store. Followed by segmenting the vertices into regions having nearly same geometrical descriptors, in order to perform subgraph matching.

3. PROPOSED FRAMEWORK

In our framework, we tend to find matching between 3D models. We start by modeling the surface of mesh as a weighted graph, where our main target is to match subgraphs obtained from the feature regions extracted depending on the descriptor map. Our descriptor map is defined by extracting several curvatures formulating a compact feature vector.

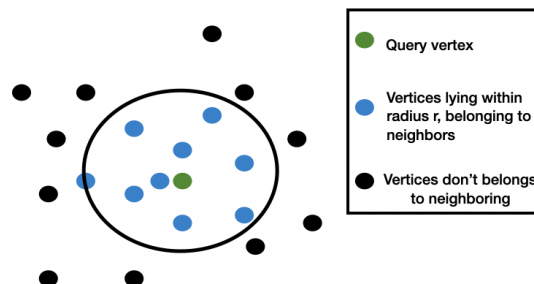


Figure 1: Neighboring Construction

3.1. Descriptor map estimation

We start by representing the 3D surface as a weighted graph $G=(\mathcal{V}, \mathcal{E}, \mathbf{w})$ where

\mathcal{V} is finite set of vertices, \mathcal{E} is finite set of edges $\mathcal{E} \subset \mathcal{V} \times \mathcal{V}$, and \mathbf{w} represents the weight function, it's a similarity measure between vertices. At the same time,

we tend to obtain the set of neighbors $\mathcal{N}(v_i)$, for a given vertex v_i where we find the neighbors within a given radius, even the vertices lying on the boundary are included. Figure 1 shows the neighborhood construction of a single vertex.

The weight function between two connected vertices is calculated as:

$$\mathbf{w}(v_i, v_j) = e^{-\frac{(d_{v_i} - d_{v_j})^2}{2\Theta^2}} \quad (1)$$

Where d of any vertex represents its descriptor vector, while Θ is the standard deviation. Each vertex has a compact feature vector, that called as a descriptor, and computed by obtaining four curvatures as below:

$$\mathcal{S}\mathcal{J} = \frac{2}{\pi} \tan^{-1} \left(\frac{\kappa_2 + \kappa_1}{\kappa_2 - \kappa_1} \right) \quad (2)$$

$$\mathcal{C}\mathcal{J} = \sqrt{\frac{\kappa_1^2 + \kappa_2^2}{2}} \quad (3)$$

$$\mathcal{G} = \kappa_1 \kappa_2 \quad (4)$$

$$\mathcal{M} = \frac{1}{2} (\kappa_1 + \kappa_2) \quad (5)$$

Ending up, with a matrix \mathcal{D} [$n * 4$] where n is the number of vertices we have in our model, and four is the components of the descriptor.

We show in Figure 2 the representation of our descriptor compared to the ground truth, and proposed approach from [4], it shows how the feature vector extracted by our approach is doing well in discriminating.

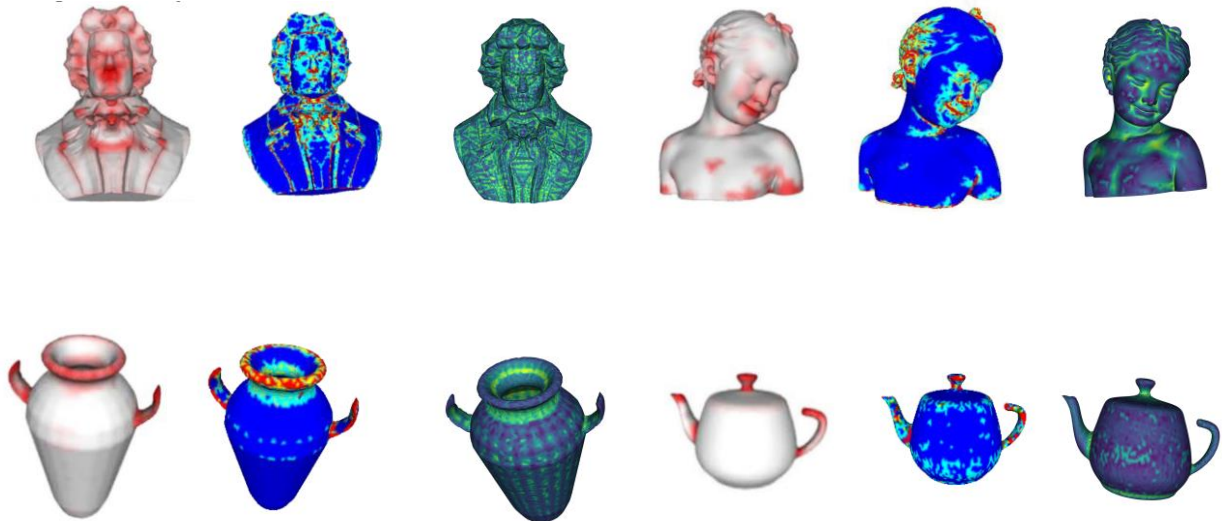


Figure 2: Descriptor Maps. Left to Right: Ground Truth, proposed approach by [], our approach

3.2. Feature Regions Detection

Clustering the 3D objects is an important step to do before matching these objects, where we end up with subgraphs which reduces the complexity of the matching. To do so, we cluster our vertices using the feature vectors and the weighted graph. Integer linear programming is the modeling for our problem, where we try to maximize the modularity of our function.

At first, each vertex has its own label, vertices similar to each other are merged and labels are decreased. The modeling is as follows:

$$Q = \frac{1}{2m} \sum_{ij} [A_{ij} - \frac{k_i k_j}{2m}] \delta(c_i, c_j), \quad (6)$$

where

- A_{ij} represents the edge weight between nodes i and j ;
- k_i and k_j are the sum of the weights of the edges attached to nodes i and j , respectively;
- m is the sum of all of the edge weights in the graph;
- c_i and c_j are the communities of the nodes; and
- δ is Kronecker delta function $\delta(x, y) = 1$ if $x = y$, 0 otherwise).

To maximize Q , First, each node in the network is assigned to its own community. Then for each node i , the change in modularity is calculated for removing i from its own community and moving it into the community of each neighbor j of i . This value is easily calculated by two steps: (1) removing i from its original community, and (2) inserting i to the community of j .

At the end, vertices that are similar in their geometric properties will have same label. This stage, will assess us to find correspondence between the regions of two models.

3.3. 3D Surface Matching

The matching is done through finding a relation between maximum number of correspondence from the feature regions extracted. This problem is modeled as a linear sum assignment known as minimum weight matching,

let X be a boolean matrix where $X[i, j] = 1$ iff row i is assigned to column j . Then the optimal assignment has cost,

$$\min \sum C_{i,j} X_{i,j} \quad (7)$$

This problem is a modified Jonker-Volgenant algorithm with no initialization, described in [3].

4. EXPERIMENTAL DATA ANALYSIS AND RESULTS

In order to show the effectiveness of our proposed approach, we perform several experimentations on downloaded datasets from “MeshsegBenchmark “ and “CAPOD” [8,12] the models are more than 500 object, with different classes, each contains different poses.

Our proposition gives well matching despite the movement changes in human, teddy, armadillo and the other models. Figure 3 shows the matchings between different poses of person, this obviously shows the invariance of our descriptor regarding movements.

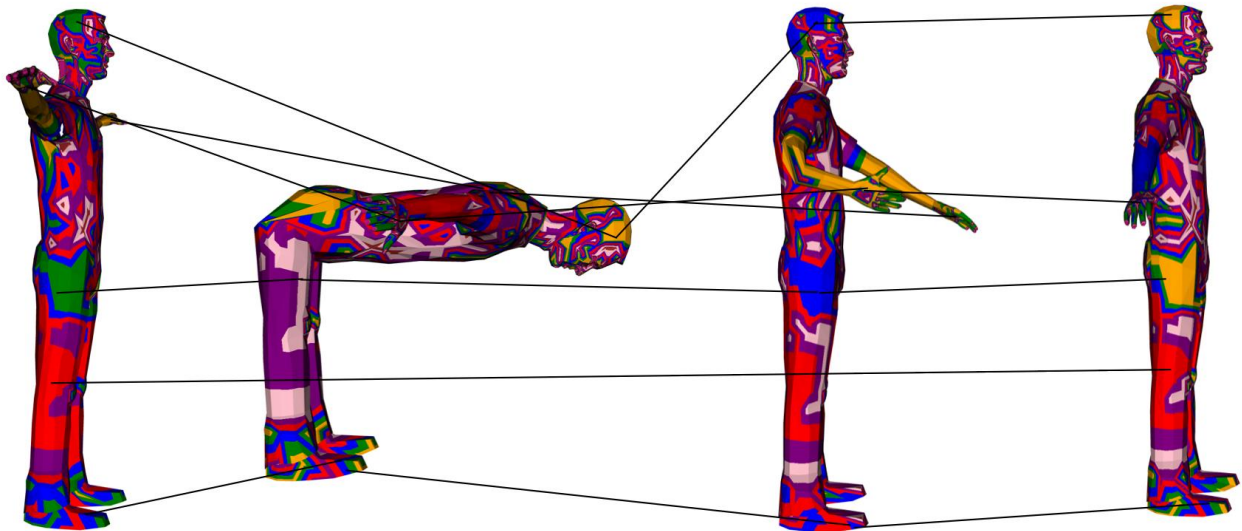


Figure 3: Matched Correspondences

The diversity between models within a class, and getting matches is seen in Figure 4, each subfigure, shows a two retrieved models matched. The results ensure that our approach is invariant to different affine transformations, whether rotation, scaling, different poses.

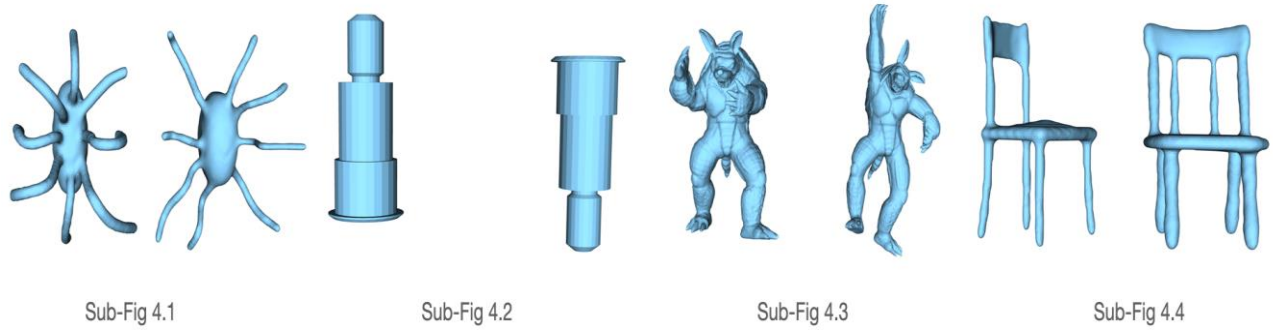


Figure 4: Articulated 3D shape matching

3D Objects of the same class share a fixed pose in terms of object center, scale and rotation while undergoing diverse shape deformations [12], the matching between two of the same class with their feature regions visualization is presented in the following figure.

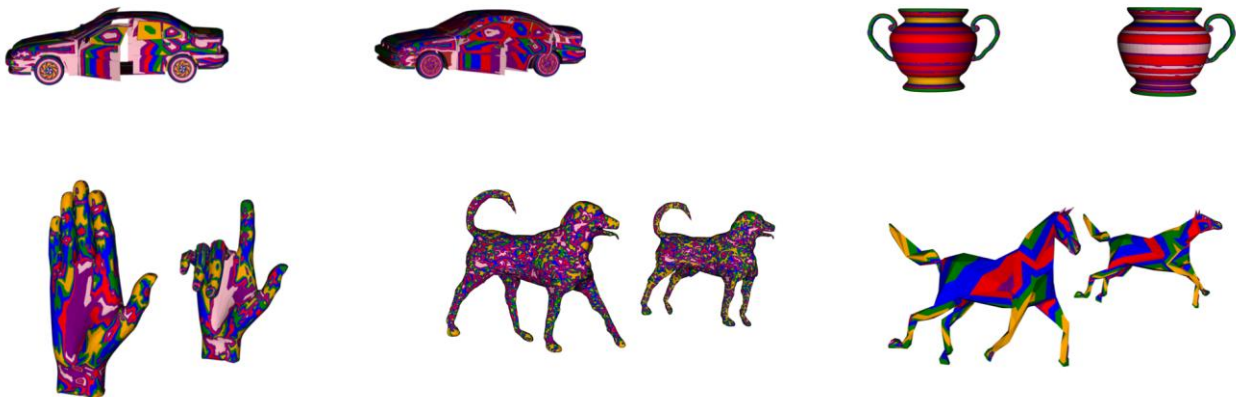


Figure 5: 3D matching within same classes

Getting optimal matches, encourage us to test our framework in order to classify the models, with a query model we try to retrieve the similar models with cosine similarity more than 80%, using the cosine similarity refers to the concept of, if the two similar models are far apart by the Euclidean distance (due to the size of the model), the chances are they may still be oriented closer together through the angle between the models. The classification of two query models as instances, where for each one, the retrieved models that refers to the same class, as well the missed objects from the same class are shown in Table 1.

Accuracy is the ratio of correct predictions to the total number of predictions. It is one of the simplest measures of a model. We must aim for high accuracy for our model. If a model has high accuracy, we can infer that the model makes correct predictions most of the time. And this what we obtain through our framework, where almost each query gives more than 85% of accuracy. At the same time, we was able to get a high recall as a second measure.


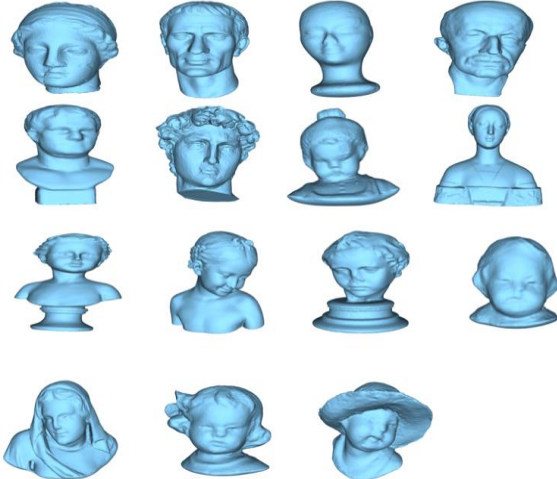
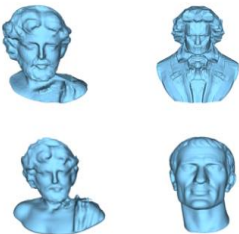
Query model	Retrieved models	Missed models
		

Table 1.1: Retrievals for Bust models


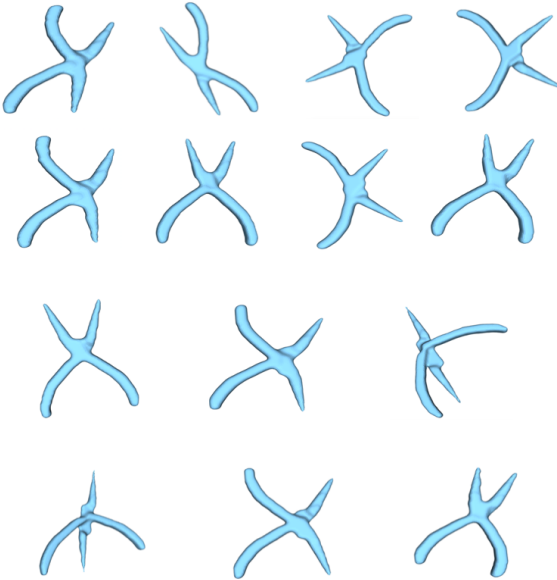

		
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Table 1.2: Retrievals for Plier models

5. CONCLUSION

A robust approach for 3D shape matching was presented in this paper. The 3D shapes that was initially represented as meshes, their surfaces were modeled as weighted graphs. A new combination of curvatures was extracted formulating a compact feature vector in order to cluster nodes, depending on the similarity measure. Combinatorial optimization is used for the graph matching problem, this is done through integer linear programming approach. Following this, we shows the robustness and efficiency of the proposed approach, with experimental

results applied on two datasets, with different affine transformations. Finally, classification results are presented, ensuring the wide range of applications to be tested on.

We believe that more experiments should be performed to study the gap in retrieving false models, as well for future work, our assumption is to apply this proposition into real world application.

REFERENCES

1. Bonald, T., de Lara, N., Lutz, Q., & Charpentier, B. (2020). Scikit-network: Graph Analysis in Python. *J. Mach. Learn. Res.*, 21, 185-1.
2. Cipriano, G., Phillips Jr, G. N., & Gleicher, M. (2009). Multi-scale surface descriptors. *IEEE Transactions on Visualization and Computer Graphics*, 15(6), 1201-1208.
3. DF Crouse. On implementing 2D rectangular assignment algorithms. *IEEE Transactions on Aerospace and Electronic Systems*, 52(4):1679-1696, August 2016, DOI:10.1109/TAES.2016.140952
4. El Chakik, A., El Sayed, A. R., Alabboud, H., & Bakkach, A. (2020). An invariant descriptor map for 3D objects matching. *International Journal of Engineering & Technology*, 9(1), 59-68.
5. Felzenszwalb, P. F., & Huttenlocher, D. P. (2004). Efficient graph-based image segmentation. *International journal of computer vision*, 59(2), 167-181.
6. Gatzke, T. D., & Grimm, C. M. (2006). Estimating curvature on triangular meshes. *International journal of shape modeling*, 12(01), 1-28.
7. H'roura, J., Bekkari, A., Mammass, D., Bouzit, A., Mansouri, A., Roy, M., & Le Goïc, G. (2017, May). 3D objects descriptors methods: overview and trends. In *2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP)* (pp. 1-9). IEEE.
8. <https://github.com/forsythrosin/cs348aHW4/tree/master/models/MeshsegBenchmark-1.0>.
9. Kurtek, S., Klassen, E., Ding, Z., & Srivastava, A. (2010, June). A novel Riemannian framework for shape analysis of 3D objects. In *2010 IEEE computer society conference on computer vision and pattern recognition* (pp. 1625-1632). IEEE.
10. Körtgen, M., Park, G. J., Novotni, M., & Klein, R. (2003, April). 3D shape matching with 3D shape contexts. In *The 7th central European seminar on computer graphics* (Vol. 3, pp. 5-17). Budmerice.
11. M. Musy et al., "vedo, a python module for scientific analysis and visualization of 3D objects and point clouds", Zenodo, 2021, doi.org/10.5281/zenodo.4287635
12. Papadakis, P. (2014, April). The canonically posed 3D objects dataset. In *Eurographics Workshop on 3D Object Retrieval* (pp. 33-36).
13. Pauli Virtanen, Ralf Gommers, Travis E. Oliphant, Matt Haberland, Tyler Reddy, David Cournapeau, Evgeni Burovski, Pearu Peterson, Warren Weckesser, Jonathan Bright, Stéfan J. van der Walt, Matthew Brett, Joshua Wilson, K. Jarrod Millman, Nikolay Mayorov, Andrew R. J. Nelson, Eric Jones, Robert Kern, Eric Larson, CJ Carey, İlhan Polat, Yu Feng, Eric W. Moore, Jake VanderPlas, Denis Laxalde, Josef Perktold, Robert Cimrman, Ian Henriksen, E.A. Quintero, Charles R Harris, Anne M. Archibald, Antônio H. Ribeiro, Fabian Pedregosa, Paul van Mulbregt, and SciPy 1.0 Contributors. (2020)

- SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python. *Nature Methods*, 17(3), 261-272.
14. Sahillioğlu, Y., & Yemez, Y. (2011, August). Coarse- to- fine combinatorial matching for dense isometric shape correspondence. In *Computer Graphics Forum* (Vol. 30, No. 5, pp. 1461-1470). Oxford, UK: Blackwell Publishing Ltd.
 15. Soltanpour, S., Boufama, B., & Wu, Q. J. (2017). A survey of local feature methods for 3D face recognition. *Pattern Recognition*, 72, 391-406.
 16. Van Kaick, O., Zhang, H., Hamarneh, G., & Cohen- Or, D. (2011, September). A survey on shape correspondence. In *Computer graphics forum* (Vol. 30, No. 6, pp. 1681-1707). Oxford, UK: Blackwell Publishing Ltd.
 17. Wang, Y., Gu, X., Hayashi, K. M., Chan, T. F., Thompson, P. M., & Yau, S. T. (2005, October). Brain surface parameterization using Riemann surface structure. In *International Conference on Medical Image Computing and Computer-Assisted Intervention* (pp. 657-665). Springer, Berlin, Heidelberg.

**DETERMINING THE FLOW RATE OF A THERMOSTATIC EXPANSION VALVE
BY NUMERICAL METHOD****BİR TERMOSTATİK GENLEŞME VALFİNİN FARKLI KLAPE AÇIKLIKLARINDAKİ
DEBİSİNİN NÜMERİK YÖNTEM İLE BELİRLENMESİ****Caner SEVER¹**¹Ege Üniversitesi, Mühendislik Fakültesi, Makine Mühendisliği, İzmir, Türkiye.¹<https://orcid.org/0000-0002-2501-3970>**Erbil İYİM²**²Valf Sanayi A.Ş., Organize Sanayi Bölgesi, Kurtuluş Cad. No: 1, Manisa, Türkiye.²<https://orcid.org/0000-0001-5969-1369>**Aydoğan ÖZDAMAR³**³Ege Üniversitesi, Mühendislik Fakültesi, Makine Mühendisliği, İzmir, Türkiye.³<https://orcid.org/0000-0002-6580-4101>**ABSTRACT**

Thermostatic expansion valves (TXV) are used to control the flow rate of the refrigerant in commercial refrigeration systems. The amount of flow passing through the TXV varies according to the valve opening rate. Valve opening rate varies according to the temperature felt by the bulb mounted at the evaporator outlet. The temperature felt by the bulb is transmitted to the diaphragm with the bulb fluid inside the capillary tube. Three different pressures act on the diaphragm, these pressures are evaporator pressure, sensor pressure and spring pressure. The spring pressure remains constant throughout the operation of the TGV and can be adjusted at any time. As the bulb temperature increases, the bulb pressure will increase and the needle will move away from the valve seat and it will allow to pass through more refrigerant inside the TXV. When the bulb temperature decreases, the bulb pressure will decrease and the fluid passing through inside the TXV will decrease. The main purpose of using the TXV in refrigeration systems is to provide a controlled passage of the refrigerant to the evaporator. It is undesirable for the refrigerant fluid to be liquid at compressor inlet so the refrigerant fluid must be completely vaporized at the evaporator outlet. In this study, the flow rate of the fluid passing through the TXV was determined for 10 different valve opening rate. The analysis of the designed models were carried out with the help of the ANSYS FLUENT program, which uses numerical analysis with finite volume method. Models were created by increasing the valve opening rate 0,1 mm in each model and the valve opening rate varying between 0,1 mm and 1 mm. Water was used as refrigerant fluid in the analysis and it is accepted as incompressible flow. In the analysis, the inlet pressure was accepted as 1 bar for each different valve opening rate. As a result of the analysis, as the valve opening rate increased, the inlet and outlet velocities increased. The increase inlet and outlet velocity decreased as the valve opening rate increased. In the analysis, it was observed that when the inlet pressure was fixed at 1 bar, the outlet pressure increased as the valve opening rate increased. The change in mass flow rate, which is the main purpose of this study, has increased as expected depending on the valve opening rate and remained constant after a certain valve opening rate.

Keywords: Thermostatic Expansion Valve, CFD, Numerical Method

ÖZET

Termostatik genişleme valfleri (TGV), birçok ticari soğutma sistemlerinde soğutucu akışkan debisinin kontrolü için kullanılmaktadır. TGV'nin içerisinden geçen akış miktarı, klape açıklık oranına göre değişmektedir. Klape açıklık oranı ise, evaporatör çıkışına monte edilen duyarganın hissettiği sıcaklığa göre değişmektedir. Duyarganın hissettiği sıcaklık, kapiler borunun içinde bulunan duyarga akışkanı ile diyaframa iletilir. Diyafram üzerine 3 farklı basınç etki eder. Bu basınçlar, evaporatör basıncı, duyarga basıncı ve yay basıncıdır. Yay basıncı, TGV'nin çalışma süresince sabit olarak kalır ve istenildiği zaman ayarlanabilir. Duyarganın hissettiği sıcaklık yükselirken, duyarga basıncı da artarak, vana iğnesinin vana yuvasından uzaklaşacak ve TGV'nin içinden daha fazla soğutucu akışkan geçişini sağlayacaktır. Duyarga sıcaklığı düştüğünde ise, duyarga basıncı da düşecek ve TGV'nin içinden geçen akışkan miktarı azalacaktır. TGV'nin soğutma sistemlerinde kullanılmasının amacı, soğutucu akışkanın kontrollü şekilde evaporatöre geçişini sağlamaktır. Kompresör girişinde soğutucu akışkanın sıvı halde olması istenmediğinden, evaporatör çıkışında soğutucu akışkan tamamen buhar halinde olmalıdır. Bu çalışmada, 10 farklı klape açıklığı için TGV'nin içerisinden geçen akışkanın debisi belirlenmiştir. Tasarlanan modellerin analizleri, sonlu hacimler nümerik yöntemini kullanan ANSYS FLUENT programı yardımıyla gerçekleştirilmiştir. Klape açıklığı, 0,1 mm ile 1 mm arasında değişecek şekilde her bir modelde klape açıklığı 0,1 mm artırılarak modeller oluşturulmuştur. Analizlerde akışkan olarak, su kullanılmıştır ve sıkıştırılamaz akış olarak kabul edilmiştir. Analizlerde, giriş basıncı her farklı açıklık için 1 bar olarak kabul edilmiştir. Analizlerde, klape açıklığı arttıkça giriş ve çıkış akışkan hızının arttığı belirlenmiştir. Giriş ve çıkış hızındaki artış ise, klape açıklığı arttıkça azalmıştır. Analizlerde giriş basıncı 1 bar sabit iken, klape açıklığı arttıkça çıkış basıncının arttığı gözlemlenmiştir. Sonuç olarak, kütleli debisinin klape açıklığına bağlı olarak artış gösterdiği ve belirli klape açıklığından sonra ise sabit kaldığı belirlenmiştir.

Anahtar sözcükler: Termostatik Genleşme Valfi, Hesaplamalı Akışkanlar Dinamiği, Nümerik Yöntem

1. INTRODUCTION

Cooling systems are used in industry, industrial sectors, refrigerators and air conditioners that we use at home and they have begun to take more place in our lives as time goes on. Thermostatic expansion valve is an expansion element commonly used in refrigeration cycles and it controls the amount of fluid passing through. Due to the slow response and low sensitivity of the TXV, it is desirable to use an expansion valve with faster response and higher sensitivity. Electronic expansion valves (EXV) have faster response operating conditions and high precision compared to TXV. Although they have different control mechanisms, EXV and TXV have similar geometries inside the valve. One of the most important control-related parameters is the mass flow rate of the refrigerant passing through the valve. The incompressible single-phase fluid equation which is derived from the Bernoulli equation is often used in many literatures to describe the mass flow rate. According to obtained equation, in order to increase the mass flow rate, the inlet pressure of the valve should increase or opening rate should increase. (Pourmahmoud, et al., 2011) carried out work on modelling the turbulent flow inside the expansion valve. In this study, they stated that the mass flow rate for R22 and R410A decreased as a result of decreasing the outlet pressure and temperature. It was compared with the experimental and CFD analysis results that the mass flow rate increased as a result of the increase in inlet pressure and valve lift. (Braun, et al., 2004) they carried out experimental and theoretical studies for three different valve geometries. He stated the relationship between the position of the valve and the degree of superheating for the mass flow change. In this study, it

shows that as the degree of superheating increases, the increase in mass flow rate changes depending on the geometry of the valve (Mulay, et al., 2005). In their study, they examined the mass flow rate change of the system according to the amount of increase in superheat value for different orifice types at constant pressure. In this study, the mass flow rate increased with the increase in superheat, but there was no increase in the mass flow rate after a certain superheat value.

2. MATERIAL AND METHODS

The opening rate of TXV is depends of three different pressures. These pressures are bulb pressure, evaporator pressure and spring pressure.

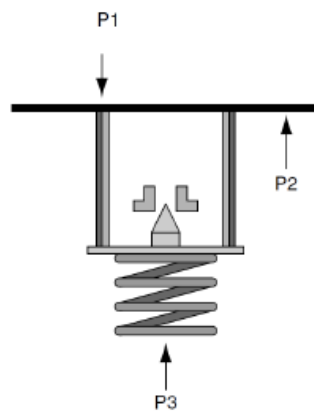


Figure 1 Pressures effect on TXV diaphragm (Shuck, 2001)

The temperature is felt by the bulb placed at the outlet of the evaporator and feels the temperature and the bulb pressure (P1) is transmitted to the diaphragm by the fluid in the capillary tube and it push down the diaphragm to open the opening rate. The evaporator pressure (P2) under the diaphragm and the spring pressure (P3), which can be adjusted with the superheat adjustment screw, act to close the diaphragm. The pressure balance of the thermostatic expansion valve is $P1 = P2 + P3$. By providing this balance, it provides a constant superheat in the evaporator.

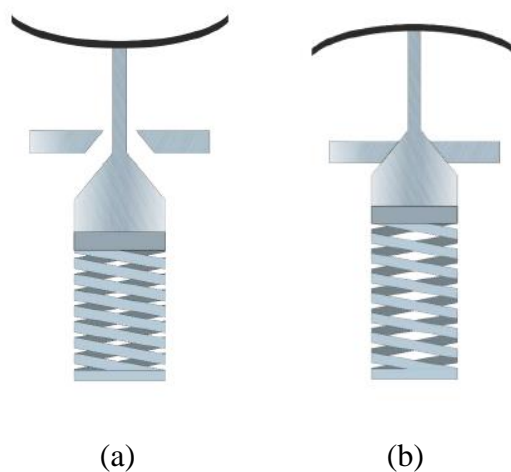


Figure 2 Opening the valve (a) and closing the valve (b)

In the Figure 2 (a) it is shown that if the P_1 pressure is higher than the other pressures (P_2+P_3) valve opening rate will be increased. If the P_1 pressure is lower than the other pressures (P_2+P_3) valve opening rate will be decreased during the refrigeration cycle and for these different opening rates the amount of refrigerant passing through the TXV will be change.

In this study, the flow rate of the fluid passing through the TXV was determined for 10 different valve opening rate.

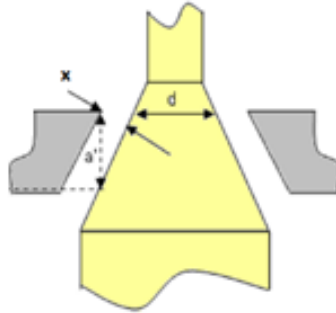


Figure 3 Valve opening rate (Braun, et al., 2004)

In the *Figure 3* the opening rate as is shown as “x”. Models were created by increasing the valve opening rate 0,1 mm in each model and the valve opening rate varying between 0,1 mm and 1 mm.

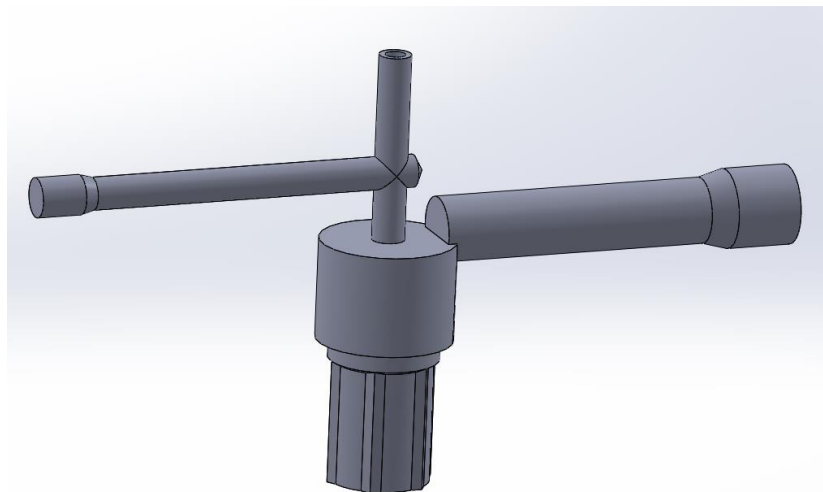


Figure 4 Internal flow region

In the *Figure 4* the internal flow region is shown. The valve inlet is 6.12 mm and the valve outlet is 12.12 mm. For the fluid water is used. Density and dynamic viscosity value of water are $998,2 \text{ kg/m}^3$ $0,001003 \text{ kg/m}^*\text{s}$ respectively. In the analysis half of the interval flow region is used and the flow is accepted single-phase. Pressure-inlet is taken as 1 bar for each different opening rate. For these conditions the Reynold number varies 3700 to 20000. Therefore the flow inside the TXV is turbulent flow. K- ϵ model is used for solver. The mesh element size is 0,3 mm. For this element size there are approximately 2,5 million number of elements for each opening rate.

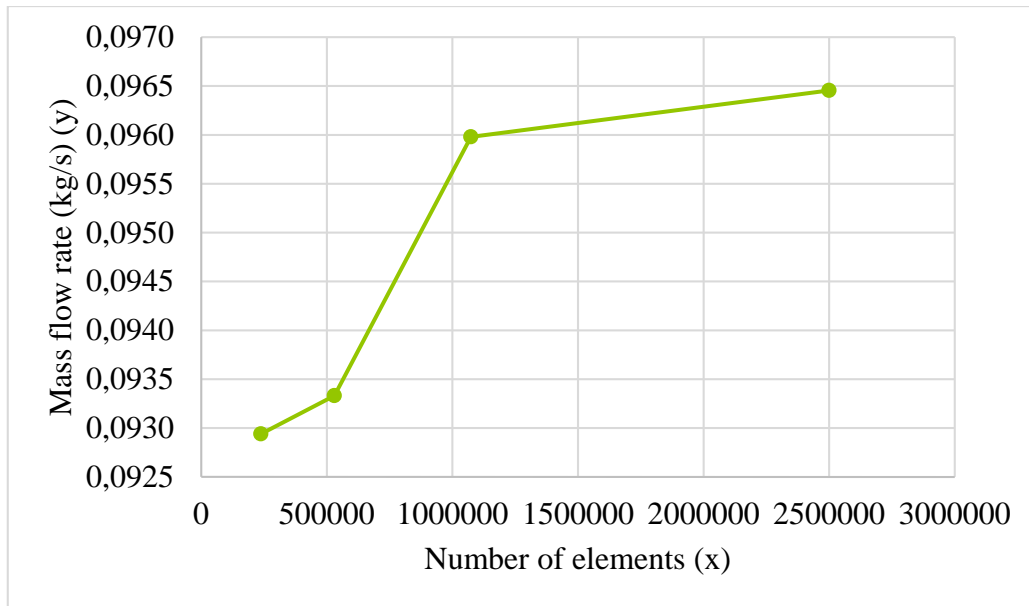
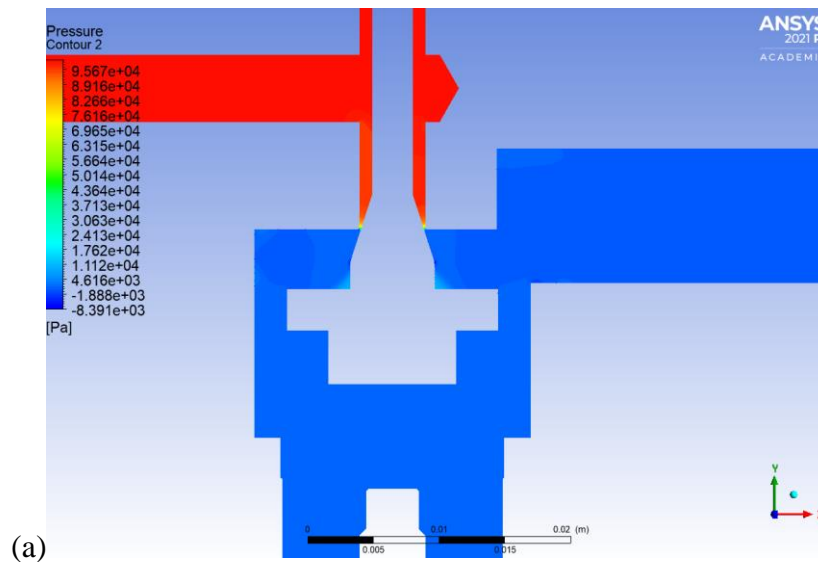


Table 1 Mass flow rate change according to the number of elements

Mass flow rate change according to the number of elements is shown in the Table 1 for 1 mm opening rate. Four different number of elements are used for calculation of mass flow rate. According to this number of elements, it can be assumed that the results are mesh independent.

3. RESULTS



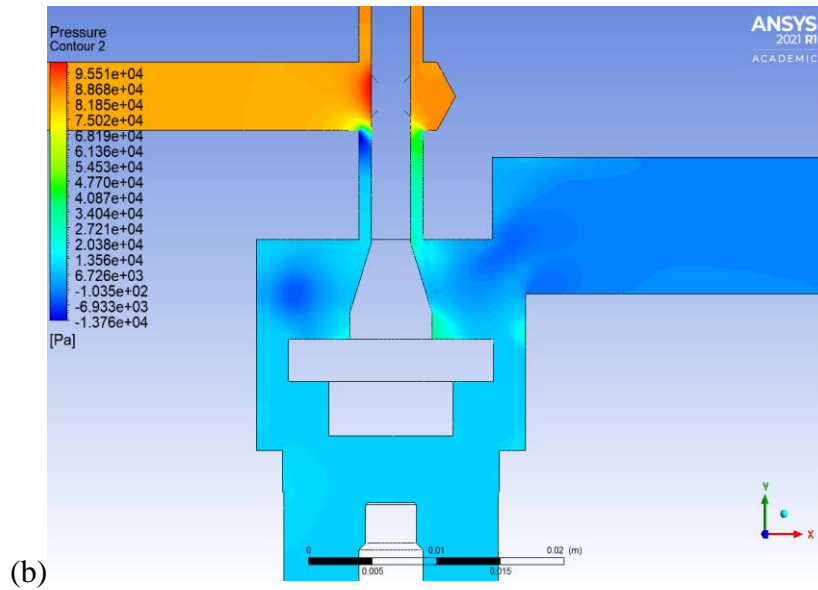
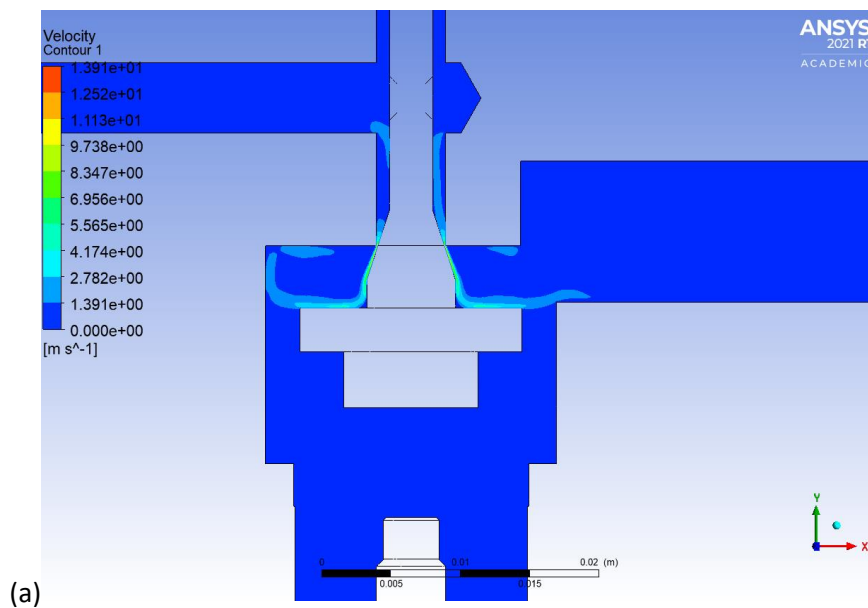


Figure 5 Pressure contours for 0,1 mm (a) and 1 mm (b)

Pressure contours for 0,1 mm and 1 mm opening rate is shown at *Figure 5*. The flow inside TXV is from high pressure to low pressure and as the opening rate increase the outlet pressure increases too. There are some regions inside the TXV that have negative pressures because of the turbulent flow.



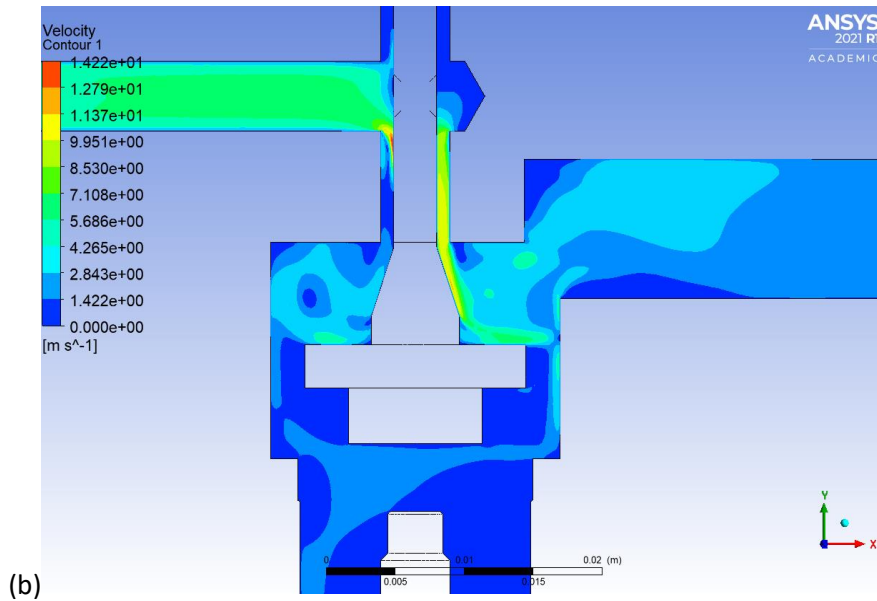
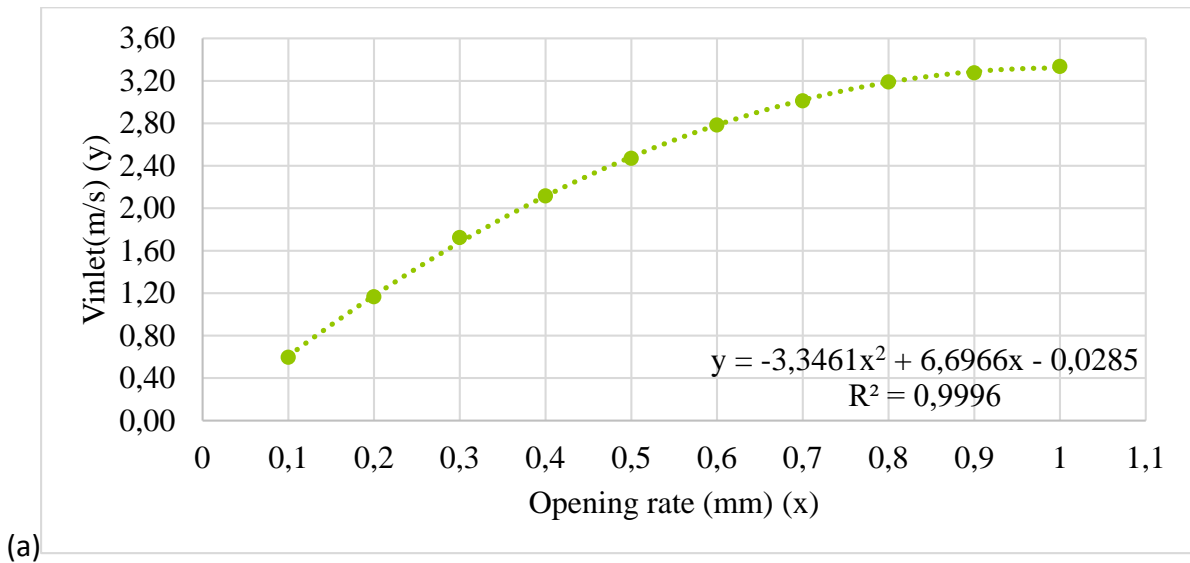


Figure 6 Velocity contours for 0,1 mm (a) and 1 mm (b)

Velocity contours for 0,1 mm and 1 mm opening rate is shown at *Figure 6*. The flow inside TXV is from high velocity inlet to low velocity outlet and as the opening rate increase the inlet-outlet velocities increase. Additionally, there are regional accelerations around the opening rate.



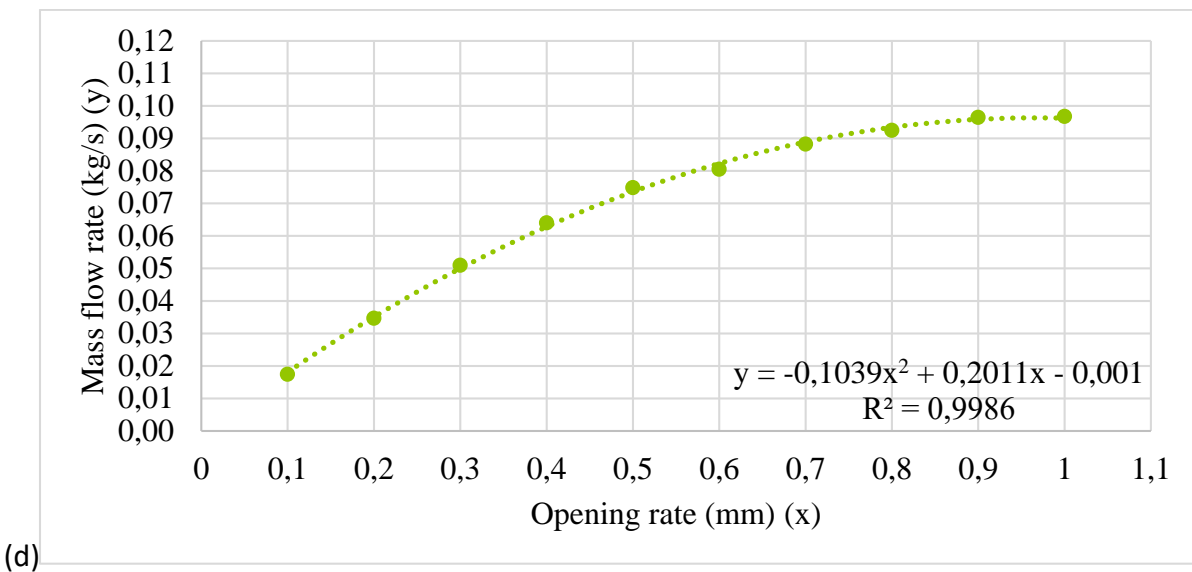
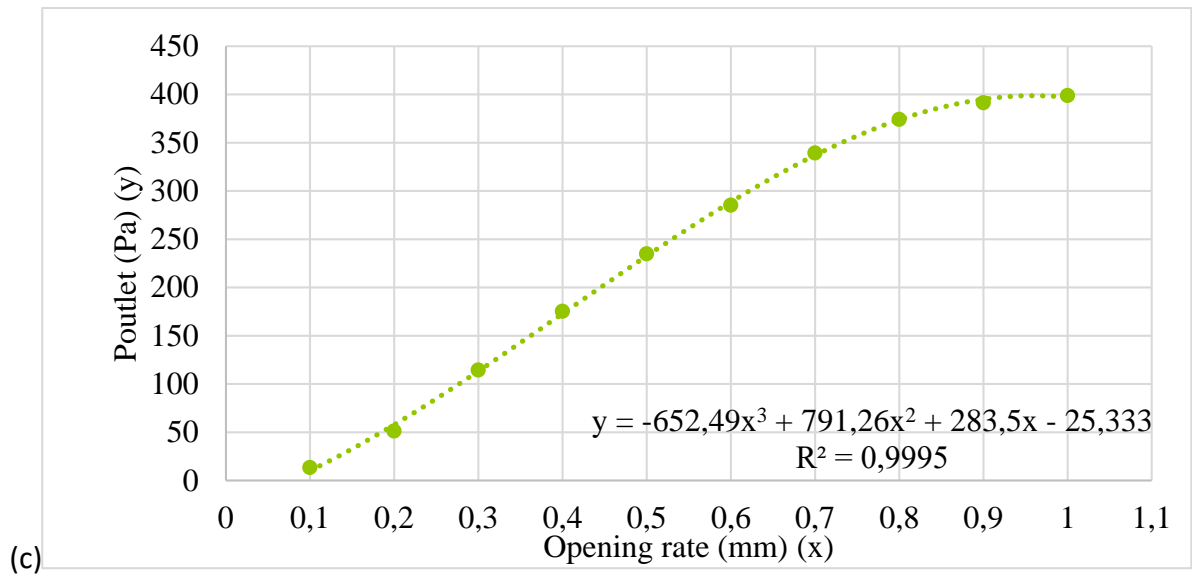
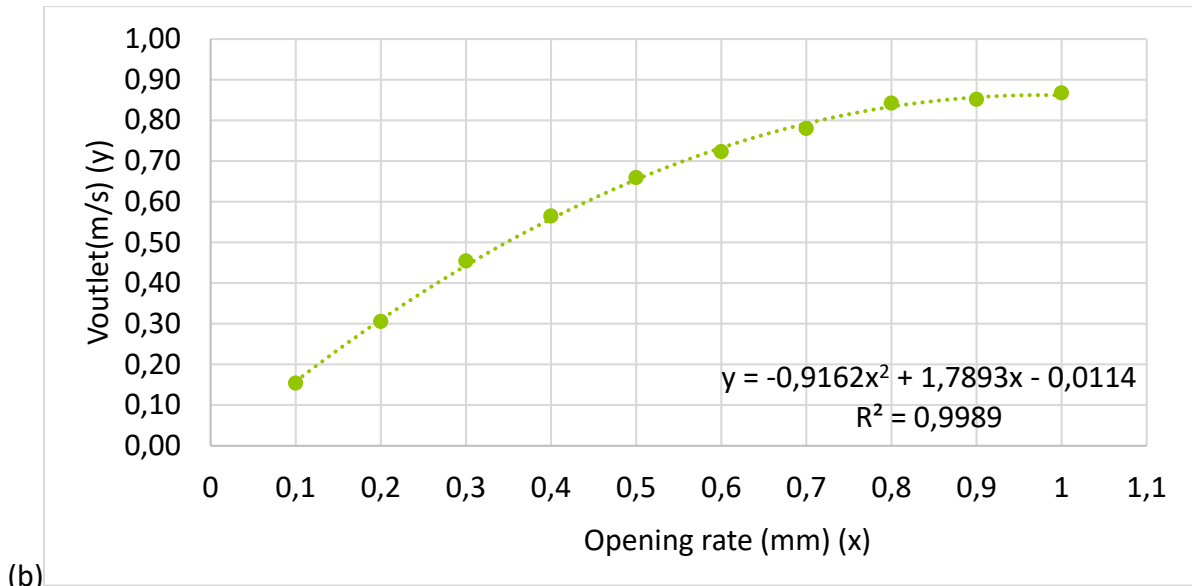


Table 2 (a)-Inlet velocity, (b) outlet velocity, (c) outlet pressure (d) mass flow rate change for opening rates

The inlet-outlet velocities and mass flow rate change is calculated for the ten different opening rates and with these results graphs are created. As seen in *Table 2* the inlet-outlet velocities increase as the opening rates increase but this increasing rate is decreasing as the opening rate is increasing and it has the same situation for the pressure. Outlet pressure increase as the opening rates increase.

Last of all, mass flow rate is increasing as the opening rate increases but for 0,9 mm and 1 mm opening rate mass flow rate remains constant.

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REFERENCES

- Braun, J. E., Li, H. & Shen, B., 2004. Modeling Adjustable Throat-Area Expansion. *International Refrigeration and Air Conditioning*.
- Mulay, V., Kulkarni, A. & Agonafer, D., 2005. Effect of the Location and the properties of thermostatic expansion valve sensor bulb on the stability of a refrigeration system. *ASME, Journal of Heat Transfer*, pp. 85-94.
- Pourmahmoud, N., Najafpour, H., Heidarpour, V. & Rezazadeh, S., 2011. Computational Fluid Dynamics Modeling of the Turbulent Flow in the Expansion Valve. *Australian Journal of Basic and Applied Sciences*, pp. 51-60.
- Shuck, L., 2001. Thermostatic expansion valves. *Refrigeration Service Engineers Society*.

BİR BİYOKÜTLE DEĞERİ OLARAK FINDIK KABUĞU VALUE OF BIOMASS AS A HAZELNUT SHELL

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ÖZET

Dünya da olduğu gibi Türkiye de de nüfus hızla artmaktadır. Bunun doğal bir sonucu olarak enerjiye olan ihtiyaç da her geçen gün artmaktadır. Fosil yakıtlar (kömür, petrol, doğal gaz, vb.) dünyanın birincil enerji kaynağıdır. Fakat, bir kaç yüzyıl içerisinde tükenecekleri öngörülmektedir. Fosil yakıtların yanmasıyla ortaya çıkan kirleticiler havayı kirletmekte, her tür canlı varlığın yaşamını tehdit etmektedir. Bunun yanında fiyatı da sürekli artmaktadır. Bu durum, fosil yakıtta sahip ülkeleri güçlü kılarken fosil yakıtı olmayan ülkelerin ekonomilerini de zora sokmaktadır.

Dünya, fosil yakıtların havayı kirletmesi, sera gazı oluşumuna sebep olması, yarattığı maddi açmazlar sebebiyle doğaya dost, ekonomik ve sürdürülebilir enerji kaynaklarını aramaya yönelmiştir. Bu nedenle yenilenebilir enerji kaynakları arayışları hız kesmeden devam etmektedir. Türkiye’de güneş enerjisi, rüzgar enerjisi, jeotermal enerji, hidrolik enerji ve biyokütle enerjisi gibi yenilenebilir enerji kaynakları mevcuttur.

Biyokütle enerjisi her tür organik maddeden elde edilen enerji kaynağı olarak tanımlanabilir. Güneş var olduğu sürece var olacağından sürdürülebilir bir enerji kaynağıdır. Biyokütle enerjisi, hayvansal atıklar, şehir atıkları, orman atıkları, vb.’ den elde edilebilir. Hem Türkiye’nin bir tarım ülkesi olması hem de çevreye duyarlı, dost tavrı ile biyokütle enerjisi, Türkiye’nin sahip olduğu en önemli yenilenebilir enerji kaynaklarından biridir.

Türkiye fındık üretiminde yıllık ortalama 700 bin ton ile dünyada birinci sırada yer almaktadır. Dolayısıyla büyük miktarda fındık kabuğuna sahiptir. Böylece, fındık kabuğu, Türkiye’nin en büyük biyokütle enerjisi kaynaklarından biridir. Bu çalışmada, fındık kabuğunun literatür taraması yapılmıştır. Bir yakıtın değerini gösteren en önemli analizlerden olan, proksimet ve elemental analizleri yapılmış çalışmalar derlenerek fındık kabuğunun değeri ifade edilmiştir. Literatür taramasında yanma verimini artırmak amacıyla yapılan, fındık kabuğunu gerek kömürlerle gerek farklı biyokütlerle yakarak, yanma verimini ve davranışlarını inceleyen çalışmalara yer verilmiştir.

Anahtar kelimeler: Yenilenebilir enerji kaynakları, biyokütle, fındık kabuğu.

ABSTRACT

As in the world, the population in Turkey is increasing rapidly. As a natural consequence of this, the need for energy is increasing day by day. Fossil fuels (coal, oil, natural gas, etc.) are the world's primary energy source. However, it is predicted that they will be extinct in a few centuries. Pollutants produced by the combustion of fossil fuels pollute the air and threaten the life of all living creatures. In addition, the price is constantly increasing. While this situation makes countries with fossil fuels strong, it puts the economies of countries that do not have fossil fuels in difficulty.

The world has tended to seek eco-friendly, economical and sustainable energy sources due to the fact that fossil fuels pollute the air, cause greenhouse gas formation, and create financial problems. Turkey has renewable energy sources such as solar energy, wind energy, geothermal energy, hydraulic energy and biomass energy.

Biomass energy can be defined as an energy source obtained from all kinds of organic matter. It is a sustainable energy source as it will exist as long as the sun exists. Biomass energy can be obtained from animal waste, urban waste, forest waste, etc. Biomass energy is one of the most important renewable energy resources that Turkey has, both with its being an agricultural country and its environmentally friendly and friendly attitude.

Turkey ranks first in the world in hazelnut production with an annual average of 700 thousand tons. Therefore, it has a large amount of hazelnut shell. Thus, hazelnut shell is one of Turkey's largest sources of biomass energy. This study is a literature research on hazelnut shell, which is an important biomass value for Turkey. In this study, literature review of hazelnut shell was made. One of the most important analyzes showing the value of a fuel, proximet and elemental analyzes were made, the studies were compiled and the value of the hazelnut shell was expressed. In the literature review, studies that examine the combustion efficiency and behavior by burning the hazelnut shell with coals or with different biomass are included in order to increase the combustion efficiency.

Keywords: Renewable energy sources, biomass, hazelnut shell

1. GİRİŞ

Dünya, endüstri devrimi ile birlikte enerji talebinde yükselişe geçmiştir. Bu yükseliş günümüzde, her geçen gün artan nüfus ve endüstriyelleşme ile birlikte en yüksek talebini yaşamayı sürdürmektedir.

Oluşumlarına bağlı olarak enerji kaynakları kabaca fosil kaynaklar ve yenilenebilir enerji kaynakları olmak üzere ikiye ayrılabilir. Fosil kaynaklar; petrol, doğal gaz, kömür, vb.'dir. Yenilenebilir enerji kaynakları ise güneş enerjisi, rüzgar enerjisi, hidrojen enerjisi, akıntı enerjisi, jeotermal enerji, hidrolik enerji ve biyokütle enerjisidir.

Rezervlerle sınırlı fosil kaynaklar, tarihin başlangıcından beri enerji üretiminde en çok kullanılan kaynaklardır. Fosil kaynaklar hiç olmadığı kadar hızla tüketilirken, yapılan araştırmalar gösteriyor ki çok uzun bir ömrü bulunmamaktadır.

Fosil yakıtlar enerji elde etmek için kullanırken başta karbondioksit olmak üzere zararlı emisyonlar (karbonmonoksit, sülfürdioksit, metan, nitrojen, vb.) yaymaktadır. Bu zararlı emisyonlar neticesinde küresel ısınma görülmektedir. Küresel ısınmanın negatif etkileri, tüm canlı formlarına zarar vermekte ve yaşamın sürdürülebilirliğini tehdit etmektedir.

Dünya bir yandan küresel ısınmayı durdurmak isterken bir yandan da her yıl %5 artan enerji talebini karşılamaya çalışmaktadır. Bu sebeple, araştırmacılar özellikle 1970 petrol krizi sonrasında hem talebi karşılayacak hem de doğaya saygılı alternatif enerji kaynakları araştırmalarına hız vermiştir.

Bu çalışmada, fındık kabuğunun literatür taraması yapılmıştır. Bir yakıtın değerini gösteren en önemli analizlerden olan, proksimet ve elemental analizleri yapılmış çalışmalar derlenerek fındık kabuğunun değeri ifade edilmeye çalışılmıştır. Literatür de yanma verimini artırmak amacıyla yapılan, fındık kabuğunu gerek kömürlerle gerek farklı biyokütlelerle yakarak, yanma verimini ve davranışlarını inceleyen çalışmalara yer verilmiştir.

2. YENİLENEBİLİR ENERJİ KAYNAKLARI

Alternatif enerji kaynakları arayışlarının başında yenilenebilir enerji kaynakları gelmektedir. Çünkü yenilenebilir enerji kaynakları, su, toprak, bitki, güneş, hava, sıcak su kaynakları gibi dünya varoldukça olan, tükenmeyecek kaynaklardır. Ayrıca, doğaya fosil yakıtlar gibi zararlı etkileri bulunmamaktadır. Geleceğin enerji kaynağı yenilenebilir enerji kaynakları ve yenilenebilir enerji teknolojileri olarak öngörülmektedir [1-2].

Başlıca alternatif enerji kaynakları şöyle tanımlanabilir;

Güneş enerjisi: Güneş enerjisi kaynağını güneşin ısı ve ışığından alır. Kurulan tesisler ile elektrik elde edilir. Ayrıca evsel ısınma, sıcak su temini gibi gündelik hayatta da kullanımı mümkündür.

Rüzgar enerjisi: Rüzgar enerjisi hava akımlarını kullanır. Havanın sahip olduğu kinetik enerjiyle rüzgar türbinlerini çevirerek elektrik enerjisi eldesini sağlar.

Hidrojen enerjisi: Hidrojenin ayrıştırılmasıyla açığa çıkan kimyasal enerjinin elektrik ve ısı enerjisine dönüştürülmesidir.

Akıntı enerjisi: Deniz akıntılarında ki kinetik enerjiyi kullanarak enerji üretilmesidir.

Jeotermal enerji: Yer kabuğunun derinliğine doğru yığılmış olan ısı enerjisinin kullanımı ile enerji elde edilmesidir.

Hidrolik enerji: Barajlarda toplanan su gücünü kullanır. Kurulan santraller ile suyun yuksekten düşmesinden ve akış hızından faydalanarak elektrik enerjisi üretir [1-3].

3. BİYOKÜTLE ENERJİSİ

Yenilenebilir enerji kaynakları içerisinde en büyük dördüncü enerji kaynağı biyokütledir. Biyokütle, güneş enerjisini fotosentez yaparak depolayan canlı veya kısa süre önce ölmüş canlılardan elde edilen bütün biyolojik kütlelere verilen addır. Hayvansal atıklar, orman atıkları, mahsullerden arta kalanlar hatta evsel atıklar bile biyokütledir.

Ana kaynağı güneş olan biyokütle, özellikle tarım ülkelerinde kullanılabilir en değerli kaynaklardan biridir. Güneş var olduğu sürece var olacağından tükenmez bir enerji kaynağıdır. Ayrıca, karbon döngüsünü nötr olacak şekilde tamamladığından çevre dostudur. Biyokütle enerjisinin negatif yönleri; biyokütle teknolojisindeki eksiklikler, sürdürülebilir biyokütle temini ve düşük kaloridir. Bunun yanında dünyanın her yerinde var olması, doğa dostu olması, teknolojiye değişim ve gelişmelerle kullanılabilir olması, yeni iş sahalarının oluşmasına imkan vermesi ve atık azaltımını sağlama pozitif yönleridir [1-4].

Türkiye, yenilenebilir enerji kaynakları bakımından zengin bir ülkedir. Bir tarım ülkesi olması sebebiyle de biyokütle potansiyeli yüksektir. Ayrıca, doğaya dost tavrıyla Türkiye'nin sahip olduğu en önemli yenilenebilir enerji kaynaklarından biridir [5-8].

Türkiye, OECD (Ekonomik Kalkınma ve İşbirliği Örgütü) ülkeleri arasında yer almaktadır. Ürün atıkları ile hesaplanmış olan toplamda enerji potansiyeli yaklaşık 10 milyon ton petrol eşdeğeridir (Mtoe). Bu değer ile Türkiye, OECD'e üye olan ülkeler arasında dördüncü sıradadır. Türkiye, yağlı tohum bitkileri, şeker pancarı, patates, fındık kabuğu, fıstık kabuğu, vs. gibi bir çok biyokütle değerine sahiptir [5].

4. FINDIK KABUĞU

Dünyada; Türkiye, İtalya, ABD ve Azerbaycan başta olmak üzere İspanya ve Gürcistan gibi birçok farklı ülkede fındık üretilmektedir. Türkiye fındık üretiminde yıllık ortalama 700 bin ton ile dünyada birinci sırada yer almaktadır [9]. Dolayısıyla büyük miktarda fındık kabuğuna sahiptir. Böylece, fındık kabuğu, Türkiye'nin en büyük biyokütle enerjisi kaynaklarından biridir.

Türkiye gelişmekte olan bir ülkedir ve enerji ihtiyacı, endüstriyelleşme ve nüfusun artışıyla her geçen gün artmaktadır. Türkiye enerjisinin % 72,6' lık gibi büyük bir oranını ithal etmektedir. Hızla azalan fosil yakıtların enerji kıtlığına sebep olacağı ve enerji fiyatlarında artış yaşanacağı açıktır. Bu durumdan ülke ekonomisinin etkilenmesi kaçınılmazdır.

Türkiye, başta badem kabuğu, mısır sapı, fındık kabuğu, vb. gibi zengin bir biyokütle potansiyeline sahiptir [10-12]. Dünyada fındık üretiminde lider olan Türkiye de sadece Giresun ilinde yıllık fındık kabuğu üretimi 102000 tondur. Şenol H., Giresun da ki fındık kabuğu ve fındık atıklarının biyogaz potansiyelini araştırmıştır. İlin yıllık biyogaz üretim potansiyelini 38,21 GW saat/yıl olarak bulmuştur [13]. Devamında, Şenol H., ve Zenk H., Türkiye de fındık üretimi yapılan tüm şehirlerin biyogaz potansiyelini incelemişlerdir. Tüm illerin potansiyel elektrik enerjisi kazanımını toplam 131,55 GW saat olarak hesaplamışlardır [14]. Boubaker K. ve arkadaşları, yenilenebilir enerji çerçevesinde İtalya da edindikleri deneyimleri Türkiye'de benzer bir ortamda projelendirmeye çalışmışlardır. Çalışmalarında İtalya'nın Viterbo eyaletindeki küçük ölçekli biyokütle gazlaştırma sistemleri ve enerji santrallerinin geliştirilmesi programına atıfta bulunmuşlardır. Türkiye'de Doğu Karadeniz bölgesinde gazlaştırma ve yenilenebilir enerji üretimi için uygun olan farklı biyokütle hammaddelerine dikkat çekmişlerdir [15].

Piroliz, organik bir ürüne uygulanan termo kimyasal bir süreçtir. Genel olarak, oksijensiz ortamda yakma olarak tanımlanabilir. Fındık kabuğu içinde piroliz çalışmaları mevcuttur. Aslan F., gerçekleştirdiği çalışmada fındık kabuğu ve ceviz kabuğunun pirolizini incelemiştir. Sıcaklığın adsorpsiyon işlemi üstündeki etkisi incelendiğinde, fındık kabuğundan elde edilen biyokömürün kullanılması durumunda adsorpsiyon veriminde artış yaşandığını görmüştür [16]. Pütün A. E., ve arkadaşları, sabit yataklı tübüler bir reaktörde fındık kabuğunun pirolizini gerçekleştirmişlerdir. Fındık kabuklarından elde edilen kimyasal karakterizasyonun, ham petrol ve şeyl yağına benzer olduğunu görmüşlerdir [17]. Onay Ö., ve Koçkar M., deneysel olarak yaptıkları çalışmalarında sabit yataklı borusal bir reaktörde fındık kabuklarının hızlı pirolizini gerçekleştirmişlerdir. Yaptıkları deneylerde piroliz sıcaklığının, parçacık boyutunun, sürükleyen gaz akım hızının pirolize olan etkilerini incelemişlerdir. Araştırmalarının neticesinde, en yüksek sıvı ürün verimine 300 °C dk ısıtma hızında, 550 °C piroliz sıcaklığında, 0, 850<Dp<1,8 mm parçacık boyutunda, 100 cm³ dk-1 azot akış hızında yaklaşık % 30 ile ulaşmışlardır [18].

Tarihin başından beri yakacak olarak kullanılan biyokütle, çevre dostudur. Canlı büyürken emdiği CO₂' i yanma sırasında yaymaktadır. Biyokütle kullanımı, karbondioksit çevrimini dengelerken hava kirliliği ve sera gazı gibi etkiler oluşturmamaktadır. Meteoğlu M., fındık kabuğunun da içinde olduğu 39 adet biyokütle numunesinin yanma özelliklerini incelemiştir. Numunelerin yanma analizlerini yapmış, yanma hızı, yanma süresi, maksimum yanma hızlarını belirlemiş, birbirleriyle karşılaştırmıştır [19]. Güler C., Şen S., fındık kabuklarının sıkıştırılmış yakıt olarak kullanılmasını incelemişlerdir. Fındık kabuğunun mangal kömürüne yakın ısıl değerlere ve yanma özelliklerine sahip olduğunu görmüşlerdir [20].

Günümüzde enerji eldesi büyük oranda fosil yakıtlardan olsa da yaydıkları emisyonun çevreye zararı ve tükenmeleri söz konusu olduğu için enerji sektörü, uygun maliyetli ve çevre dostu bir enerji arayışındadır. Bu enerji arayışında ana amaç sürdürülebilir ve temiz olmasıdır.

Yeni enerji kaynakları arayışları sürerken eldeki kaynakların kullanımını en temiz ve en verimli şekilde tüketmekte bir hayli önemlidir. Yapılan çalışmalarda, fosil yakıtlara karıştırılan biyokütlenin yanmayı iyileştirdiği ve yanma emisyonlarını azalttığı bilinmektedir. Sahu ve arkadaşları, bu mesnetle çeşitli biyokütle türlerinin kullanımını, kısıtlarını incelemişlerdir. Ayrıca tutuşma, yanma, kül biriktirme davranışının temellerini dikkate alarak birlikte yanmanın teknik yönlerini irdelemişlerdir [21].

Kayısı çekirdeği, fındık kabuğu, üzüm çekirdeği ve kestane kabuğu Türkiye'deki gıda işleme endüstrisinden elde edilen önemli biyokütle kalıntılarıdır ve enerji kaynağı olarak büyük önem taşımaktadır. Özçimen D., ve Meriçboyu A.E., hazırladıkları çalışmalarında, kayısı çekirdeği, fındık kabuğu, üzüm çekirdeği ve kestane kabuğunun karbonizasyonundan elde edilen biyo-yag ve biyokömür örneklerinin özelliklerini araştırmışlardır. Biyokömür ürünlerinin karbon bakımından zengin, yüksek ısıtma değeri ve nispeten kirlilik içermeyen potansiyel katı biyoyakıtlar olarak nitelendirilebileceği tespit etmişlerdir. Biyo-yag ürünlerinin çevre dostu yeşil biyoyakıt adayları olduklarını öne sürmüşlerdir [22].

Haykiri –Acma H., Yaman S., Küçükbayrak S., kimyasal olarak izole edilmiş biyokütle bileşenlerinin yanma özelliklerini incelemişlerdir. Bu çalışmayı, bir biyokütle türünün izole edilmiş fraksiyonlarının yanma özelliklerini araştırmak için yapmışlardır. Aktivasyon enerjileri, holoselüloz < özütleyici içermeyen biyokütle < hammadde <lignin şeklinde düzenlenebileceğini ifade etmişlerdir [23].

Biyokütleyi yakıt olarak kullanmayı hedefleyen bir tesis için kullanacağı biyokütlenin ısı değeri oldukça önemlidir. Duranay N., Yılgin M., kısa analiz verileri kullanılarak fındık kabuğu, ceviz kabuğu, çam talaşı, vb. gibi bir çok biyokütlenin üst ısı değerlerini hesaplamışlardır [24]. Demirbaş A., fındık kabuğu da dahil olmak üzere, Türkiye de var olan on altı farklı biyokütlenin ısı değeri analizini yapmıştır [25]. Demirbaş A., yenilenebilir enerji kaynaklarının potansiyel uygulamalarını incelemiştir. Ayrıca biyokütle yanmasını ve yanma sorunlarını incelemiştir. Çalışmasında, çeşitli ülkelerde birincil enerji kaynakları olarak fosil yakıt yanmasının yerini alacak yenilenebilir enerji kaynaklarının potansiyel uygulamalarını açıklamıştır. Kazan güç sistemlerinde biyokütle yanmasıyla ilgili sorunları tartışmıştır [26]. Bakışgan C. ve arkadaşları, Türkiye de ki biyokütle (buğday samanı, fındık kabuğu, zeytin küspesi) kaynaklarının iz elementleri üzerine çalışmışlardır. Biyokütlelerin ortalama kül değerleri sırasıyla; buğday samanı % 7.9, zeytin küspesi % 3.9, fındık kabuğu % 1.2'dir. Ayrıca, incelenen küllerin tamamında diğer iz elementler arasında en yüksek konsantrasyona sahip olan Fe, daha yüksek konsantrasyonlar sergileyen ikinci element ise Mn olduğunu ifade etmişlerdir. Küllerdeki elementlerin en yüksekten en düşüğe doğru konsantrasyon sırası şu şekilde sıralanmıştır: Fe> Mn> Zn> Cu> Ni> Cr> Pb> Co [27].

Biyokütle, uygun yanma şartlarında yüksek verimli ve çevre dostudur. Yanlış şartlar altında yakıldığında verimi oldukça düşüktür. Ayrıca çevreye de zarar verebilmektedir. Bu bakımdan doğru şartlar altında, verimli yakıcılarla kullanılması önemlidir. Kulah G., kabarcıklı akışkan yatakta fındık kabuğu ve linyiti birlikte yakmıştır. Birlikte yanmanın SO₂ emisyonunu azalttığını görmüştür [28].

Proksimet ve elemental analizler bir yakıtın yakacak değerini gösteren en önemli analizlerdendir. Bu sebeple yanmayı iyileştirmek için yapılan çalışmalarda, proksimet ve elemental analizler tablolar halinde verilmiştir. Turan A. Z., Soma Deniz linyit kömürüne değişen oranlarda biyokütle (pirina, fındık kabuğu, ayçekirdeği kabuğu, pirinç kabuğu) katarak yakmış, yanma özelliklerini ve termal analizini gerçekleştirmiştir. Analizi yapılan biyokütleleri incelediğinde en yüksek sabit karbon içeriğinin fındık kabuğunda olduğunu tespit etmiştir. Bunun etkisiyle kuru hava ortamında en yüksek verimli biyokütle numunesinin fındık kabuğu olduğunu görmüştür.

Numune (%)	Nem	Uçucu madde	Sabit karbon	Kül	Üst ısıl değer (kJ/kg)
Soma-Deniş Linyiti	11.3	39.5	16.0	33.2	15851
Ayçekirdeği Kabuğu	8.3	76.7	12.5	2.5	17619
Fındık kabuğu	10.8	64.2	18.8	6.2	18104
Zeytin küspesi	8.8	65.0	13.2	13.0	17117
Pirinç kabuğu	7.5	61.3	9.2	22.0	13819

Tablo 1: Kömür ve biyokütle numunelerinin kısa analiz sonuçları ve üst ısıl değerleri [29]

Ayrıca, fındık kabuğunun Soma Deniş linyitine ve diğer biyokütlelere göre sabit karbon değerinin ve üst ısıl değerinin yüksek olduğunu, kül oranının ise oldukça düşük olduğunu görmüştür [29].

Özgür E., petrol şeyli ve biyokütle yakıtlarının (fındık kabuğu, buğday kepeği, kavak odunu, fil otu) ve karışımlarının yanma performansını incelemiştir. Karbon ve uçucu bileşen miktarının numune tutuşma sıcaklığını düşürücü bir etkisi olduğunu görmüştür.

	Proksimet Analiz				Elemental Analiz			
	Nem	Uçucu madde	Sabit Karbon	Kül	C	H	N	(O+S)
Ulukışla petrol şeyli	7.0	8.4	0.1	84.5	3.75	1.05	0.22	10.48
Himmetoğlu petrol şeyli	5.0	63.0	13.5	18.5	53.30	6.13	1.73	20.54
Fındık kabuğu	1.5	69.5	28.9	0.1	50.50	5.63	0.18	43.59
Fil otu	2.0	80.5	16.0	1.5	45.20	5.28	0.01	48.01
Kavak	1.0	74.0	24.0	1.0	46.60	5.71	0.45	46.24
Buğday kepeği	8.0	65.0	24.1	2.9	43.20	6.19	2.58	45.13

Tablo 2: Petrol şeylleri ve biyokütlelerin proksimet ve elemental analizleri [30]

Ayrıca fındık kabuğu, petrol şeylleri ve diğer biyokütleler ile kıyaslandığında, sabit karbon değerinin en yüksek, C değerinin ise Himmetoğlu petrol şeylinden sonra geldiğini tespit etmiştir (Tablo 2) [30].

Haykiri-Acma H. ve Yaman S., Türkiye Elbistan linyiti ile fındık kabuğu karışımlarının yanmasını TGA cihazı kullanarak incelemiş, SEM cihazı ile her bir karışımı görüntülemişlerdir. Maksimum yanma hızları (R_{max}), maksimum yanma hızlarının sıcaklıkları (TR_{max}) ve ana numunelerin ve karışımların nihai yanma değerlerini karşılaştırmışlardır. Sonuçları, linyit özellikleri, hemiselülozikler ve lignin gibi başlıca biyokütle bileşenlerini dikkate alarak yorumlamışlardır. Sonuç olarak, ağırlıkça % 20' lik fındık kabuğu karışımının diğerlerine göre daha elverişli yanma şartları sağladığını görmüşlerdir [31]. Demirbaş A.,

çalışmasında, kömür ve biyokütle karışımlarını pülverize kömür yakan bir kazanda incelemiştir. Biyokütle ve kömürün pülverize kömürle çalışan kazanlarda birlikte yakılması sonucunda yanmanın iyileştiğini, NO_x ve SO_x emisyonlarında ise azalma olduğunu belirtmiştir. Salınımı azalan emisyona paralel olarak hava, su ve toprak kirliliğinin azaltıldığını ifade etmiştir [32].

SONUÇLAR

Bu çalışma, Türkiye için önemli bir biyokütle değeri olan fındık kabuğunun literatür incelemesidir. Fındık kabuğunun, farklı çalışmalarda yapılan proksimet ve elemental analizleri alıntılanmıştır. Fındık kabuğu ile farklı biyokütle ve kömür analizleri aynı tabloda gösterilerek fındık kabuğunun bir yakıt olarak değeri gösterilmeye çalışılmıştır. Yapılan araştırmalar incelendiğinde, fındık kabuğunun yanmayı iyileştirdiği ve yanma verimini artırdığı görülmüştür.

KAYNAKÇA

- [1] Yaman Y., 2007. Enerji tasarrufu ve yenilebilir enerji kaynakları, Birsen Yayınevi, İstanbul.
- [2] Öztürk H., 2012. Enerji bitkileri ve biyoyakıt üretimi, Hasad Yayıncılık, Adana.
- [3] Öztürk H., 2016. Biyoyakıt üretimi, Umuttepe Yayınları, Kocaeli.
- [4] Akova, İ. 2008. Yenilenebilir Enerji Kaynakları, Nobel Yayınları No:1229, Ankara.
- [5] Topal M., Arslan I., 2008. Biyokütle enerjisi ve Türkiye, VII. Ulusal Temiz Enerji Sempozyumu UTES'2008, 17 – 19 Aralık 2008, 241 - 247.
- [6] Koç E., Kaya K., 2015. Enerji kaynakları-yenilenebilir enerji durumu, Mühendis ve Makine Dergisi, Cilt 56, Sayı 668, Sayfa 36-47.
- [7] Atılğan, İ. 2000. Türkiye'nin enerji potansiyeline bakış, Gazi Üniversitesi Müh. Mim. Fak. Dergisi,15(1): 31-47.
- [8] Karayılmazlar S., Saraçoğlu N., Çabuk Y., Kurt R., 2011. Biyokütlenin Türkiye' de enerji üretiminde değerlendirilmesi, Bartın Orman Fakültesi Dergisi, Cilt 13, Sayı 19, 63 - 75.
- [9] <https://arastirma.tarimorman.gov.tr/tepge>, 06.07.2021.
- [10] Kar Y., Tekeli Y., 2008. The potential of biomass residues in Turkey and their importance as energy resources, Energy Sources, Part 30, 483 – 493.
- [11] Kaygusuz K., Türker M. F., 2002. Biomass energy potential in Turkey, Renewable Energy, 26, 661 – 678.
- [12] Kapluhan E., 2014. Enerji coğrafyası açısından bir inceleme: Biyokütle enerjisinin dünyadaki ve Türkiye' deki kullanım durumu, Marmara coğrafya dergisi, 30, 97 -125.
- [13] Şenol H., 2019. Biogas potential of hazelnut shells and hazelnut wastes in Giresun city, Biotechnology Reports, 24, 1 – 6.
- [14] Şenol H., Zenk H., 2020. Determination of the biogas potential in cities with hazelnut production and examination of potential energy savings in Turkey, Fuel, 270, 1 - 8.
- [15] Boubaker K., de Franchi M., Colantoni A., Monarca D., Cecchini M., Longo L., Allegrini E., Di Giacinto S., Biondi P., Menghini G., 2015. Prospective for hazelnut

- cultivation small energetic plants outcome in Turkey: Optimization and inspiration from an Italian model, *Renewable Energy*, 74, 523 – 527.
- [16] Arslan F., 2018. Fındık kabuğu ve ceviz kabuğunun pirolizi ile biyokömür üretimi ve sulu çözeltilerden ağır metal gideriminde adsorpsiyon özelliklerinin incelenmesi, Hitit Üniversitesi, Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü, 160.
- [17] Pütün A. E., Özcan A., Pütün E., 1999. Pyrolysis of hazelnut shells in a fixed – bed tubular reactor: yields and structural analysis of bio – oil, *Journal of Analytical and Applied Pyrolysis*, 52, 33 – 49.
- [18] Onay Ö., ve Koçkar M., 1998. Fındık kabuklarından hızlı piroliz yöntemiyle sentetik sıvı yakıt eldesi, *Osmangazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, XI, 72 – 81.
- [19] Meteoglu M., 2006. Çeşitli biyokütle numunelerinin yanma özelliklerinin incelenmesi, İstanbul Teknik Üniversitesi, Yüksek lisans tezi, Fen bilimleri enstitüsü, 39.
- [20] Güler C., Şen S., 2013. Fındık kabuğunun (Hazelnut shell) sıkıştırılmış yakıt olarak değerlendirilmesi, 9 (2), 111 – 116.
- [21] Sahu S.G., Chakraborty N. ve Sarkar P., 2014. Coal-biomass co-combustion: An review, *Renewable and Sustainable Energy Reviews*, 39, 575 – 586.
- [22] Özçimen D., Meriçboyu A.E., 2010. Characterization of biochar and bio-oil samples obtained from carbonization of various biomass materials, *Renewable Energy*, 35, 1319 – 1324.
- [23] Haykiri –Acma H., Yaman S., Küçükbayrak S., 2011. Burning characteristic of chemically isolated biomass ingredients, *Energy Conversion and Management*, 52, 746 – 751.
- [24] Duranay N., Yılgin M., 2018. Kısa analiz verileri kullanılarak biyokütlenin üst ısı değerinin hesaplanması, 6 - 2, 103 -108.
- [25] Demirbaş A., 1997. Calculation of higher heating values of biomass fuels, *Fuel*, 76 (5), 431 – 434.
- [26] Demirbaş A., 2005. Potential applications of renewable energy sources, biomass combustion problems in boiler power systems and combustion related environmental issues, *Progress in Energy and Combustion Science*, 31, 171 – 192.
- [27] Bakışgan C., Dumanlı A.G., Yürüm Y., 2009. Trace elements in Turkish biomass fuels: Ashes of wheat straw, olive bagasse and hazelnut shell, *Fuel*, 88, 1842 – 1851.
- [28] Kulah G., 2010. Validation of a FBC model for co-firing of hazelnut shell with lignite against experimental data, *Experimental Thermal and Fluid Science*, 34, 646 – 655.
- [29] Turan A. Z., 2009. Linyit biyokütle karışımlarının oksijen ortamında yakılması, İstanbul Teknik Üniversitesi, Yüksek lisans tezi, Fen bilimleri enstitüsü, 133.
- [30] Özgür E., 2014. Combustion performance of oil shale and biomass fuels and their blends, Ortadoğu Teknik Üniversitesi, Doktora tezi, Fen bilimleri enstitüsü, 161.
- [31] Haykiri-Acma H. ve Yaman S., 2008. Effect of co-combustion on the burnout of lignite/biomass blends: A Turkish case study, *Waste Management*, 28, 2077 – 2084.
- [32] Demirbaş A., 2003. Sustainable cofiring of biomass with coal, *Energy Conversion and Management*, 44, 1465 – 1479.

**EVALUATION OF DIFFERENT PHOTOVOLTAIC PANEL TECHNOLOGIES FOR
TEKİRDAĞ PROVINCE****FARKLI FOTOVOLTAİK PANEL TEKNOLOJİLERİNİN TEKİRDAĞ İLİ İÇİN
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ABSTRACT

Technology, which is constantly developing to facilitate humanity's living conditions, increases the need for energy day by day. Meeting this energy demand with carbon-based fossil fuels causes environmental problems as well as reserve problems. This situation makes the use of renewable energy sources indispensable. Among renewable energies, solar energy is one of the most preferred renewable energy sources. Today, there are different types of photovoltaic solar panels manufactured to generate electricity from solar energy. These are mono-crystalline, poly-crystalline, and thin-film solar panels. Thin-film solar panels are flexible solar panels formed by coating semiconductor materials on large surfaces. In this way, it can be easily used on inclined surfaces. However, the fact that they need very large areas in practice and their energy efficiency is lower than other photovoltaic panels limits their use. The efficiency of solar panels varies according to the solar radiation in the places where they are used, the slope of the panels and environmental conditions. Panel temperature is one of the most important parameters affecting the performance of the panels. Generally, the nominal operating temperatures of crystalline silicon panels are around 45 ± 2 °C. Above these temperatures, severe yield losses are experienced. Considering such factors, the properties of photovoltaic panels to be selected for the generation of electrical energy from solar energy should be examined in detail.

In this study, the performance of four different types of photovoltaic solar panels was investigated for a grid-connected house, which is considered to be located in three different districts of Tekirdağ province. In the research, performance analyzes of 800 W capacity solar energy systems, which were formed by selecting 10 of 80 W mono-crystalline, poly-crystalline, cadmium-telluride (CdTe) and amorphous silicon (a-Si) photovoltaic panels, was analyzed by RETScreen Expert (Clean energy management software) software. The findings were evaluated in terms of technical, economic, and environmental aspects. It is thought that this study will provide valuable information to researchers and investors for the investigated regions and photovoltaic panels.

Keywords: Mono-crystalline PV panel, Poly-crystalline PV panel, Cadmium-telluride PV panel, Amorphous-silicon PV panel, Thin-film solar panels.

ÖZET

İnsanlığın yaşam şartlarını kolaylaştırmak adına sürekli gelişmekte olan teknoloji, enerjiye gereksinimi her geçen gün daha da artırmaktadır. Bu enerji talebinin karbon kökenli fosil yakıtlar ile karşılanması ise rezerv sorunlarının yanı sıra çevresel sorunlara da neden olmaktadır. Bu durum yenilenebilir enerji kaynaklarının kullanımını vazgeçilemez kılmaktadır. Yenilenebilir enerjiler arasında güneş enerjisi, en çok tercih edilen yenilenebilir enerji

kaynaklarından biridir. Günümüzde, güneş enerjisinden elektrik enerjisi üretmek için imal edilmiş farklı tiplerde fotovoltaik güneş panelleri bulunmaktadır. Bunlar, mono-kristal, poli-kristal ve ince film güneş panelleridir. İnce film güneş panelleri yarı iletken malzemelerin geniş yüzeyler üzerine kaplanması ile oluşturulan esnek yapılı güneş panelleridir. Bu sayede eğimli yüzeyler üzerinde kolaylıkla kullanılabilir. Fakat uygulamada çok geniş alanlara ihtiyaç duymaları ve enerji verimliliklerinin diğer fotovoltaik panellere göre daha az olması kullanım yerlerini sınırlamaktadır. Güneş panellerinin verimlilikleri kullanıldıkları yerlerdeki güneş ışınımına, panellerin eğimine ve çevre şartlarına göre değişim göstermektedir. Panellerin performansını etkileyen en önemli parametrelerin başında panel sıcaklığı gelmektedir. Genellikle kristal silikon panellerin nominal çalışma sıcaklıkları 45 ± 2 °C civarındadır. Bu sıcaklıkların üzerinde ciddi verim kayıpları yaşanmaktadır. Bu gibi etkenler düşünüldüğünde, güneş enerjisinden elektrik enerjisi üretimi için seçilecek fotovoltaik panellerin özellikleri ayrıntılı olarak incelenmelidir.

Bu çalışmada, dört farklı tip fotovoltaik güneş panelinin performansı, Tekirdağ ilinin üç farklı ilçesinde bulunduğu kabul edilen şebekeye bağlantılı bir konut için araştırılmıştır. Araştırmada, 80 W kapasiteye sahip mono-kristal, poli-kristal, kadmiyum-tellür (CdTe) ve amorf-silisyum (a-Si) fotovoltaik panellerden 10'ar adet seçilerek oluşturulan 800 W kapasiteli güneş enerji sistemlerinin performans analizleri RETScreen Expert (Temiz enerji yönetim yazılımı) yazılımı kullanılarak gerçekleştirilmiştir. Elde edilen bulgular, teknik, ekonomik ve çevresel açıdan değerlendirilmiştir. Bu çalışmanın, incelenen bölgeler ve fotovoltaik paneller için araştırmacılara ve yatırımcılara yararlı bilgiler sunacağı düşünülmektedir.

Anahtar Kelimeler: Mono-kristal PV panel, Poli-kristal PV panel, Kadmiyum-tellür PV panel, Amorf-silisyum PV panel, İnce film güneş panelleri.

INTRODUCTION

Today, a large part of the researches carried out to meet the ever-increasing energy needs are on renewable energy (alternative energy) sources and the development of electrical energy production technologies from these sources. The potential of renewable energy sources, especially in the regions where energy conversion facilities are planned to be established, is effective on the development of these technologies or methods. Among the alternative energy sources, solar energy is preferred more than other renewable energy sources due to its potential, easy availability and environmental friendliness. (Varınca & Gönüllü, 2006). It is possible to come across many studies on the use of solar energy in the literature. Some of these studies are briefly mentioned here. In a study by Loulas et al., detailed shadow analysis of a building in Thessaloniki was investigated with Google Sketchup and PVSyst programs. As a result of the analyzes made, the situation of placing solar panels in areas without shadows was examined with the PVSyst program (Loulas, Karteris, Pilavachi, & Papadopoulos, 2012). In a study by Sharma and Chandel, they analyzed the performance of a photovoltaic power plant consisting of 36 polycrystalline panels with 75 Wp power and an installed power of 190 kWp in Khatkar-Kalan, India. As a result of the analysis they carried out with the PVSyst program, the annual performance rate of the system was 74% and the annual average measured energy efficiency was 823 kWh/kWp (Sharma & Chandel, 2013). In a study by İzgi and Özcan, monthly and annual performance analyzes of a 1MW grid-connected photovoltaic power plant created with three different solar module technologies, namely mono-crystalline, poly-crystalline and thin film, were performed in Osmangazi, Bursa. In the analyses, PVSyst and PV*SOL programs were used. According to the results obtained from the studies, they stated that the use of mono-crystalline PV panels showed more suitable results (İzgi & Özcan, 2020). In a study by Ramanan et al., they investigated the year-round performance values of a photovoltaic system

consisting of grid-connected poly-crystalline silicon and thin-film panels in Tamil Nadu, South India, by comparing the results obtained from the PVsyst software with the actual measurement results. They calculated the annual energy measured as 1536.9 kWh for poly-crystal and 1698.4 kWh for thin film (Ramanan & Karthick, 2019). In a study by Ali and Khan, they evaluated the electricity production of a 42 kWp PV system designed with poly-crystalline and thin film under the same environmental conditions (radiation, temperature, precipitation and dust) using the PV*SOL program. The results obtained from the simulation were compared with the real measurement data of one year. According to their results, they stated that the annual energy production of thin-film PV panels is higher than that of poly-crystalline. In addition, when evaluated according to the cost analysis, it was observed that poly-crystalline panels would be a more viable commercial solution in Pakistan with low electricity costs (Ali & Khan, 2020).

In this study, the performances of PV panels consisting of mono-crystalline, poly-crystalline, cadmium-telluride (CdTe) and amorphous-silicon (a-Si) solar cells were investigated for Şarköy, Saray and Marmara Ereğlisi districts of Tekirdağ province. In the research, the capacity of each solar cell examined is 80 W. A total of 10 of these cells were selected, and solar energy systems with a capacity of 800 W were compared. Performance analyzes of solar panels were carried out using the RETScreen Expert program. The findings were evaluated in terms of technical, economic and environmental aspects. Thus, by comparing different PV panel performances in regions with almost the same solar radiation values but different atmospheric conditions, a different approach from the studies in the literature has been presented.

MATERIAL and METHOD

Atmospheric Conditions of the Study Areas

The regions chosen for the performance analysis of PV panels are Sarkoy (41.0° N, 27.5° E), Saray (41.3° N, 28.0° E) and Marmara Ereğlisi (41.2° N, 27.8° E) districts of Tekirdag province. Atmospheric conditions of these districts were taken from the NASA meteorology database integrated into the RETScreen Expert program. Atmospheric conditions of the districts are presented in Table 1.

Table 1. Atmospheric conditions of the studied regions (RETScreen, 2021)

Region	Şarköy			
Month	Air Temperature (°C)	Relative humidity (%)	Horiz. solar radiation (kWh/m ² /day)	Wind speed (m/s)
January	5.2	83.1	1.66	2.6
February	5.0	80.7	2.43	2.8
March	7.2	80.5	3.61	2.7
April	11.8	79.2	4.82	2.2
May	16.4	77.5	6.13	2.2
June	21.0	75.2	7.00	2.2
July	23.6	75.2	7.06	2.6

August	23.7	71.8	6.25	2.8
September	20.2	73.1	4.85	2.5
October	15.5	76.0	3.03	2.6
November	10.3	80.2	1.88	2.6
December	6.7	83.3	1.37	2.8
Annual	13.9	78.7	4.18	2.5

Region

Saray

Month	Air Temperature (°C)	Relative humidity (%)	Horiz. solar radiation (kWh/m ² /day)	Wind speed (m/s)
January	5.1	85.0	1.52	5.0
February	5.0	82.9	2.27	5.0
March	7.0	80.4	3.39	4.7
April	11.2	78.2	4.60	4.0
May	16.2	75.1	5.79	3.6
June	21.2	69.0	6.63	3.6
July	23.8	66.1	6.87	4.4
August	24.1	66.6	5.92	4.8
September	20.6	67.9	4.54	4.5
October	15.9	76.0	2.75	4.8
November	11.0	81.5	1.73	4.7
December	6.9	84.5	1.27	5.2
Annual	14.1	76.1	3.95	4.5

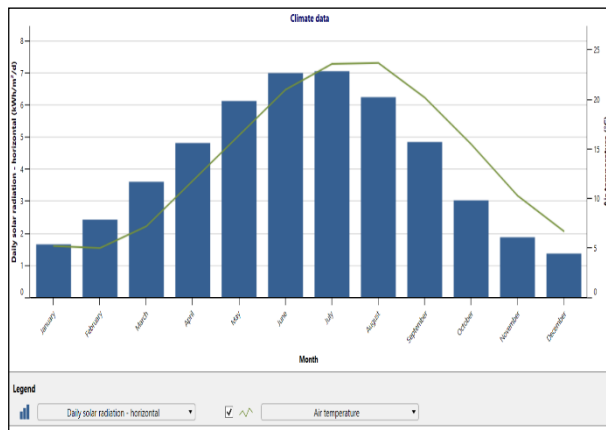
Region

Marmara Ereğlisi

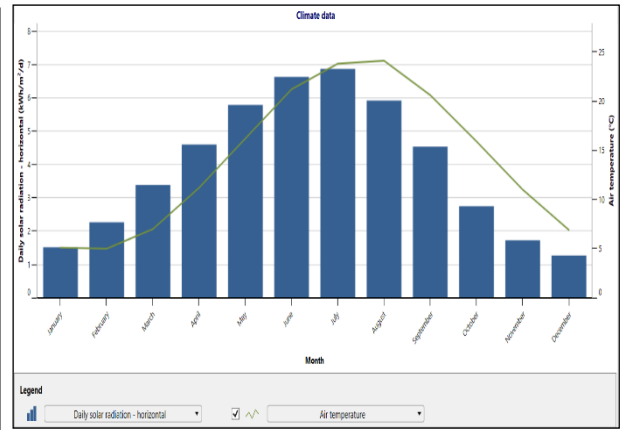
Month	Air Temperature (°C)	Relative humidity (%)	Horiz. solar radiation (kWh/m ² /day)	Wind speed (m/s)
January	4.1	86.5	1.57	4.6
February	4.2	83.5	2.35	4.6
March	6.6	80.0	3.48	4.5
April	11.2	76.3	4.63	3.8
May	16.4	71.9	5.76	3.5

June	21.5	64.0	6.42	3.4
July	24.2	59.2	6.59	4.1
August	24.2	60.4	5.82	4.4
September	20.3	64.2	4.56	4.1
October	15.1	75.0	2.90	4.4
November	10.0	82.7	1.82	4.3
December	5.7	86.5	1.31	4.8
Annual	13.7	74.1	3.94	4.2

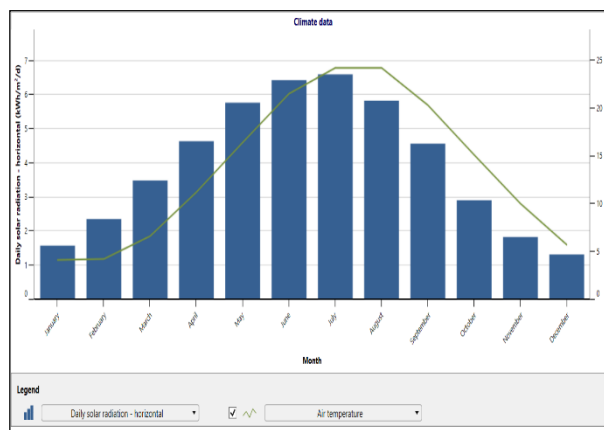
The daily horizontal solar radiation and air temperature graphs of the examined regions are given in Figure 1.



a) Şarköy



b) Saray



c) Marmara Ereğlisi

Figure 1. Horizontal solar radiation and air temperature variation of the studied regions (RETScreen, 2021)

Technical Specifications of Examined Photovoltaic Panels

The technical specifications of the examined photovoltaic panels are presented in Table 2.

Table 2. Technical characteristics of PV panels (RETScreen, 2021)

Type	Poly-Si	Mono-Si	cd-TE	a-Si
Power capacity (kW)	8	8	8	8
Manufacturer	BP Solar	Apin Solar	GE	Sungen
Model	BP SX 80 U	SP80	GE-CdTe80	SG-NH80-GS
Efficiency (%)	10.9	12.2	11.1	5.19
Nominal operating cell temperature (°C)	45	45	46	45
Temperature coefficient	0.4	0.4	0.24	0.11
Collector area (m ²)	7.3	6.6	7.2	15.4
Bifacial cell adjustment (%)	3	3	3	3
Miscellaneous losses (%)	10	10	10	10

Techno-Economic and Environmental Evaluation Criteria

Performance evaluation of PV panels was made using RETScreen Expert software (RETScreen, 2021). The financial values used in the economic analysis of PV modules were obtained from the ENF solar website (ENF Solar, 2021). The values used in financial sustainability analyzes are Central Bank of Turkey (Central Bank of Turkey, 2021), Turkey Electricity Distribution Inc. (Turkey Electricity Distribution Inc., 2021), Turkish Statistical Institute (Turkish Statistical Institute, 2021) web sites. These values used are presented in Table 3.

Table 3. Financial parameters

PV Type	Poly-Si	Mono-Si	cd-TE	a-Si
Total initial cost (\$)	2400	3096	2160	1600
Annual cost (\$)	258	258	258	258
Electricity export rate (\$/kWh)		0.133		
GHG emission factor (tCO ₂ /MWh)		0.472		
Fuel cost escalation rate (%)		9		
Inflation rate (%)		14		
Debt ratio (%)		70		
Debt interest rate (%)		7		
Debt term (yrs.)	15		10	

Electricity export escalation rate (%)	2
GHG reduction credit escalation rate (%)	9
Clean energy production credit rate (\$/kWh)	0.129
Clean energy credit escalation rate (\$/kWh)	9

In Table 3, annual maintenance fees of PV panels are assumed to be \$258. In addition, the service life of Crystal PV panels is accepted as 15 years and the service life of thin film PV panels as 10 years. PV systems are connected to the grid and the excess energy that is not used is sold to the grid. In addition, the amount of government incentives received from greenhouse gas reduction and clean energy production thanks to the PV system can be seen in Table 3.

FINDINGS AND DISCUSSION

The performance results of three different regions and four different PV panels examined are given in Table 4.

Table 4. Analysis results of the examined PV panels

District	Şarköy				Saray				Marmara Ereğlisi			
	Poly-Si	Mono-Si	cd-TE	a-Si	Poly-si	Mono-Si	cd-TE	a-Si	Poly-Si	Mono-Si	cd-TE	a-Si
Power capacity (kW)	8	8	8	8	8	8	8	8	8	8	8	8
Collector area (m ²)	7.3	6.6	7.2	15.4	7.3	6.6	7.2	15.4	7.3	6.6	7.2	15.4
Capacity factor (%)	16.2	16.2	16.5	16.8	15.3	15.3	15.6	15.8	16.4	16.4	16.6	16.9
Electricity produced (MWh)	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2
Annual GHG emission reduction (tCO ₂)	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6
Equity payback (year)	6.5	8.3	3.5	4.3	7	8.9	3.8	4.7	6.4	8.2	3.5	4.3

In order for the values given in Table 4 to be compared more easily, their performance according to the regions examined and PV panel selection, according to capacity factors, simple payback periods and energy production costs are given in Figure 2-4.

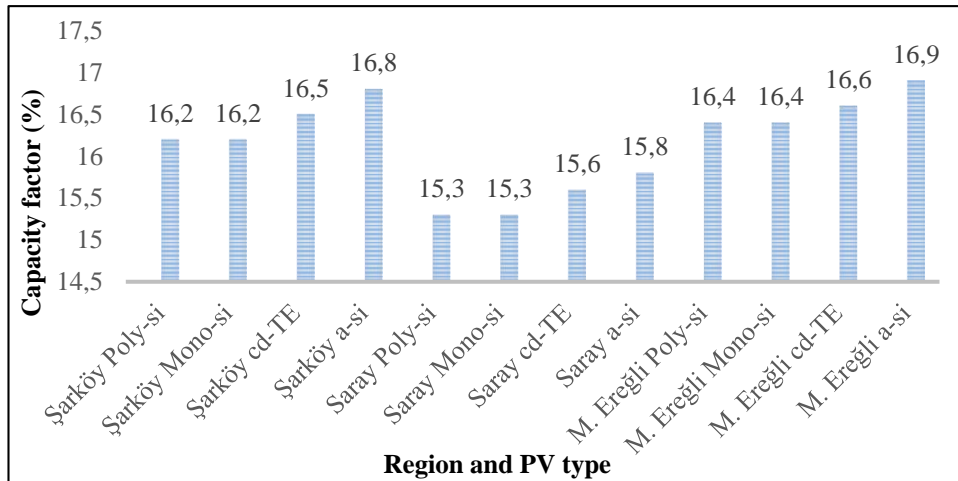


Figure 2. Variation of capacity factor according to region and PV panel type

Figure 2 shows the variation of the capacity factors according to the PV panel systems selected for the examined regions. Accordingly, it is seen that the region with the highest capacity factors of PV panels is Marmara Ereğlisi, and the region with the lowest is Saray. If an evaluation is made within the same region, the capacity factors of the PV panels are a-Si, cd-Te and crystal panels, respectively, from the most to the least.

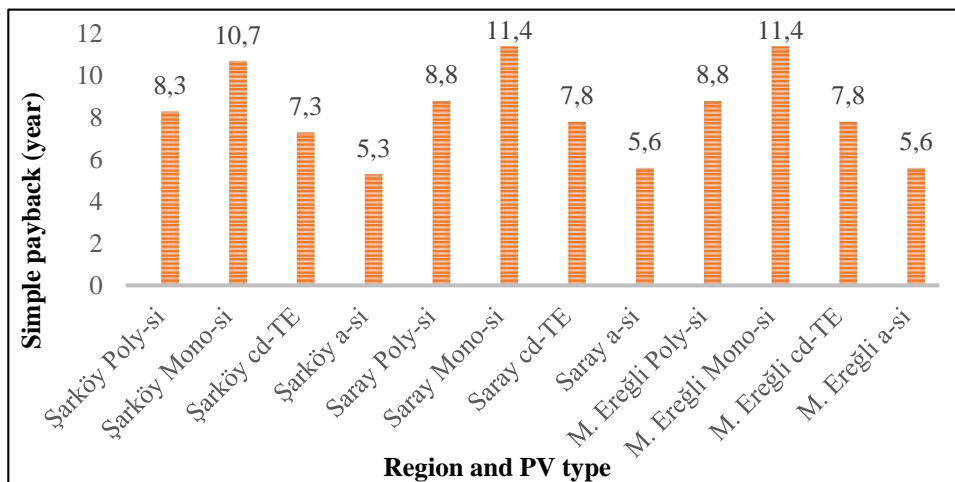


Figure 3. Variation of simple payback period according to region and PV panel type

When the simple payback period is analyzed according to the region and panel type examined in Figure 3, it is seen that the payback period of the a-si PV panel is the shortest and the payback period of the Mono-si PV panel is the longest. Although thin film panels seem to be advantageous in terms of payback periods, they are not preferred much because they have a short lifetime and need more collector area to produce the same amount of power as other PV panels.

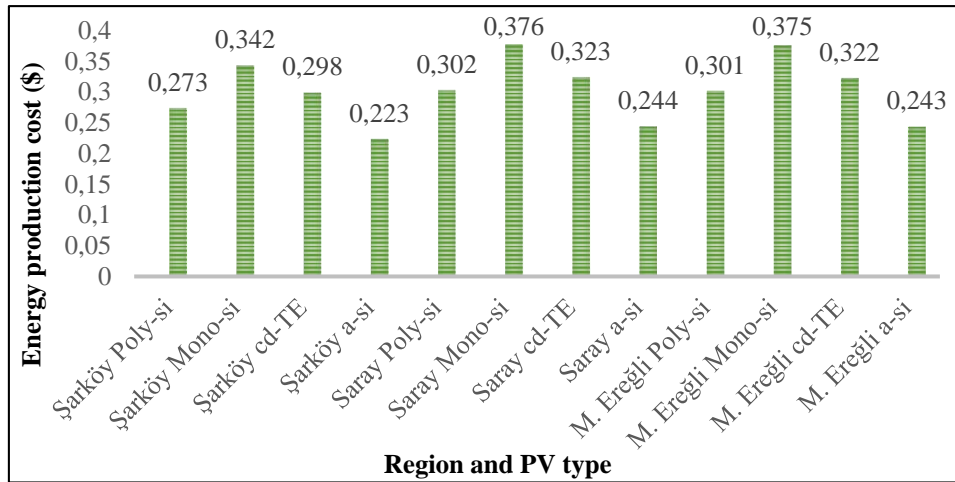


Figure 4. Variation of energy production cost according to region and PV panel type

When Figure 4 is examined, the energy production costs of PV panels are determined as a-Si, Poly-Si, cd-TE and Mono-Si, respectively, from the least to the highest. Although the initial investment costs of mono-si PV panels and accordingly the energy production costs are high, they are the most preferred PV panels today due to their higher efficiency and longevity.

CONCLUSION

In this study, the performance analysis of four different PV panel technologies for three different districts of Tekirdağ province was investigated from Techno-economic and environmental aspects. According to the results obtained from the study, of the mono-Si, poly-Si, cd-Te and a-Si PV panels that will be used to generate power at the same capacity from solar energy, a-Si is the one with the highest collector area requirement, and mono-Si is the one with the least collector area requirement. When the PV systems to be used in Saray, Şarköy and Marmara Ereğlisi districts are compared in terms of capacity factors, it has been determined that the district with the highest capacity factor of PV panels is Marmara Ereğlisi, and the district with the lowest capacity factor of PV panels is Saray. It has been determined that the amount of electrical energy produced by PV panels will vary between 1.1 and 1.2 MWh annually and the potential to reduce the amount of CO₂ emissions released to the environment will vary between 0.5 and 0.6 tCO₂. When the simple payback period and the unit cost of the electricity produced are evaluated, it has been determined that a-Si PV panel technology is the most suitable technology.

Although a-Si PV panels, one of the thin-film PV panel technologies, exhibited the most appropriate performance values in the examinations, their limited useful life and their tendency to deteriorate quickly limit the usage preferences of such PV panels. In this respect, it has been determined that the use of crystal PV panels, which is considered appropriate for the examined regions and which is the most preferred today, will be more appropriate in the examined regions. In particular, it has been concluded that Mono-crystalline PV panels will be the most appropriate PV panel technology choice when evaluated in terms of requiring less space, although having a slightly higher initial installation cost, lower annual maintenance and operating costs than other PV panels, and providing long-lasting use.

REFERENCES

- Ali, H., & Khan, H. A. (2020). Techno-economic evaluation of two 42 kWp polycrystalline-Si and CIS thin-film based PV rooftop systems in Pakistan. *Renewable Energy*, 1252, 347-357.
- Central Bank of Turkey. (2021, 7 1). Central Bank of Turkey: <https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN> adresinden alındı
- ENF Solar. (2021, 7 1). ENF: <https://www.ensolar.com/> adresinden alındı
- İzgi, E., & Özcan, Ö. (2020). Comparative Performance Analysis Of Grid-Connected Photovoltaic Roof System. *KSU J Eng. Sci.*, 23(3), 128-140.
- Loulas, N. M., Karteris, M. M., Pilavachi, P. A., & Papadopoulos, A. M. (2012). Photovoltaics in urban environment: a case study for typical apartment building in Greece. *Renewable Energy*, 453-463.
- Ramanan, P., & Karthick, A. (2019). Performance analysis and energy metrics of grid-connected photovoltaic systems. *Energy for Sustainable Development*, 52, 104-115.
- RETScreen. (2021, 7 1). RETScreen Expert: <https://www.nrcan.gc.ca/maps-tools-and-publications/tools/modelling-tools/retscreen/7465> adresinden alındı
- Sharma, V., & Chandel, S. S. (2013). Performance analysis of a 190 kWp grid interactive solar photovoltaic power plant in India. *Energy*, 476-485.
- Turkey Electricity Distribution Inc. (2021, 7 1). Turkey Electricity Distribution Inc.: <https://www.tedas.gov.tr/> adresinden alındı
- Turkish Statistical Institute. (2021, 7 10). Turkish Statistical Institute: <https://www.tuik.gov.tr/> adresinden alındı
- Varınca, K. B., & Gönüllü, M. T. (2006). Türkiye’de Güneş Enerjisi Potansiyeli ve Bu Potansiyelin Kullanım. *UGHEK’2006: I. Ulusal Güneş Ve Hidrojen Enerjisi Kongresi*, (s. 270-275). Eskişehir.

LC-MS/MS METHODOLOGY FOR DETERMINATION OF IMIDACLOPRID IN LEAFY VEGETABLES BY QUECHERS EXTRACTION

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ABSTRACT

The pesticides are chemicals used to prevent, destroy and control unwanted pests and their species during the cultivation, storage, transportation, distribution of agricultural products or during the processing of food and agricultural products. Pesticides are classified according to their intended use (insecticides, herbicides and fungicides) and their chemical structure (organic chlorides, organic phosphorus, carbamates, natural and synthetic pyrethroids). Difficulty of pesticide residue analysis; it arises from the necessity to analyze hundreds of active substances with very different physico-chemical properties in different matrices simultaneously. Therefore; It is extremely important to develop reliable, robust, fast, precise and cost-effective methods. The objective of present study was developed and optimized by liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) analytical method with QuEChERS (quick, easy, cheap, effective, rugged and safe) sample preparation procedures for imidacloprid residue determination in lettuce, spinach and parsley. Retention time was 8 min. Linearity was expressed as the coefficient of linear correlation ($R^2 \geq 0.99$) and slope of the calibration curve $y = 79.732x$ for the 20-150 $\mu\text{g/L}$ concentration range. The detector of the MS was tuned for the maximum sensitivity of precursor ion at $m/z = 255.9$, and of the product ions at $m/z = 209$ and $m/z = 175$. There are two specific fragmentations of imidacloprid. The first fragment is due to the loss of NO_2 (at $m/z = 209$). The second fragment is due to the losses of both NO_2 and Cl (at $m/z = 175$). Imidacloprid residue were below the already established European maximum residue limits (EU MRLs).

Keywords: Pesticide, imidacloprid, QuEChERS, LC-MS/MS, leafy vegetables.

1.INTRODUCTION

According to the environmental protection agency (EPA), while pest means living things that harm people and products, chemical and biological substances that destroy them are called pesticides [1]. Moreover, pesticides are chemicals used to prevent, destroy and control unwanted pests and their species during the cultivation, storage, transportation, distribution or during the processing of food and agricultural products.

Today, one of the most important problems of the rapidly increasing world population is nutrition. Despite the rapid population growth, today's agricultural land is limited. As a result, taking the highest place from the unit area emerges as a necessity. On the other hand, according to FAO data, almost half of the current world population cannot be fed sufficiently, and therefore, thousands of people die every year due to hunger and misery. It is estimated that more than half of the crops will be lost if pesticides are not used.

While most pesticides are effective for the target organism, they also harm non-target humans and other living things. Organochlorine pesticides, especially resistant to natural degradation and soluble in adipose tissues, accumulate in the bio-ecosystem and reach harmful levels for all living things [2]. Due to the negative effects of pesticides on humans and environment, the number of studies conducted with pesticides is increasing day by day.

More than 1000 pesticides are used worldwide to prevent pests from damaging or destroying food or plants. Each pesticide has different properties and toxicological effects.

In general, pesticides are classified according to their intended use (insecticides, herbicides and fungicides) and their chemical structure (organic chlorides, organic phosphorus, carbamates, natural and synthetic pyrethroids). Difficulty of pesticide residue analysis; It arises from the necessity to analyze hundreds of active substances with very different physico-chemical properties in different matrices simultaneously. Therefore; It is extremely important to develop reliable, robust, fast, precise and cost-effective methods. The most preferred extraction method in pesticide analysis is QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe) method [3]. This original method was developed in 2003 by Anastassiades et al [4]. It has been described as a fast, simple, inexpensive, efficient, reliable and safe extraction method that allows the analysis of a large number of pesticides with different structures in various matrices of fruits and vegetables . This method has a very wide analytical range and is an extraction method suitable for both GC and LC analysis; combined with the advantages of selectivity and sensitivity, the QuEChERS method has been adopted and applied by many laboratories around the world performing pesticide analysis.

The very common used methods for detection methods of pesticide residue; imidacloprid (IM) in fruit and vegetables are gas chromatography mass spectrometry (GC-MS), liquid chromatography–tandem mass spectrometry (LC-MS/MS) and enzyme-linked immunosorbent assay (ELISA)[5][6][7]. Since most of pesticides decompose at high temperatures, derivatization may be required while using GC, which makes the method complicated and time consuming. LC-MS/MS is the most commonly used detection method can provide qualitative and quantitative information for a wide range of analytes . In this technique multiple reaction monitoring (MRM) mode can reduced interference and improved instrument analysis accuracy , and can also scan in positive and negative ion modes[8] . Owing to these features, the popularity of LC-MS/MS the technology is increasing gradually[9].

Pesticide residues content is a limiting factor affecting the commercialization of food products. Maximum residue limit (MRL) value is the maximum permitted mass concentration level of pesticide in food products [10]. According to the EU pesticides database, MRL values imidacloprid in fruiting vegetables including tomatoes, cucumbers and peppers ranged from 0.2 to 1.0 mg/kg which are lower, on average, 10 times than in leafy vegetables.

This study was to develop of the Quick, Easy, Cheap, Effective, Rugged, and Safe (QuEChERS) method coupled with LC-MS/MS to evaluate imidacloprid residues in lettuce, parsley and spinach samples.

2. MATERIALS AND METHODS

2.1. Reagents and solvents

Imidacloprid (purity > 99.9% w/w) was purchased from Riedel-de Hën (Seelze, Germany). HPLC grade acetonitrile (MeCN), methanol (MeOH), formic acid, ammonium formate, magnesium sulfate (MgSO₄), sodium chloride (NaCl), primary secondary amine (PSA), acetic acid (AcOH), sodium acetate (NaOAc) were purchased from Merck (Darmstadt, Germany) and Sigma-Aldrich (Steinheim, Germany). The water used was purified with water purification system from Millipore (Bedford, MA, USA).

2.2. Sampling

The materials (letuce, parsley and spinach) were bought from local market in Tokat/ Turkey. The samples were prepared and analyzed at the same day. Samples were chopped to pieces and ground in a household blender (Vestel/Turkey). After homogenization, the green samples were extracted following a generic QuEChERS method.

2.3. Stock solution preparation

Stock solution of imidacloprid was prepared by dissolving in acetonitrile (1000 ppm). The working solutions were prepared by diluting the stock standard solution with acetonitrile. They were stored at refrigerator at 4°C.

2.4. The QuEChERS protocol

The QuEChERS method was performed for extraction. 15 g sample was weighed and placed in 50 mL tube and added 15 mL 1 % acetic acid in acetonitrile and shake by hand for a minute. MgSO₄ (6g) and NaOAc (1.5 g) were added and vortexed for 2 minute. The samples were centrifuged for 5 min at 5000 rpm. The supernatant (8mL) was transferred in to 15 mL tube containing 150 mg MgSO₄, 50 mg PSA, 50 mg graphitized carbon black, after which it was vortexed for 1 min. The samples tubes were centrifuged for 5 min 5000 rpm. The supernatants were filtered and transferred to autosampler vials (2mL) for LC-MS/MS analysis.

2.5.LC analysis

LC-MS–8050 triplequadrupole tandem mass spectrometer (Shimadzu, Kyoto, Japan) equipped with solvent degassing unit (DGU-20A3R), pump (LC-30AD), autosampler (SIL20A) and column furnace (CTO-10ASVP) were used in the LC-MS/MS. Separation of the analytes was achieved on a C18 intersil ODS-4 column (3µm; 2,1mm×150mm)with a column temperature 35°C. The mobile phase consisted of distilled water with 5 mmol ammonium formate (A), methanol with 5 mmol ammonium formate (B). The gradient profile was as follows: 0-3 min 95% A, 5%B; 3-6 min 40% A, 60%B; 6-7 min 30% A, 70% B; 7-8 20% A, 80% B. Flow rate was 0.6 mLmin⁻¹. LC-MS/MS was operated with a multimode interface in positive (+) ion mode. The heater gas temperature was 300 °C. Collision energy was optimized and the most abundant fragment ion was chosen for imidacloprid.

3.RESULT AND DISCUSSION

The analytical method for determination of imidacloprid in samples was validated all the necessary requirements of Europe Union (EU) SANTE/11813/2017 – method validation and quality control procedures for pesticide residue analysis in food and feed. The following parameters were studied selectivity, linearity, limit of detection (LOD) and limit of quantification (LOQ), accuracy, precision and specificity.

The selectivity of the method was confirmed comparing chromatograms obtained with and without analytes in the blanks.

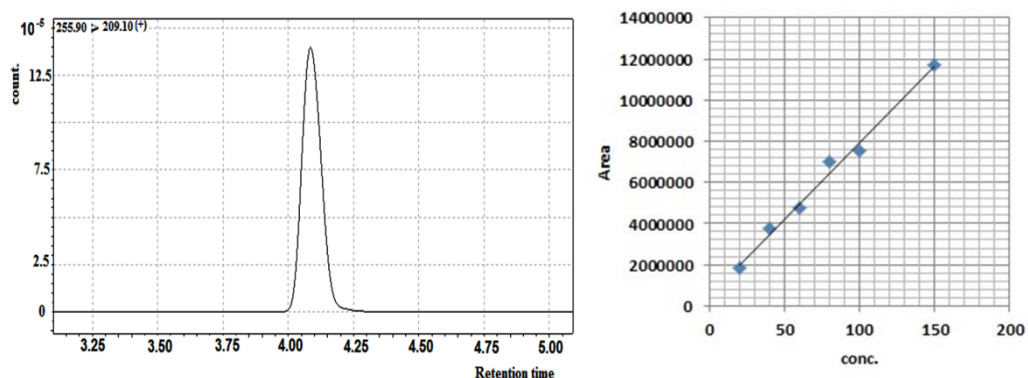


Figure 1. LC-MS/MS chromatogram of imidacloprid standard and calibration curve.

The calibration curve was obtained by plotting the peak area against the concentration of the corresponding calibration standard. As shown **Fig 1**; the linearity was evaluated from calibration curve by triplicate analyses of reference standard analyte at six (20.0, 40.0, 60.0, 80.0, 100.0, 150.0 µg/L) concentrations levels. Linearity was expressed as the coefficient of linear correlation ($r = 0.996$) and slope of the calibration curve $y = 79.732x$. The correlation coefficient (R^2) was higher than 0.99. The sensitivity of the proposed method was determined from the signal-to-noise ratio (S/N) of the analyte response in the calibration standards. The limit of detection (LOD) and (LOQ) was determined at S/N of 3, S/N of 10 by calibration curve. The noise was measured from ten injections of blank. The LOD was determined and S/N was greater than 10. The accuracy and precision were evaluated by recovery and repeatability tests, respectively. Samples were analyzed on the same day (N=5) with the same instrument and repeatability was calculated as relative standard deviation (RSD).

Table 1. MS/MS parameters for the analysis of imidacloprid in the MRM, ESI + mode.

Pesticide	Molecular formule	Molecular weight	Precursor ion (m/z)	Product ion (m/z)
Imidacloprid	C ₉ H ₁₀ ClN ₅ O ₂	255.66	255.9	209.1/175

Table 2. Chemical structure, molecular ion, and product ions of imidacloprid

Compound	Chemical structure, precursor ion	Product ion 1	Product ion 2
Imidacloprid			

The detector of the MS was tuned for the maximum sensitivity of precursor ion at $m/z = 256$, and of the product ions at $m/z = 212$ and $m/z = 175$ (tab.1). They are two specific

fragmentations of imidacloprid. The first fragment is due to the loss of N₂O (at m/z =212). The second fragment is due to the losses of both NO₂ and Cl (at m/z =175) (tab 2). (256 [M + H]⁺, 212 [M + H-N₂O]⁺, 175[M + H-NO₂-Cl]⁺)

4. CONCLUSION

In this study LC-MS/MS was used for determination of imidacloprid in plant samples. They were extracted and cleaned up by QuEChERS method before determination. The method showed a good linearity with determination coefficient (R²) higher than 0.99 for the 20-150 µg/L concentration range. Imidacloprid residue were below the already established European maximum residue limits (EU MRLs).

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REFERENCES

- 1 Watanabe, E., Eun, H., Baba, K., *et al.*: ‘Rapid and simple screening analysis for residual imidacloprid in agricultural products with commercially available ELISA’*Anal. Chim. Acta*, 2004, **521**, (1), pp. 45–51.
- 2 Nadaf, H.A., Singh Yadav, G., Kumari, B.: ‘Validation and monitoring of pesticide residues in honey using QuEChERS and gas chromatographic analysis’2016.
- 3 Wiest, L., Buleté, A., Giroud, B., *et al.*: ‘Multi-residue analysis of 80 environmental contaminants in honeys, honeybees and pollens by one extraction procedure followed by liquid and gas chromatography coupled with mass spectrometric detection’*J. Chromatogr. A*, 2011, **1218**, (34), pp. 5743–5756.
- 4 Santana-Mayor, Á., Socas-Rodríguez, B., Herrera-Herrera, A. V., Rodríguez-Delgado, M.Á.: ‘Current trends in QuEChERS method. A versatile procedure for food, environmental and biological analysis’ (Elsevier B.V., 2019), 116, pp. 214–235
- 5 Kiljanek, T., Niewiadowska, A., Semeniuk, S., Gawel, M., Borzęcka, M., Posyniak, A.: ‘Multi-residue method for the determination of pesticides and pesticide metabolites in honeybees by liquid and gas chromatography coupled with tandem mass spectrometry—Honeybee poisoning incidents’*J. Chromatogr. A*, 2016, **1435**, pp. 100–114.
- 6 Gbylik-Sikorska, M., Sniegocki, T., Posyniak, A.: ‘Determination of neonicotinoid insecticides and their metabolites in honey bee and honey by liquid chromatography tandem mass spectrometry’*J. Chromatogr. B Anal. Technol. Biomed. Life Sci.*, 2015, **990**, pp. 132–140.
- 7 Ma, H., Xu, Y., Li, Q.X., Xu, T., Wang, X., Li, J.: ‘Application of enzyme-linked immunosorbent assay for quantification of the insecticides imidacloprid and thiamethoxam in honey samples’*Food Addit. Contam. Part A*, 2009, **26**, (5), pp. 713–718.
- 8 Crupi, P., Bleve, G., Tufariello, M., Corbo, F., Clodoveo, M.L., Tarricone, L.: ‘Comprehensive identification and quantification of chlorogenic acids in sweet cherry

- by tandem mass spectrometry techniques' *J. Food Compos. Anal.*, 2018, **73**, pp. 103–111.
- 9 Aldayel, T.S., Grace, M.H., Lila, M.A., Yahya, M.A., Omar, U.M., Alshammary, G.: 'No Title' *Arab. J. Chem.*, 2020, **13**, (4), pp. 5040–5049.
- 10 Badawy, M.E.I.I., Ismail, A.M.E.E., Ibrahim, A.I.H.H.: 'Quantitative analysis of acetamiprid and imidacloprid residues in tomato fruits under greenhouse conditions' *J. Environ. Sci. Heal. Part B*, 2019, **54**, (11), pp. 898–905.

PHARMACEUTICAL FORMULARY LIST OF DRUGS

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ABSTRACT

The was analysed specialized departments of the state communal enterprise on the right of economic management «Children's City Clinical Hospital No.2» was carried out to include them in the list of the hospital's drug formulary.

Keywords: drugs, drug formulary, clinical protocols, Kazakhstan national drug formulary.

RELEVANCE

The Kazakhstan National Pharmaceutical Formulary is today the leading source of evidence-based information.

PURPOSE OF THE WORK

Apply in practice for prescribing medicines in accordance with clinical protocols for the diagnosis and treatment of the disease included in the list of the drug formulary, and having proven efficacy according to the list of drugs available in the Kazakhstan National Formulary.

MATERIALS AND METHODS

The analysis of applications for the availability of medicines in the Kazakhstan National Formulary was carried out.

The Kazakhstan National Pharmaceutical Formulary (KNF) is a list of medicines with proven clinical efficacy and safety, formed for the provision of medical care within the guaranteed volume of free medical care and compulsory social health insurance, indicating the maximum prices and is a mandatory basis for the development and approval of drug formularies in healthcare organizations. The Kazakhstan National Formulary is developed on the basis of pharmaco-therapeutic and (or) anatomical-therapeutic classification of medicines. In the Kazakhstan National Formulary, in accordance with the formation rules approved by order of the Minister of Health of the Republic of Kazakhstan dated April 2, 2020 No. 24/2020, only those medicines that have proven clinical efficacy are included. A new edition of the Kazakhstan National Pharmaceutical Formulary - Pharmaceutical Review of Kazakhstan was approved. (Ministry of Health of the Republic of Kazakhstan No. 931 dated April 21, 2020 No. 40/2020 as part of the provision of a guaranteed volume of free medical care and compulsory social health insurance)

For the inclusion of medicines in the Kazakhstan national drug formulary under the international non-proprietary name, the Formulary Commission assesses the compliance of the submitted data on:

- 1) the availability of research results of high methodological quality that reliably and convincingly prove clinical efficacy and safety;
- 2) presence in the clinical protocols of the Republic of Kazakhstan and (or) in international clinical guidelines;
- 3) the presence in the list of essential medicines of the World Health Organization and (or) in the British National Pharmaceutical Formulary (including for children);
- 4) availability of approval from the Food and Drug Administration of the United States of America (hereinafter - the USA) and (or) the European Medicines Agency. (Ministry of Health of the Republic of Kazakhstan No. 931 dated April 21, 2020 No. 40/2020 as part of the provision of guaranteed the volume of free medical care and compulsory social health insurance)

If the submitted data correspond to one of the subparagraphs of the Formulary Commission, a decision is made to include the drug under the international non-proprietary name in the Kazakhstan National Pharmaceutical Formulary.

The Kazakhstan National Pharmaceutical Formulary helps to increase the availability of effective drug care for every citizen, regardless of his social status and income, since it specifies the ceiling price levels for drugs. Its regular updating allows medical workers to receive data on drugs, on the practice of their use, to constantly improve their qualifications and improve their knowledge in the field of rational pharmacotherapy.

The Formulary Commission of the authorized body (hereinafter referred to as the Formulary Commission) coordinates and provides methodological support for the activities of the formulary system.

On the basis of the order of the Ministry of Health of the Republic of Kazakhstan No. 931 dated April 21, 2020 No. 40/2020, as part of the provision of a guaranteed volume of free medical care and compulsory social health insurance, for the provision of high-quality medical care to patients of the children's population of the city of Almaty, as well as the rational use of medicines, we annually we develop the clinic's drug formulary, through discussions at the formulary commission meetings, which are held on a quarterly basis. The medicinal form of the clinic is:

1. a list of medicinal products that are clinically proven to be effective;
2. drugs that are available in the clinical protocols for the diagnosis and treatment of all diseases, according to the list of nosologies of our clinic.

For the formation of the Kazakhstan National Pharmaceutical Formulary, the State Register of Medicines and Medical Devices is used. Order of the Minister of Health of the Republic of Kazakhstan dated May 18, 2021 No. 41.

The list of drugs for inclusion in the drug formulary of the clinic is formed on the basis of applications from specialized departments. The list of medicinal products included in the medicinal formulary of the clinic is discussed at the meeting of the formulary commission. When correcting the list of drugs in the list of the drug formulary, a commission is created for discussion at a meeting of the formulary commission (on the inclusion of this drug in our drug formulary).

DRUG FORM

№	Group of drugs	Drugs	Number in the department
1	H2-antihistamines blocking drugs	Famotidine	250
2	Proton pump inhibitors	Omeprazole	4220
		Esomeprazole (Nexium)	500
3	Antispasmodics	Papaverine (Papaverine hydrochloride)	1790
		Drotaverine	60
4	M-anticholinergics	Atropine sulfate (Atropine)	1820
5	Antiemetics	Metoclopramide (Cerucal)	1840
		Domperidone	3100
6	Bile preparations	Ursodeoxycholic acid	1500
7	Laxatives	Magnesium sulfate	5300
		Lactulose	131
8	Antifungal agents	Nystatin	366
9	Digestive drugs	Creon Pancreatin	8030
10	Vitamin A	Retinol Retinol acetate	500
	Vitamin C	Ascorbic acid	3912
	Vitamin B1	Thiamine Thiamine hydrochloride	910
	Vitamin B3	Nicotinic acid	150
	Vitamin B6	Pyridoxine Pyridoxine hydrochloride	4600
	Vitamin B12	Cyanocobalamin	560
11	Cardiac glycosides	Digoxin	1535
		Simdax (Levosimendan)	20
12	Cardiotonic drugs	Dopamine	460
13	Adrenomimetics	Adrenaline (Epinephrine)	916
14	Beta-adrenergic blockers	Anaprilin	100
15	Calcium channel blockers	Amlodipine (Koronym)	105
		Nifedipine	60
16	Angiotensin-converting enzyme inhibitors	Captopril	185
		Enalapril	10
		Fosinopril	150
17	Glucocorticosteroids	Budesonide	11300
		Dexamethasone	11030
		Prednisolone	30007
		Mometasone	60
		Methylprednisolone	3515
18	First generation cephalosporins	Cefazolin	13300
	Second generation cephalosporins	Cefuroxime	12660
	Third generation cephalosporins	Ceftazidime	10220
		Ceftriaxone	17106
		Cefoperazone	2200

	Fourth generation cephalosporins	Cefepim	12340
19	Carbapenems	Meropenem	6253
20	Macrolides	Spiramycin	1940
		Clarithromycin	1500
		Azithromycin	715
21	Aminoglycosides	Gentamicin	2170
		Amikacin	6420
22	Fluoroquinolones	Ciprofloxacin	450
23	Diuretics	Mannitol	690
		Spironolactone (Aldaron)	1580
	Thiazide diuretics	Hydrochlorothiazide	10
	Non-thiazide diuretics	Dichlor (Chlorthalidone)	15075
	Loop diuretics	Furosemide	6770
24	Vasodilators	Magnesium sulfate	5300
25	Antiviral drugs	Acyclovir	5715
26	Antifungal agents	Fluconazole	3913
		Voriconazole	233
		Caspofungin	50
27	Antimicrobial agents	Biseptol	1025
28	Antibacterials	Metronidazole	6730
29	Iron preparations	Firkile	200
		Ferrovit	404
30	Plasma-substituting drugs	Albumin	865
		Dextran (Reopolyglyukin)	227
		Polygyukin	13
		Gelofusine	300
31	M-anticholinergics	Tropicamide	81
32	Anticoagulants	Heparin	1081
		Fraxiparine	1000
33	Antiplatelet agents	Dipyridamole	6810
34	Somatostatins	Octreotide	50
35	Glycopeptides	Vancomycin	1370
36	Oxazolidinones	Linezolid	250
37	Amphenicols	Levomyccetin(Chloramphenicol)	50
38	Calcium preparations	Calcium gluconate	430
39	Antidotes	Sodium thiosulfate	1340
40	Amino acids	Levocarnitine	14500
		Cartan	
41	Hemostatics, vitamin K	Amri-K	10
	Hemostatics	Etamsylate	2200
42	Amino acid complexes	Aminoplasmal	30
43	Drugs for the treatment of erectile dysfunction	Sildenafil	1000
44	Adsorbents	Activated charcoal	23620
45	Rehydrating drugs	Regidron	850
46	Fibrinolysis inhibitors	Aminocaproic acid	500
		Tranexam	400
47	Electrolytes	Trisol	5
		Acesol	5
		Disol	5

		Ringer's solution	5020
	Saline solutions	Sodium chloride	80062
	Irrigation solutions	Glucose	24097
	Electrolyte solutions	Potassium chloride	1925
		Calcium chloride	304
48	Antiseptics	Chlorhexidine	1410
		Lugol's solution	2
		Povidone iodine	560
		Iodine	3
		Brilliant green alcohol solution	151
		Hydrogen peroxide	5279
		Potassium permanganate	166
		Ethanol	15936
49	Immunoglobulins	Immunoglobulin normal human	176
50	Dermatotropic agents	Dexpanthenol	220

RESULTS

The drug formulary of the clinic for 2021 includes 50 groups of drugs: H2-antihistamines blocking drugs, proton pump inhibitors, antispasmodics, M-anticholinergics, antiemetics, bile preparations, laxatives, antifungal agents, digestive drugs, vitamins(A, C, B1, B3, B6, B12), cardiac glycosides, cardiotoxic drugs, adrenomimetics, beta-adrenergic blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, glucocorticosteroids, cephalosporins (first generation, second generation, third generation, fourth generation), carbapenems, macrolides, aminoglycosides, fluoroquinolones, diuretics (thiazide, non-thiazide, loop), vasodilators, antiviral drugs, antifungal agents, antimicrobial agents, antibacterials, iron preparations, plasma-substituting drugs, M-anticholinergics, anticoagulants, antiplatelet agents, somatostatins, glycopeptides, oxazolidinones, amphenicols, calcium preparations, antidotes, amino acids, hemostatics, amino acid complexes, drugs for the treatment of erectile dysfunction, adsorbents, rehydrating drugs, fibrinolysis inhibitors, electrolytes (saline, irrigation, electrolyte solutions), antiseptics, immunoglobulins, dermatotropic agents and 108 drug names.

RESUME

The drug formulary determines the list of medicines purchased by the clinic according to their evidence-based effectiveness, the presence of the diagnosis and treatment of the disease in the clinical protocol, which contributes to the rational use of budgetary funds and the use of effective therapy in patients.

BIBLIOGRAPHY

1. By the Order of the Minister of Health of the Republic of Kazakhstan dated April 21, 2020 No. Ministry of Health of the Republic of Kazakhstan-40/2020 "" On the approval of the Kazakhstan national drug formulary ""
2. Order of the Minister of Health of the Republic of Kazakhstan dated May 18, 2021 No. Ministry of Health of the Republic of Kazakhstan - 41 "On approval of the Kazakhstan national drug formulary"

3. <http://pharm.reviews/>
4. (/ 100 / KNF_PR_for population.pptx)

ЛЕКАРСТВЕННЫЙ ФОРМУЛЯР ПЕРЕЧЕНЬ ЛЕКАРСТВЕННЫХ СРЕДСТВ

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Аннотация

Проведен анализ заявок от профильных отделений КГП на ПХВ «Детской городской клинической больницы №2» для включения их в перечень лекарственного формуляра клиники .

Ключевые слова: лекарственные препараты, лекарственный формуляр, клинические протоколы, Казахстанский национальный лекарственный формуляр.

Актуальность: Казахстанский национальный лекарственный формуляр на сегодняшний день является передовым источником доказательной информации.

Цель работы: Применить в практике для назначений лекарственных средств согласно клинических протоколов диагностики и лечения заболевания, вошедших в

перечень лекарственного формуляра, и имеющих доказанную эффективность согласно перечня лекарственных средств имеющихся в КНФ .

Материалы и методы: Проведен анализ заявок на предмет наличия лекарственных средств в КНФ.

Казахстанский национальный лекарственный формуляр (КНФ) представляет собой перечень лекарственных средств с доказанной клинической эффективностью и безопасностью, сформированный для оказания медицинской помощи в рамках ГОБМП и ОСМС с указанием предельных цен и являющийся обязательной основой для разработки и утверждения лекарственных формуляров в организациях здравоохранения. КНФ разрабатывается на основе фармако-терапевтической и (или) анатомо-терапевтической классификации лекарственных средств. В КНФ, в соответствии с правилами формирования, утвержденными приказом Министра здравоохранения РК от 2 апреля 2020 года № ҚР ДСМ-24/2020, включаются только те лекарственные средства, которые имеют доказанную клиническую эффективность. Утверждена новая редакция Казахстанского национального формуляра - Фармацевтическое обозрение Казахстана. (МЗ РК № 931 от 21 апреля 2020 года № ҚР ДСМ-40/2020 в рамках оказания ГОБМП и ОСМС)

Для включения лекарственных средств в КНФ по МНН Формулярная комиссия производит оценку соответствия представленных данных на:

- 1) наличие результатов исследований высокого методологического качества, достоверно и убедительно доказывающих клиническую эффективность и безопасность;
- 2) наличие в клинических протоколах Республики Казахстан и (или) в международных клинических руководствах;
- 3) наличие в списке основных лекарственных средств Всемирной организации здравоохранения и (или) в Британском национальном лекарственном формуляре (в том числе для детей);
- 4) наличие одобрения Управления по контролю пищевых продуктов и лекарственных средств Соединенных штатов Америки (далее – США) и (или) Европейского агентства по лекарственным средствам.(МЗ РК № 931 от 21 апреля 2020 года № ҚР ДСМ-40/2020 в рамках оказания ГОБМП и ОСМС).

При соответствии представленных данных одному из подпунктов Формулярной комиссией принимается решение о включении в КНФ лекарственного средства по МНН.

КНФ способствует увеличению доступности эффективной лекарственной помощи для каждого гражданина независимо от его социального статуса и дохода, поскольку в нем указаны предельные уровни цен на медикаменты. Его регулярное обновление позволяет получать медицинским работникам данные о препаратах, о практике их использования, постоянно повышать квалификацию и совершенствовать знания в области рациональной фармакотерапии.

Формулярная комиссия уполномоченного органа (далее – Формулярная комиссия) осуществляет координацию и методологическую поддержку деятельности формулярной системы.

На основании приказа МЗ РК № 931 от 21 апреля 2020 года № ҚР ДСМ-40/2020 в рамках оказания ГОБМП и ОСМС ,для осуществления качественной медицинской

помощи пациентам детского населения города Алматы, а также рационального использования лекарственных средств мы ежегодно разрабатываем лекарственный формуляр клиники, обсуждениями на заседаниях формулярной комиссии, которые проходят ежеквартально. Лекарственный формуляр клиники это:

1. перечень лекарственных препаратов, которые имеют клиническую доказанную эффективность;
2. лекарственные препараты, которые имеются в клинических протоколах диагностики и лечения всех заболеваний, согласно перечня нозологий нашей клиники.

Для формирования КНФ используется Государственный реестр лекарственных средств и медицинских изделий. Приказ Министра здравоохранения Республики Казахстан от 18 мая 2021 года № КР ДСМ – 41.

Формирование списка лекарственных препаратов для включения в лекарственный формуляр клиники происходит на основании заявок от профильных отделений. Перечень лекарственных препаратов, включаемых в лекарственный формуляр клиники обсуждаются на заседании формулярной комиссии. При корректировке перечня лекарственных средств в списке лекарственного формуляра создается комиссия по обсуждению на заседании формулярной комиссии (о включении данного лекарственного препарата в наш лекарственный формуляр).

ЛЕКАРСТВЕННЫЙ ФОРМУЛЯР

№	Группа препаратов	Препараты	Кол-во в отделении
1	Блокаторы гистаминных H ₂ -рецепторов	Фамотидин (Квамател)	250
2	Ингибиторы протонного насоса	Омепразол (Омес, Омегаст)	4220
		Эзомепразол (Нексиум)	500
3	Спазмолитики	Папаверин (Папаверина гидрохлорид)	1790
		Дротаверин (Но-шпа)	60
4	М-холиноблокаторы	Атропина сульфат (Атропин)	1820
5	Противорвотные средства	Метоклопрамид (Церулин, Церукал)	1840
		Домперидон (Дамелиум, Дониум-ТК)	3100
6	Препараты желчи	Урсодезоксихолевая кислота (Урсосан)	1500
7	Слабительные препараты	Магния сульфат	5300
		Лактулоза (Дюфалак)	131
8	Противогрибковые средства	Нистатин	366

9	Пищеварительные препараты	Креон Панкреатин	8030
10	Витамин А	Ретинол Ретинола ацетат	500
	Витамин С	Аскорбиновая кислота	3912
	Витамин В1	Тиамин Тиамина гидрохлорид	910
	Витамин В3	Никотиновая кислота	150
	Витамин В6	Пиридоксин Пиридоксина гидрохлорид	4600
	Витамин В12	Цианокобаламин	560
11	Сердечные гликозиды	Дигоксин	1535
		Симдакс (Левосимендан)	20
12	Кардиотонические препараты	Допамин	460
13	Адреномиметики	Адреналин (Эпинефрин)	916
14	β -адреноблокаторы	Анаприлин	100
15	Блокаторы кальциевых каналов	Амлодипин (Короним)	105
		Нифедипин	60
16	Ингибиторы АПФ	Каптоприл	185
		Эналаприл	10
		Фозиноприл (Фозикард)	150
17	Глюкокортикостероиды	Будесонид	11300
		Дексаметазон	11030
		Мометазон (Элоком)	60
		Преднизолон	30007
		Метилпреднизолон (Адвантан)	3515
18	Цефалоспорины первого	Цефазолин	13300

	поколения		
	Цефалоспорины второго поколения	Цефураксим (Мегасеф; Зиннат)	12660
	Цефалоспорины третьего поколения	Цефтазидим	10220
		Цефтриаксон (Цеф III)	17106
		Цефоперазон (Медоцеф)	2200
	Цефалоспорины четвертого поколения	Цефепим (Цеф 4)	12340
19	Карбапенемы	Меропенем	6253
20	Макролиды	Спирамицин (Ровамицин)	1940
		Кларитромицин (Клабел, Класид)	1500
		Азитромицин (Сумамед; Азитро)	715
21	Аминогликозиды	Гентамицин	2170
		Гентамицина сульфат	
		Амикацин (Меркацин)	6420
22	Фторхинолоны	Ципрофлоксацин (Ципролет)	450
23	Диуретики	Маннитол (Маннит)	690
		Спиринолактон (Альдарон)	1580
	Тиазидные диуретики	Гидрохлоротиазид	10
	Нетиазидные диуретики	Дихлор (Хлорталидон)	15075
	Петлевые диуретики	Фуросемид	6770
24	Вазодилататоры	Магния сульфат	5300
25	Противовирусные препараты	Ацикловир (Медовир; Улкарил)	5715
26	Противогрибковые средства	Флуконазол (Флунол)	3913
		Вориконазол (Вифенд)	233
		Каспофунгин (Касфоцин)	50
27	Противомикробные средства	Бисептол	1025

28	Антибактериальные	Метронидазол	6730
29	Препараты железа	Феркайл	200
		Ферровит	404
30	Плазмозамещающие препараты	Альбумин	865
		Декстран (Реополиглюкин)	227
		Полиглюкин	13
		Гелофузин	300
31	М-холинолитики	Тропикамид	81
32	Антикоагулянты	Гепарин	1081
		Фраксипарин (Надопарин)	1000
33	Антиагреганты	Дипиридамол	6810
34	Соматостатины	Октреотид	50
35	Гликопептиды	Ванкомицин	1370
36	Оксазолидиноны	Линезолид	250
37	Амфениколы	Левомецетин (Хлорамфеникол)	50
38	Препараты кальция	Кальция глюконат	430
39	Антидоты	Натрия тиосульфат	1340
40	Аминокислоты	Левокарнитин	14500
		Карган	
41	Гемостатики, витамин К	Амри-К	10
	Гемостатики	Этамзилат	2200
42	Комплексы аминокислот	Аминоплазмаль	30
43	Препараты для лечения эректильной дисфункции	Силденафил (Синегра)	1000
44	Адсорбенты	Уголь активированный	23620
45	Регидратирующие препараты	Регидрон	850

46	Ингибиторы фибринолиза	Аминокапроновая кислота	500
		Транексам	400
47	Электролиты	Трисоль	5
		Ацесоль	5
		Дисоль	5
		Раствор Рингера	5020
	Солевые растворы	Натрия хлорид	80062
	Ирригационные растворы	Глюкоза	24097
	Электролитные растворы	Калия хлорид	1925
		Кальция хлорид	304
48	Антисептические средства	Хлоргексидин	1410
		Раствор Люголя	2
		Повидон-йод	560
		Йод	3
		Бриллиантовый зеленый спиртовой раствор	151
		Перекись водорода	5279
		Калия перманганат	166
		Спирт этиловый (Этанол)	15936
49	Иммуноглобулины	Иммуноглобулин человеческий нормальный	176
50	Дерматотропные средства	Декспантенол (Бепантен)	220

Результаты:

Лекарственный формуляр клиники на 2021 год включает 50 групп препаратов: Блокаторы гистаминных H₂-рецепторов, ингибиторы протонного насоса, спазмолитики, М-холиноблокаторы, противорвотные средства, желчегонные средства, слабительные препараты, противогрибковые средства, пищеварительное ферментное средство, витамины (А, С, В1, В3, В6, В12), сердечные гликозиды, кардиотонические препараты, адреномиметики, β-адреноблокаторы, блокаторы кальциевых каналов, ингибиторы АПФ, глюкокортикостероиды, цефалоспорины (первого, второго, третьего,

четвертого поколения), карбапенемы, макролиды, аминогликозиды, фторхинолоны, диуретики (тиазидные, нетиазидные, петлевые), вазодилататоры, противовирусные препараты, противогрибковые средства, противомикробные средства, антибактериальные, препараты железа, плазмозамещающие препараты, М-холинолитики, антикоагулянты, антиагреганты, соматостатины, гликопептиды, оксазолидиноны, амфениколы, препараты кальция, антидоты, аминокислоты, гемостатики, комплексы аминокислот, препараты для лечения эректильной дисфункции, адсорбенты, регидратирующие препараты, ингибиторы фибринолиза, электролиты (солевые, ирригационные, электролитные растворы), антисептические средства, иммуноглобулины, дерматотропные средства и 108 наименований лекарственных средств.

Заключение: Лекарственный формуляр определяет перечень лекарственных средств закупаемых клиникой согласно их доказательной эффективности, наличия в клиническом протоколе диагностики и лечения заболевания, что способствует рациональному использованию бюджетных средств и применения эффективной терапии у пациентов.

Список литературы:

1. Приказом Министра здравоохранения РК от 21 апреля 2020 года № ҚР ДСМ-40/2020 ««Об утверждении Казахстанского национального лекарственного формуляра»»
2. Приказ Министра здравоохранения Республики Казахстан от 18 мая 2021 года № ҚР ДСМ – 41 «Об утверждении Казахстанского национального лекарственного формуляра»
3. <http://pharm.reviews/>
4. (/100/КНФ_PR_для населения.pptx)

THE MAIN DIRECTIONS OF EXPORT PROMOTION AND IMPORT SUBSTITUTION POLICY IN AZERBAIJAN

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ABSTRACT

The experience of both the world countries and the complexity of the issues to be solved require the comprehensive and gradual improvement of the system of state regulation of foreign economic activity in our country. In my opinion, this system should, first of all, ensure the implementation of the principles underlying the state regulation of foreign economic activity of our country. One of the main conditions for the effective functioning of the market economy is the development of free enterprise, the provision of favorable conditions for it, and another important condition is the involvement of entrepreneurial structures and businesses in the regulation process. Such cooperation between state authorities and business organizations is of greater importance in the context of foreign economic policy. Among the measures to be taken to improve the regulatory system are the strengthening of control over the prices of exported goods and services. This mechanism should be mainly aimed at addressing two objectives: increasing the country's foreign exchange earnings and accusing local producers of dumping. Implementation of the selective protection strategy of the domestic market should be based on a number of principles aimed at addressing the objectives of improving the competitiveness of production and the impact on importers' lobbying:

- maximizing the rules for the implementation of tariff protection in the domestic market, establishing clear and transparent procedures for changing prices, levels for manufacturers, importers and investors;

- strengthening the responsibility of local producers to enhance the competitiveness of foreign producers, in other words, the level of tariff protection of those producers based solely on their commitment to carry out the restructuring.

Keys words: foreign trade, international standards, key factors, political stability, export-oriented sectors, logical development.

РЕЗЮМЕ

Опыт стран мира и сложность решаемых вопросов требуют комплексного и постепенного совершенствования системы государственного регулирования внешнеэкономической деятельности в нашей стране. На мой взгляд, эта система должна, прежде всего, обеспечивать реализацию принципов государственного регулирования внешнеэкономической деятельности нашей страны. Одним из основных условий эффективного функционирования рыночной экономики является развитие свободного предпринимательства, создание для него благоприятных условий, а еще одним важным условием является вовлечение предпринимательских структур и бизнеса в процесс регулирования. Такое сотрудничество между государственными органами и бизнес-организациями имеет большее значение в контексте внешнеэкономической политики. Среди мер, которые необходимо принять для улучшения системы регулирования, - усиление контроля над ценами на экспортируемые товары и услуги. Этот механизм в основном должен быть направлен

на решение двух задач: увеличение валютных поступлений страны и обвинение местных производителей в демпинге. Реализация стратегии избирательной защиты внутреннего рынка должна основываться на ряде принципов, направленных на решение задач повышения конкурентоспособности продукции и влияние на лоббирование импортеров:

- максимизация правил реализации тарифной защиты на внутреннем рынке, установление четких и прозрачных процедур изменения цен, уровней для производителей, импортеров и инвесторов;
- усиление ответственности местных производителей за повышение конкурентоспособности иностранных производителей, другими словами, уровень тарифной защиты этих производителей, основанный исключительно на их приверженности проведению реструктуризации.

Although oil, oil and gas sales are an important part of exports in Azerbaijan, the share of the non-oil sector in foreign trade is increasing. In order to accelerate development in this area, the country has successfully taken measures to stimulate the production of high-quality and competitive products according to international standards in world markets and to create enterprises based on modern technology and business. In recent years, the production of competitive products in our country has increased significantly. Interest in these products is growing in the world markets. Significant changes have occurred in the structure of the foreign trade turnover in the Republic of Azerbaijan, which has improved the competition index year by year. For this reason, products manufactured in new sectors of our country are gradually suppressing similar foreign goods sold in the domestic market, and in some cases even for export. This will ultimately reduce the dependence of the domestic market on imports. Overall, significant efforts have been made recently to increase the export capacities of Azerbaijan for non-oil products. Thus, the legislative framework was improved, the production of exported goods was stimulated, and the infrastructure of export was improved. Creation of industrial cities, trade houses of Azerbaijan in export market countries is one of the important work done in this direction. Export products are dominated by crude oil, oil products, natural gas, fruit and vegetable oils, oils and vegetable and animal products, food products, ferrous metals and their products, machinery, machinery, electrical equipment, vehicles and parts. 24 Continuous improvement of business environment for development of entrepreneurship in the country, improvement of legislative base in this area, attraction of local and foreign investments, modern technologies, management experience and production of high quality, competitive products are the priorities of economic development strategy set by the President of the Republic of Azerbaijan. At the moment, our main goal is to maintain the dynamic development achieved in the country through enhancing the competitiveness of the national economy and its efficient integration into the world economy, accelerating the development of the non-oil sector and entrepreneurship. As a result of reforms targeted since 1995, macroeconomic stability in the country's economy has stabilized. Large-scale economic reforms implemented in 1995 have created favorable conditions for a significant improvement in living standards and the solution of socio-economic problems in the regions.

In general, the formation and development of exports in the country should be carried out in the following strategic directions:

- regularly changing the export structure through the formation and development of export potential, the bonus system (expansion of the export of finished products through subsidies and other means); increasing the competitiveness of Azerbaijani enterprises in foreign markets;

- attracting foreign direct investment for technical modernization;
- the need to create and develop export potential changes in the export structure (from raw exports to semi-finished products and then to competitive goods exports in the world market);
- stimulating the comparative advantages of the national economy.

Azerbaijan's export potential development program will not be able to cut exports of goods and products through exports. At this time it is necessary to create conditions for active participation of local business, especially small and medium-sized businesses and creation of large international corporations in Azerbaijan. From a strategic economic point of view, exports should be considered appropriate in national currency. In this case, it is easier to provide the value of the manat. The current export structure is not satisfactory for the industry. Low-grade industrial products and mainly raw and semi-finished agricultural products make up about 90% of our exports. Azerbaijan has reference points for the development of the electronics and electrical industry, as well as the complex home appliances industry. The scientific and technological potential of military-industrial complex enterprises can transform these areas into leading regional and world-leading enterprises in their fields with the latest technology and management. Agro-industrial products occupy a special place in the export potential of Azerbaijan. Increasing the export of a range of products, including cotton production and yarn, grapes and grapes and wine products, fast growing vegetables and melons, can bring significant money into the country, taking into account agricultural traditions, natural climatic conditions and restorative properties. Because, historically, the aforementioned areas have been areas that have recognized Azerbaijan both in the former Soviet Union and at the global level. As is known, the Azerbaijani economy has limited opportunities for exporting finished products. Almost all the products of the republic can be sold on the world market. In this case, flexible marketing tactics, low contract prices, world standards and high quality can be applied to certain products (engineering and light industry, home appliances, etc.) under certain conditions. Currently, the main barrier to increased exports of finished products is the weak processing industry. In the 1990s, only 12% of machinery manufacturing exports were at world standards. One of the reasons why exports are underdeveloped is the nature of the capital accumulation process. Most businesses, including those with foreign investment, predominantly prefer brokerage activities rather than manufacturing. This is primarily due to the fact that capital in these areas is more rotating. One of the serious reasons is the conservative mentality of the population of the republic. In the 70 years of communism, private entrepreneurial entrepreneurship was engulfed, and now it will take some time and effort to restore it. One of the most profitable areas for increasing export potential could also be the service sector. It should be noted that the share of this sector in the world accounts for about 30% of exports. Given the enormous potential of Azerbaijan's favorable natural and geographical transport, it is urgently needed to take advantage of the millions of tourist-transit travel opportunities available here. I think that the development of this area is the construction of hotels and recreation houses, sanatoriums and boarding houses in accordance with international standards, the construction of airports and transportation lines, the construction of large consignment warehouses for transit goods. These measures will make the service sector one of the most influential areas of Azerbaijani exports. All this will create a logistical base for the reconstruction of a number of industries, providing the necessary institutional environment for the investment flow. The country's economic policy for export promotion, given the state's financial resources, should include:

- a) elimination of existing barriers to investment by creating favorable conditions for capital mobilization and efficient resource allocation;

b) establishment of optimal competitive mode with the help of customs policy tools for various industries.

In this regard, it is necessary to develop regional and sectoral programs for the rational use of the export potential of the national economy. Its development is important not only from government agencies, but also from local entrepreneurs, foreign investors, technical assistance experts and international organizations. Availability of accurate programs and projects is one of the main conditions for making the Azerbaijani market attractive for foreign investors. Therefore, state support should be provided to areas that are able to enter the competitive market with a competitive product. This assistance can be directly subsidized, concessional loans, etc. It is provided through. indirectly or indirectly, tax cuts, export insurance, export rewards, etc. can be applied with the application. For example, the state may assume personnel training for export-oriented entities and may establish the political and economic conditions necessary for the operation of these enterprises abroad. For example, the state may assume personnel training for export-oriented entities and may establish the political and economic conditions necessary for the operation of these enterprises abroad. But here comes another problem. Thus, there is still no law in the country that can protect the interests of national producers both inside and outside the country. This is explained by the fact that the country does not have a fully developed policy in the field of foreign economic activity, lack of determination of the country's interests in the foreign market and, accordingly, no foreign economic strategy. Positive tendency is the formation and increase of the share of the private sector in the export turnover of the Republic of Azerbaijan. The conditions for the transition to this market relationship, as well as the formation of national entrepreneurship in both agriculture and industry, are legal. At the same time, the slow development of market relations, as well as domestic production, has slowed the expansion of exports by the private sector. Despite the existence of a law on the equality of various owners, there is still discrimination among some private companies and businesses trying to enter the foreign market. Along with the probability of expanding export opportunities and promoting export, it is necessary to pay close attention to the import policy in the republic. Thus, imports play an important role in the country's overall foreign economic strategy. Practically, the state's import policy reflects its overall economic growth strategy, closely linked to the country's domestic economic policy. Analysis of the structure of imports in the Republic of Azerbaijan shows that food and consumer goods have a higher share in imports. However, it is quite clear that the import structure, which contains a significant part of the production facilities, or rather modern machines and equipment, is considered to be more effective. Naturally, the existing structure of imports is due to the difficult situation in the economy of the country as a whole. The weakness of agriculture, the lighter and the lagging behind the food industry have caused these products to have a high share in imports. Therefore, the improvement of imports is impossible without changing the overall economic situation in the country, or rather improving the structure of domestic consumption and production in general. At the same time, there are also some internal challenges to the development of imports and its structure. Thus, the existing inefficient import structure itself does not meet the requirements of the country's consumer market. Existing tax and customs tariff systems prevent the import of high quality products into the country. These conditions, on the one hand, destroy the domestic production market and, on the other, lead to the formation of low and non-economic consumption. It should be noted that cooperation of the Republic of Azerbaijan with international and regional economic unions and organizations is of necessity and now plays an important role for the country in reviving its economy and restructuring its economy by bringing both political and socio-economic dividends. Based on the results of the analysis and taking into account the international experience, it is concluded that there is a potential for full cooperation with international and regional economic associations and organizations in ensuring sustainable

economic growth in Azerbaijan, accelerating the economic restructuring and integration of the world economy and improving living standards. It is advisable to improve the policy of the country in the following areas for effective use:

- strengthening of operational control over the targeted use of the loans received;
- to reach agreements with international and regional financial institutions to provide technical and financial assistance to the sectors that play an important role in the development of the national economy;
- maximizing opportunities for international and regional financial institutions to modernize and improve their production, service and market infrastructure in line with international standards;
- purposeful work with international financial institutions to identify effective manufacturing areas in these areas and to attract loans in these areas to revitalize economic life in other parts of the country, including Absheron economic district;
- Strengthening cooperation with relevant international financial institutions on relevant programs for addressing social protection and other social and economic problems;
- The purposeful expansion of cooperation with these institutions in order to attract more preferential loans from the Kuwait Fund;
- Further cooperation with the International Fund for the Development of Agriculture to overcome existing financial and technical deficiencies and financial deficits in agriculture;
- elimination of existing bureaucratic barriers in cooperation with international financial institutions;
- strategic orientation of loans and other financial aid from international and regional financial and credit institutions, as well as international commercial banks of developed countries.

Based on the results of the analysis and taking into account the specific conditions and the advanced world experience, it is concluded that it is advisable to improve the system of state regulation of foreign economic activity in Azerbaijan in the following areas:

- improvement of the legal and regulatory framework of the national system of foreign economic activity in terms of covering all areas of its activities. In this regard, it is very important to develop a legal and regulatory framework for regulating foreign economic relations, particularly in the areas of service and labor migration. In order to ensure systematic regulation of foreign economic relations in general, there is a need for revisions and complete consolidation of the terms and conditions of the adoption of laws and other regulatory documents directly related to this field, taking into account some inconsistencies and certain gaps in the field;
- strengthening the links between the activities of the organizational and administrative structures that carry out state regulation of foreign economic activity;
- In addition to the preference of economic instruments in the state regulation of foreign trade, the use of administrative instruments in the world practice, borders and expectations without any prejudice;
- Customs tariff regulation of imports, including the improvement of the taxation system (VAT and excise duties), taking into account the country's economic security interests, needs and development prospects;
- Identify and apply appropriate technical standards to improve the security system for goods imported into the country in accordance with international standards.

As the export-oriented economic model is based on the Concept of Development “Azerbaijan 2020: Looking into the Future” approved by the Decree of the President of the Republic of Azerbaijan, the following are the priority directions of foreign trade policy in the medium term:

- further liberalization of foreign trade and ensuring the maximum use of the country's export potential, and the continuation of the WTO accession by ensuring national economic interests of the country;
- increasing access to markets that play a major role in the development of agriculture and processing regions;
- continuation of efforts to improve the relevant legislation for the smooth export of Azerbaijani products to foreign markets;
- taking appropriate measures to maximize the use of the benefits received under the Universal Preference Systems;
- to continue the work on simplification of trade, including shortening of terms of clearing during trading and reduction of expenses;
- taking appropriate measures to further improve and improve the infrastructure for the development of foreign trade;
- implementation of import policies to optimize tariff rates, reduce non-tariff restrictions, support domestic production growth and ensure economic security of the country;
- improvement of anti-dumping legislation and, where appropriate, appropriate action;
- encouraging exporters' participation in international exhibitions and fairs in order to increase their access to world markets with comparative advantages;
- to continue relevant work towards Azerbaijan's accession to bilateral and multilateral trade agreements in line with national interests;
- to undertake relevant work towards the study and development of opportunities for broad use of e-commerce services in exports;
- investigation of mechanisms of state support to exporters for export expansion, the implementation of appropriate measures by banks to develop export credits by providing financial support to exporters.

The development of foreign trade relations is one of the key factors for increasing the efficiency of the country's economy and its integration into international economic cooperation; In order to increase the efficiency of exports, first of all, the weight of the finished product in its structure must be increased. In general, the problem of establishing an effective foreign economic policy is crucial. Therefore, this is not only a part of the development of foreign trade, but also closely related to domestic production, the recovery of the economy, social orientation and the political stability of the country. At the same time, it should be noted that the development of not only export-oriented sectors of the economy, but also the areas oriented to the domestic consumer market, depends on the choice of the right direction of foreign economic policy and its effectiveness. Logical development of export potential, diversification of commodity export and import structure have a significant impact on development of processes not only in the economic sphere, but also in the political sphere of the country.

Several types of exports and imports can be categorized, which we can present in Table 1 for a more explicit view.

Table №1**Classification of export and import types**

	Import
1) Shipment of goods manufactured (manufactured and processed) in a particular country to foreign countries;	1) Importing goods from abroad for sale on the domestic market, as well as purchasing foreign services for a fee;
2) Delivery of raw materials and semi-finished products to foreign countries for processing under customs control;	2) Delivery of raw materials, semi-finished products and details for later processing abroad;
3) Re-export - sending goods previously imported from abroad, including those sold at international auctions and exchanges abroad;	3) Re-import - return of national goods previously sent abroad;
4) Delivery of national goods to foreign countries (exhibitions, fairs) for a specified period, with the subsequent return of goods, or previously exported (auctions, exhibitions, fairs) to foreign countries;	4) bringing goods to international exhibitions, fairs, auctions for a specified period;
5) Shipment of products abroad through direct production links, as well as within multinational companies;	5) delivery of products within transnational companies;

Source: S. Dominic, International Economics. Moscow 1998

The export of Azerbaijan is dominated by oil and oil products. Oil and oil products account for 80% of exports. Exported oil is delivered to the world market by sea and pipeline. The main importers of Azerbaijani oil are the countries of Europe, the Middle East and Russia. Most of our state budget consists of oil exports. Therefore, fluctuations in oil prices directly affect the economic development of our country. Therefore, fluctuations in oil prices directly affect the economic development of our country. OPEC (The Organization of the Petroleum Exporting Countries) countries are also strongly affected by changes in world oil prices. These countries account for 60-70% of world oil production and export. Changes in oil prices by these countries have a direct impact on world oil prices, which is reflected in the change in the price of oil exported by Azerbaijan. Thus, Azerbaijan plays its role in cooperation with non-member countries in finding ways to maintain price volatility in the world oil market, ensure profitability of oil producing and exporting countries and stabilize oil prices in the world market.

REFERENCES

1. Allahverdiyev HB, Gafarov KS, Ahmadov AM "Government regulation of the economy. Baku, 2002.
2. A.Aliyev, A.Shakarliyev "Transition to market economy: State Economic Policy", Baku-2002.

3. A. Z. Korobkin, "Economics of Industry Organization", 2013.
4. Azerbaijani industry. Statistical collection. Baku, 2011.
5. Abdullayev Z., Bagirova ZA, "The essence and organization of industry principles", Baku, 2010.
6. Ganjiyev. G.A. "International economic relations, current situation and development problems". Baku, 2005.
7. Ganjiyev GA Abbasov V.H. Changizi X. "Current state and prospects of trade relations between the Republic of Azerbaijan and the Islamic Republic of Iran". Azerbaijan Agrarian Scientific Journal. N.3-4. Baku, 2009.
8. Harlanov A.S., "Problems of the development of the competitiveness of the world metallurgical industry ", Monograph, 2011.
9. Molchanova, S. 2015, "Prospects of Import Substitution: Foreign Experience". Retrieved March 29, 2017, from <https://goo.gl/0gk7Rg>
10. Nick Godfrey, "Why is Competition Important for Growth and Poverty Reduction", Global forum on international investment, 2008.
11. Shafa Aliyev, "Modernization of industries in Azerbaijan problems and perspectives", Baku, 2010.
12. Shchukin V.K., "Socio-economic problems of restructuring coal industry ", 1998.
13. Risk analysis: technology of CJSC "Industrial Risk", <http://alros.com/risk> .
14. Yusufov, R.A., and R.H. Adukov, 2013, "Agriculture of the Russian Federation in Terms of WTO: The Use of the Potential of the Green Basket", Public Administration. EJournal 41, 142-152.

WETTING-DRYING RESISTANCE OF SLAG AND KAOLIN-BASED GEOPOLYMER CONCRETES WITH THE TALL AND SHORT BASALT FIBERS

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ABSTRACT

Geopolymer concrete is known as cementless concrete according to the literature. High CO₂ emission in cement production has attracted the attention of many environmentalist human societies by creating negative effects on environmental problems and therefore human health. Increasing environmental pollution at a level that will affect the world has led to an increase in environmental sensitivity due to the fact that cement factories produce more than cement consumption in the market and have an excess of CO₂ emissions. Due to this situation, many types of research have started to be made on the use and recycling of alternative materials to cement. Within the scope of this study, different binder materials were used interchangeably to produce sustainable and environmentally friendly geopolymer concrete. Slag obtained as a by-product in the production of cast iron and natural and cheap kaolin were used as substitutes in geopolymer concrete. Kaolin and slag were substituted in four different proportions (15%, 30%, 45%, and 60% by weight). In addition, in the series with the highest result, two different basalt fibers with different lengths (tall basalt fiber (TBF) and short basalt fiber (SBF)) were substituted with each other so that the total ratio was 2% by weight (2% TBF, 1.6% TBF+0.4% SBF, 1.2% TBF+0.8% SBF, 0.8% TBF+1.2% SBF, 0.4% TBF+1.6% SBF). The 28 and 90 days compressive strength and ultrasonic pulse velocity (UPV) results of the geopolymer concretes were found. According to the results, it was positively affected by the substitution of kaolin up to 30% as it would increase geopolymerization. Tall basalt fiber gave the highest result by limiting cracks up to 1.2%. In order to see the behavior in the durability effect, a wetting-drying test consisting of 10 and 50 cycles was applied. Geopolymer concretes showed significant resistance to the wetting-drying test.

Keywords: Geopolymer concrete, Kaolin, Slag, Basalt fiber, Wetting-drying.

1. INTRODUCTION

In Ordinary Portland Cement production, a lot of energy consumption occurs with limestone decomposition. The cement industry is responsible for about 7% of CO₂ emissions and causes environmental problems [1-2]. Alternatively, alkali-activated or geopolymer composites create a durable and sustainable approach. Geopolymer is an inorganic polymer type that can be produced with different industrial waste materials and by-products and has a room temperature hardening property. Thus, it acts as a binder in concrete like Ordinary Portland Cement. In addition, it is more advantageous than Ordinary Portland Cement in gaining early strength and resistance to durability conditions (high temperature and aggressive chemicals). Aluminosilicate mineral content (silicon, aluminum, and oxygen ratios) is important in binder selection for geopolymer. High silicon and aluminum content is important for geopolymerization. The most commonly used aluminosilicate binders are fly ash and blast furnace slag. The production increase in waste industrial products allows such materials to be used as raw materials. In addition, considering the global problems of these waste products, innovative and environmentally friendly materials are obtained in case of reuse [1].

Slag with significant calcium content has different properties than fly ash with the low calcium content. If fly ash is used alone, the slag must be blended to achieve room temperature hardening. Blast furnace slag is obtained as a by-product in the combustion process in the cast iron industry [2]. Blast furnace slag is a non-metallic by-product produced by mixing iron with fondants and coke and melting them in furnaces [3]. In the furnace crucible, slag is obtained at the top and cast iron is obtained at the bottom. It is fine-grained and has a high potential for hydraulic activity due to the fact that the oven is cooled with plenty of water. This feature provides an important advantage in geopolymer production. In slag mixed systems, the reaction rate increases with the amount of slag and activator. Despite this advantage, it causes problems such as creating rapid slump loss and reducing workability. Because of this, instead of using it alone, using it with a different binder will support the solution of the problem [4-5].

Kaolin is in white or near-white shading with a pseudo-hexagonal precious stone alongside plates which are some vermicular stacks and bigger books. However, when considered as a binding material for geopolymer, it creates a weak structure with low reactivity that requires a certain time to gain strength [6]. In this case, the particle shape of the kaolin is effective. The fact that kaolin has a small surface area causes the alkali activator to dissolve Si and Al at a minimum rate and thus obtain low strength. The reaction of the kaolin and alkali activator slowly penetrates the structure from the surface and the edge. Due to this situation, it does not create sufficient strength if used alone. Despite these conditions, kaolin has good volume stability in water and it provides strength increase with increasing age, which is its positive feature. Pozzolanic activity is higher in metakaolin produced by calcining kaolin at high temperature [7]. However, this also brings a significant amount of energy and costs. Due to these conditions, it will be an important advantage to be used with different binders with high calcium oxide ratios to be used without calcination [6, 8].

The fiber addition to the geopolymer composite affects the durability and mechanical properties by changing the degree of geopolymerization. The use of different fibers such as woven fabric, carbon, wood, steel, glass, and basalt has been used extensively in the construction sector [9-11]. These studies have been also carried out intensively in geopolymer concrete. However, in general, fiber types have been used alone in these studies. However, studies on the use of different types of fibers by combination are limited. With this method, it is possible to take advantage of fiber types. Basalt fiber is an important support in limiting cracks. According to Arunagiri et al. [12], it has been observed that when 2% basalt fiber by volume was added to geopolymer concrete, it increased the mechanical properties.

Geopolymer concrete is an environmentally friendly and sustainable material that has significant advantages over Ordinary Portland Cement-based concrete. The realization of this situation with low energy consumption provides an important advantage. It is important to evaluate the slag obtained as a by-product of cast iron and natural and common kaolin together in the geopolymer concrete production. Kaolin and slag were substituted in four different proportions (15%, 30%, 45%, and 60% by weight) in this study. In addition, in the series with the highest result, two different basalt fibers with different lengths were substituted with each other so that the total ratio was 2% by weight (2%TBF, 1.6%TBF+0.4%SBF, 1.2%TBF+0.8%SBF, 0.8%TBF+1.2%SBF, 0.4%TBF+1.6%SBF). The results of 28 and 90-day compressive strength and UPV of the obtained geopolymer concretes were found, and the wetting-drying test was also applied. After 10 and 50 cycles of wetting-drying test, compressive strength, UPV, and weight changes were investigated while the visual examination was also carried out.

2. MATERIAL AND METHODS

In this study, slag obtained from Akçansa Company was used as a binding material. While the Blaine-specific surface of the slag is $4500 \text{ cm}^2/\text{g}$, its specific gravity is 2.91. The other binder material, kaolin, was supplied from Kaolin EAD Company and its specific gravity is 2.52. The Blaine-specific surface area of the kaolin is $14.6 \text{ m}^2/\text{g}$. The chemical properties of binder materials are given in Table 1. In addition, basalt fibers with a length of 24 mm and 12 mm were used in this study. The properties of tall and short basalt fibers are shown in Table 2. 12M of sodium hydroxide and sodium silicate with $\text{SiO}_2/\text{Na}_2\text{O}$ ratio of 3.29 were used for the alkali activator solution.

Table 1. Chemical composition of cement and slag (%)

Chemical analysis, %	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	L.O.I.
Slag	40.60	12.83	1.37	36.08	6.87	0.68	0.79	0.78
Kaolin	47.40	40.50	0.80	0.60	0.30	0.50	0.30	9.60

Table 2. The basalt fibers' properties

Fiber type	Length (mm)	Modulus of elasticity (GPa)	Diameter (μm)	Tensile strength (MPa)	Elongation (%)	Density (g/cm^3)
Tall basalt fiber	24	89	20	4800	3.15	2.80
Short basalt fiber	12	89	13	4100	3.15	2.80

10 series were prepared for this study. For the first 5 series, kaolin was replaced with slag in four different proportions (15%, 30%, 45%, and 60% by weight). In addition, in the series with the highest result, two different basalt fibers with different lengths were substituted with each other so that the total ratio was 2% by weight (2% TBF, 1.6% TBF+0.4% SBF, 1.2% TBF+0.8% SBF, 0.8% TBF+1.2% SBF, 0.4% TBF+1.6% SBF). Mixing details of the produced series are shown in Table 3. As coarse aggregates, crushed limestone aggregates of a maximum of 16 mm were used. The water absorption percentage and specific gravity of crushed limestone aggregate are 0.31% and 2.70, respectively. Conventional river sand was also used. It has a water absorption rate of 1.59% and a specific gravity of 2.61. A proper aggregate mix classification has been prepared. The mixture's fineness modulus is 4.09. Volume percentages of aggregates were held constant for all mixtures. In addition, MasterGlenium 51 was used as a water reducer to increase fluidity in the study. While preparing the mixture, firstly the dry mixture (binding materials+ aggregates) was put into the concrete mixer and mixed for 2 minutes. Then the superplasticizer added activator solution was added and mixed for a further three minutes. In the fibrous series, the fibers were added to the mixture at this stage. After the mixtures were placed in a 150 mm cube mold, they were exposed to vibration. All samples were demolded in a controlled room at $23 \pm 1^\circ\text{C}$ 1 day after

casting. It was then kept in room conditions until the day of testing. Compressive strength and UPV tests were carried out on 28 and 90 days. In addition, a wetting-drying test was carried out at the end of 90 days. For the wetting-drying test, 10 and 50 cycles were applied. 1 cycle included drying for 24 hours at 65°C and soaking in the water for 24 hours at room temperature. After the wetting-drying tests, the results of UPV, compressive strength, and weight changes were found. In addition, a visual inspection was made.

Table 3. Mixture proportions

Component (%)	Kaolin	Slag	Short Basalt Fiber (%)	Tall Basalt Fiber (%)
1	-	100	-	-
2	15	85	-	-
3	30	70	-	-
4	45	55	-	-
5	60	40	-	-
6	45	55	-	2
7	45	55	0.4	1.6
8	45	55	0.8	1.2
9	45	55	1.2	0.8
10	45	55	1.6	0.4

3. RESULT AND DISCUSSION

The 28 and 90-day compressive strength and UPV results of 10 geopolymer concrete series prepared within the scope of this study and the results at the end of 10 and 50 cycles of the wetting-drying test are given in Figures 1-2. In addition, the weight change after the wetting-drying test is given in Figure 3. Slag was an important binder that had the potential to be used in geopolymer concrete. Due to its high CaO content, an exothermic reaction occurred. Due to the heat generated as a result of the reaction, the production of sodium aluminate hydrate (N-A-S-H) and calcium aluminate hydrate (C-A-S-H) was accelerated and a 3-D silico-aluminate structure network was formed. In addition, with the CaO content, hydration occurred and C-S-H gel was produced. With the combination of these two gels, the particles were tightly bound and a dense microstructure of the geopolymer was formed, increasing the compactness. This situation contributed to the hardened properties of the geopolymer concrete [13]. However, the increase in slag increased the demand for alkali activators. It led to a decrease in workability. Therefore, it was necessary to investigate the use of different binders with slag as a substitute instead of using it alone. Kaolin was an important alternative binder in this sense. With the addition of kaolin as a binder, the reaction process and physical properties were affected and the geopolymer matrix changed. Its fine particle size contributed to filling the pores and air voids of concrete samples. In addition, having small particles helped to create a denser aggregate mixture and increase strength. It was important for kaolin to be a good source of alumina and silica for geopolymerization. The inclusion of kaolin increased the reactive SiO₂ ratio for geopolymerization, allowing the formation of more Si-O-Al bonds. Thus, a denser tetrahedral aluminosilicate structure was formed. Because of this situation, the strength results increased with the use of 30% kaolin. The UPV test and the compressive strength results were in parallel. If it was used at higher rates, a weaker structure was formed due to the low reactivity of kaolin, and this situation negatively affected the strength

development of the geopolymer [14]. The effect of fiber lengths on mechanical properties was studied by using two different lengths of basalt fibers together as a substitute for a total of 2%. Since basalt fiber with 24 mm provided a longer anchorage by keeping the particles more robust than the basalt fiber with 12 mm, it provided higher mechanical properties by controlling the cracks. But here 1.2% ratio was critical. Workability was adversely affected by using longer basalt fiber than this ratio. This situation reflected negatively on mechanical properties [15]. The fiberless series with 30% kaolin substitution achieved 63.14 MPa and 71.25 MPa of compressive strengths after 28 days and 90 days, while UPV results were 4090 m/s and 4221 m/s, respectively. In the series using 1.2% tall basalt fiber, compressive strength of 72.64 MPa and 78.72 MPa was obtained after 28 days and 90 days, while UPV results were 4243 m/s and 4385 m/s, respectively.

The results of UPV, compressive strength and weight changes fluctuated due to the wetting-drying effect. According to the examination of the results, the results were increased after 10 cycles, while a decrease occurred after 50 cycles. These fluctuations were expected due to the severity of the regime affecting the concrete samples' integrity under the influence of service conditions. The wetting-drying and cooling-heating cycles were repeated. This caused hydration and evaporation to occur continuously. In this way, the crystallization of ions in water was repeated. Thus, expansion and shrinkage followed each other and internal stresses occurred in the pore structure that caused the strength to increase and decrease. The thermal expansion coefficient and drying shrinkage were the main reasons for this situation. On the other hand, heating the sample with the effect of wetting-drying caused an increase in density. Thus, geopolymerization was provided to be faster. Due to this situation, UPV and compressive strength results increased. While more geopolymerization occurred with the wetting stage, a denser structure was formed with drying, resulting in higher results. Having a high calcium content accelerated the hydration during the wetting phase, while the drying phase strengthened the geopolymer with improved bond structure. This resulted in an increase in short cycles. In the higher cycles, the differences in thermal expansion coefficient and drying shrinkage in the geopolymer structure caused micro-crack formation. However, this situation has been limited due to the compact structure of the geopolymer. While the weight ratios were initially increased due to the wetting effect, they decreased a little later due to micro-cracks. Surface examination of the samples after 50 cycles is shown in Figure 4. According to the visual inspection, no significant damage was observed in the geopolymer concrete specimens, and it was observed that the deterioration remained at the micro-crack levels [16]. The results after the wetting-drying test were in parallel with the pre-test. After 50 cycles, the series using 30% kaolin without fiber and the series using 1.2% tall basalt fiber had 63.18 MPa and 73.39 MPa, respectively, while the UPV results were 4174 m/s and 4298 m/s. The weight changes after 50 cycles were between 0.46% and 1.71%.

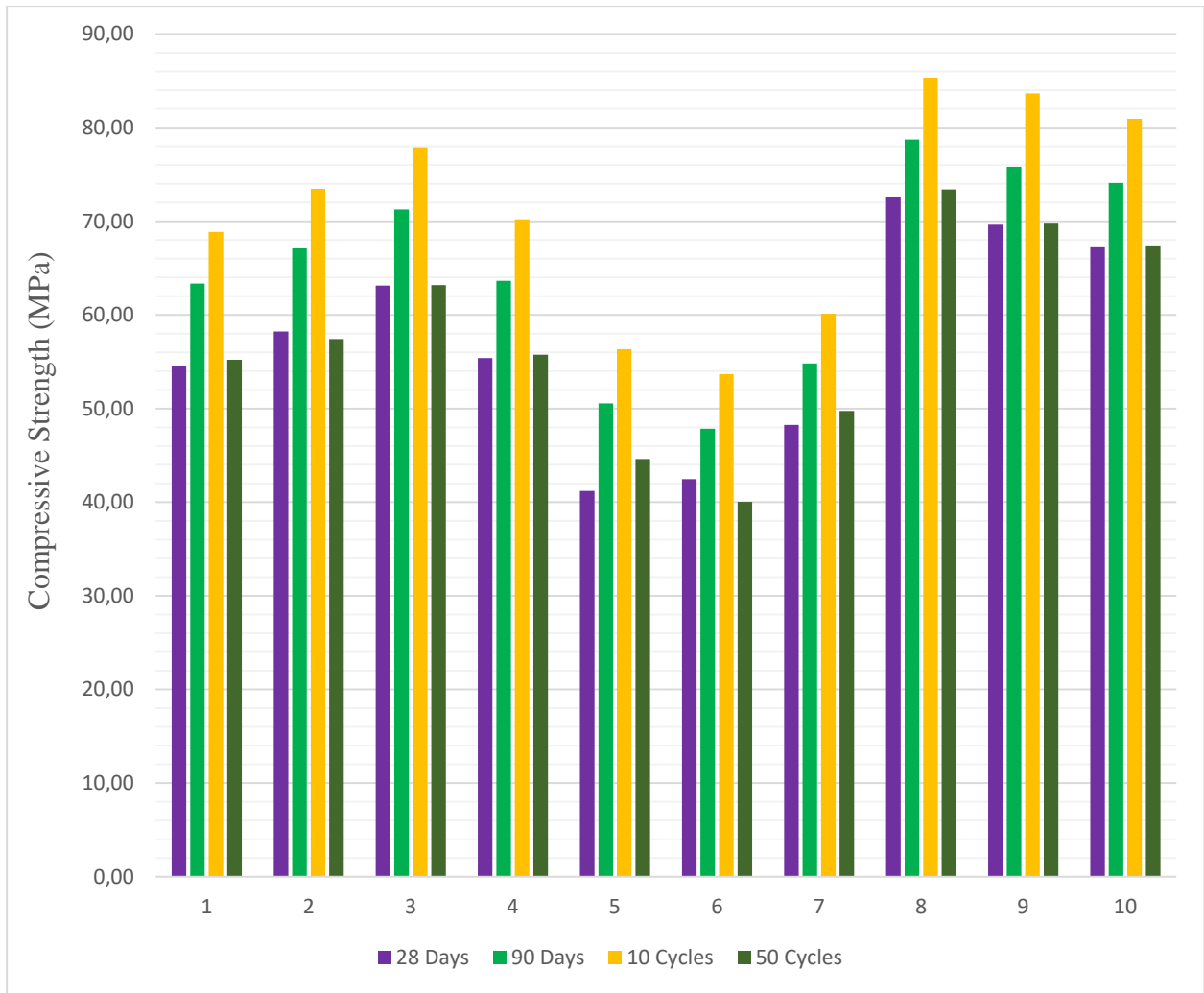


Figure 1. Compressive strength results

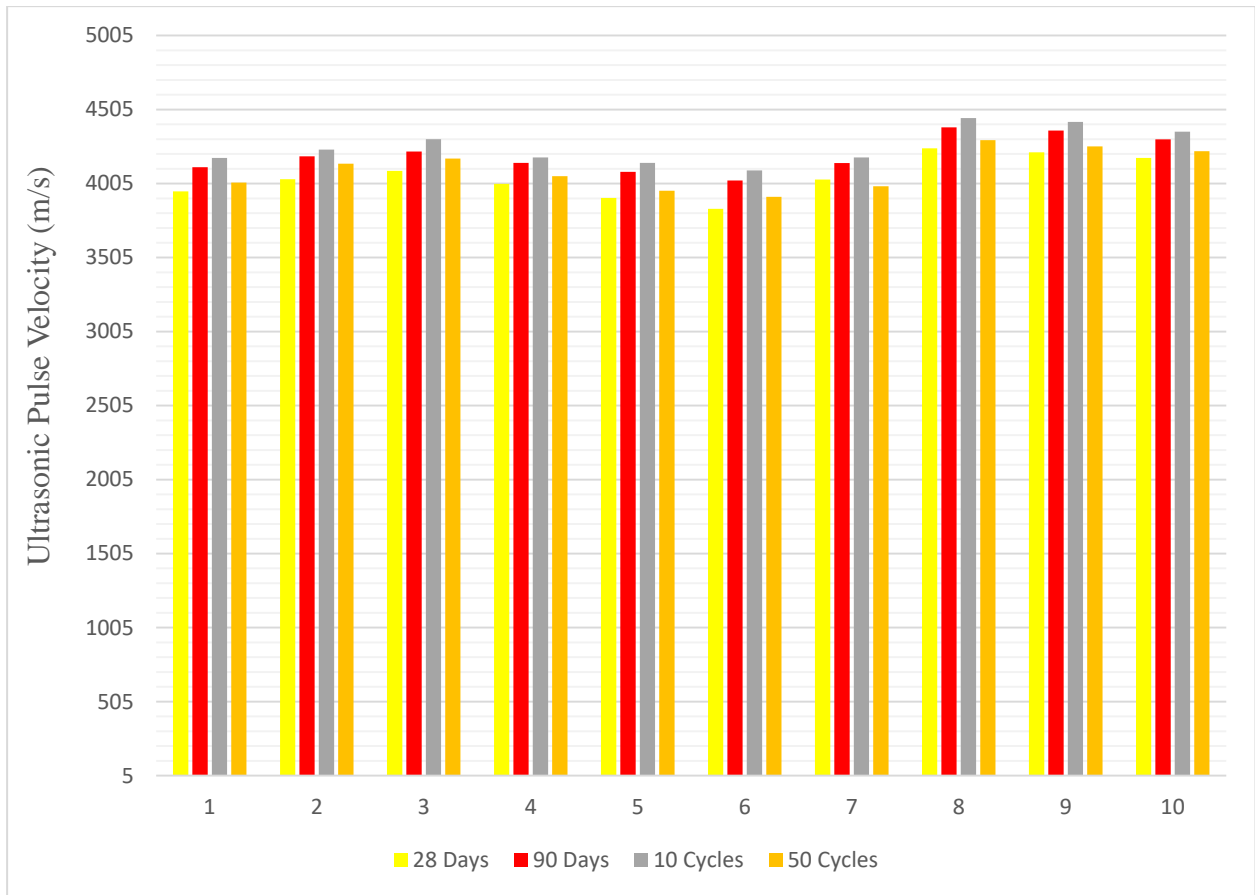


Figure 2. UPV results

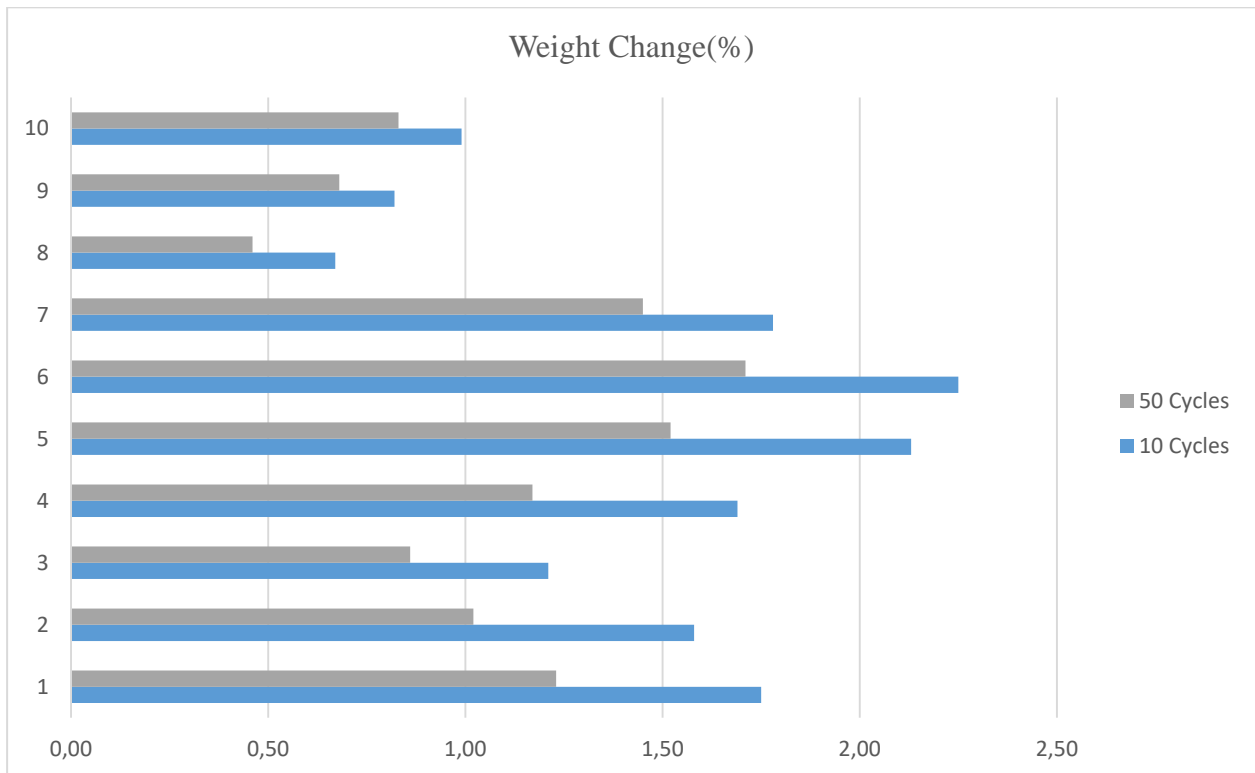


Figure 3. Weight-change results



Figure 4. Visual inspection after the wetting-drying test

4. CONCLUSIONS

Within the scope of the study, the following results were found according to the compressive strength, UPV and weight properties, and visual inspection of the kaolin-substituted slag-based geopolymer concrete specimens before and after the wetting-drying test.

- Slag created a 3-D silico-aluminate structure network by providing significant N-A-S-H and C-A-S-H production in geopolymer concrete due to its high CaO content. This situation provided an important advantage. However, its high rate of use negatively affected workability. Due to the substitution of kaolin up to 30%, because of its fine particle size and the high percentage of SiO₂ and Al₂O₃, it increased geopolymerization and increased mechanical properties. If it was used at a higher rate, it was affected negatively due to its low reactivity.

- The use of tall basalt fiber up to 1.2% provided long anchoring, limiting the cracks, and positively affected the mechanical properties. If it was used at a higher rate, it had a negative effect on workability and has reduced mechanical properties.

- Before and after the wetting-drying test, the results were parallel. After the wetting-drying test, fluctuations in mechanical properties were observed. Hydration formation with the effect of wetting and formation of a denser structure with the effect of drying in short cycles reflected positively on the results. The differences in thermal expansion coefficient and drying shrinkage caused micro-cracks in the following cycles and negatively affected the mechanical properties. Despite these conditions, the geopolymer concrete series showed significant resistance to the wetting-drying effect.

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REFERENCES

1. Zhuguo, L. I., & Sha, L. (2018). Carbonation resistance of fly ash and blast furnace slag based geopolymer concrete. *Construction and Building Materials*, 163, 668-680.
2. Shen, H., & Forssberg, E. (2003). An overview of recovery of metals from slags. *Waste management*, 23(10), 933-949.
3. Liu, J., & Wang, D. (2017). Application of ground granulate blast furnace slag-steel slag composite binder in a massive concrete structure under severe sulphate attack. *Advances in Materials Science and Engineering*, 2017.
4. Nath, P., & Sarker, P. K. (2014). Effect of GGBFS on setting, workability and early strength properties of fly ash geopolymer concrete cured in ambient condition. *Construction and Building materials*, 66, 163-171.
5. Provis, J. L. (2014). Geopolymers and other alkali activated materials: why, how, and what?. *Materials and structures*, 47(1), 11-25.
6. Heah, C. Y., Kamarudin, H., Al Bakri, A. M., Binhussain, M., Luqman, M., Nizar, I. K., Ruzaidi, C. M., & Liew, Y. M. (2011). Effect of curing profile on kaolin-based geopolymers. *Physics Procedia*, 22, 305-311.
7. Uysal, M., Al-mashhadani, M. M., Aygörmez, Y., & Canpolat, O. (2018). Effect of using colemanite waste and silica fume as partial replacement on the performance of metakaolin-based geopolymer mortars. *Construction and Building Materials*, 176, 271-282.
8. Heah, C. Y., Kamarudin, H., Al Bakri, A. M., Binhussain, M., Luqman, M., Nizar, I. K., Ruzaidi, C. M., & Liew, Y. M. (2012). Study on solids-to-liquid and alkaline activator ratios on kaolin-based geopolymers. *Construction and Building Materials*, 35, 912-922.
9. Assaedi, H., Alomayri, T., Shaikh, F. U., & Low, I. M. (2015). Characterisation of mechanical and thermal properties in flax fabric reinforced geopolymer composites. *Journal of Advanced Ceramics*, 4(4), 272-281.
10. Amuthakkannan, P., Manikandan, V., Jappes, J. W., & Uthayakumar, M. (2013). Effect of fibre length and fibre content on mechanical properties of short basalt fibre reinforced polymer matrix composites. *Materials Physics and Mechanics*, 16(2), 107-117.
11. Shen, D., Liu, X., Li, Q., Sun, L., & Wang, W. (2019). Early-age behavior and cracking resistance of high-strength concrete reinforced with Dramix 3D steel fiber. *Construction and Building Materials*, 196, 307-316.
12. Arunagiri, K., Elanchezhiyan, P., Marimuthu, V., Arunkumar, G., & Rajeswaran, P. (2017). Mechanical properties of basalt fiber based geopolymer concrete. *International Journal of Science, Engineering and Technology Research (IJSETR)*, 6(4), 551.
13. Patel, Y. J., & Shah, N. (2018). Enhancement of the properties of ground granulated blast furnace slag based self compacting geopolymer concrete by incorporating rice husk ash. *Construction and Building Materials*, 171, 654-662.
14. Nnaemeka, O. F., & Singh, N. B. (2020). Durability properties of geopolymer concrete made from fly ash in presence of Kaolin. *Materials Today: Proceedings*, 29, 781-784.
15. Ali, N., Canpolat, O., Aygörmez, Y., & Al-Mashhadani, M. M. (2020). Evaluation of the 12–24 mm basalt fibers and boron waste on reinforced metakaolin-based geopolymer. *Construction and Building Materials*, 251, 118976.
16. Aygörmez, Y., Canpolat, O., Al-mashhadani, M. M., & Uysal, M. (2020). Elevated

temperature, freezing-thawing and wetting-drying effects on polypropylene fiber reinforced metakaolin based geopolymer composites. *Construction and Building Materials*, 235, 117502.