



isarc

INTERNATIONAL SCIENCE AND ART RESEARCH CENTER

<https://www.isarcconference.org/>



Editörler:

Dr. YEŞİM AKÜZÜM

Dr. Özgür ERDAĞ

8. ULUSLARARASI FEN BİLİMLERİ VE İNOVASYON KONGRESİ

14 - 15 EKİM 2023 / ANKARA

KONGRE KİTABI

CONGRESS ID

CONGRESS TITLE

**8. INTERNATIONAL
SCIENCES AND INNOVATION CONGRESS**

DATE AND PLACE

14-15 OCTOBER 2023 ANKARA

ORGANIZATION

ISARC

INTERNATIONAL SCIENCE AND ART RESEARCH CENTER

GENERAL COORDINATOR

Yasemin AĞAOĞLU

COORDINATOR

Gamze KÖYMEN

EDITOR

**Asst. Prof. Dr. Muhammed Yaşar DÖRTBUDAR
Dr. Merve ERDOĞAN**

ORGANIZING COMMITTEE

Assoc. Prof. Dr. Fatih ÇİĞ

Dr. Gönül GÖKÇAY

Dr. Figen CERİTOĞLU

Dr. Serkan KÖKSOY

ISBN: 978-625-367-374-1



SCIENCE AND ADVISORY COMMITTEE

Prof. Dr. Cenk YAVUZ

SAKARYA UNIVERSITY

Prof. Dr. Morakeng Edward Kenneth LEBAKA

UNIVERSITY OF ZULULAND/SOUTH AFRICA

Prof. Dr. Faiz Muhammad SHAIKH

SINDH AGRICULTURE UNIVERSITY TANDO JAM

Prof. Dr. Anwar Ali Shah G. SYED

UNIVERSITY OF SINDH JAMSHORO

Prof. Dr. Syed Ali Raza NAQVI

GOVERNMENT COLLEGE UNIVERSITY, PAKISTAN

Prof. Dr. Abdullah ÖZTÜRK

MIDDLE EAST TECHNICAL UNIVERSITY

Prof. Dr. Aparna SRIVASTA

NOIDA INTERNATIONAL UNIVERSITY

Prof. Dr. Hasan Hüseyin DOĞAN

SELÇUK UNIVERSITY

Prof. Dr. Mustafa Onur ALADAĞ

SELÇUK UNIVERSITY

Prof. Dr. Edip ÖRÜCÜ

BANDIRMA ONYEDİ EYLÜL UNIVERSITY

Prof. Dr. Erdin BOZKURT

ORTA DOĞU TEKNİK UNIVERSITY

Prof. Dr. Haluk ÖZPARLAK

SELÇUK UNIVERSITY

Prof. Dr. Nilüfer PEMBEÇİOĞLU

İSTANBUL UNIVERSITY

Prof. Dr. Sevi ÖZ

ANKARA HACI BAYRAM VELİ UNIVERSITY

Assoc. Prof. Dr. Amit ARORA

SHAHEED BHAGAT SINGH STATE UNIVERSITY

Assoc. Prof. Dr. Arzu AKPINAR BAYİZİT

ULUDAĞ UNIVERSITY

Assoc. Prof. Dr. Fatih ÇİĞ

SİİRT UNIVERSITY

Assoc. Prof. Dr. Iqbal HOSSAIN

BANGLADESH UNIVERSITY



Assoc. Prof. Dr. İsmail AKALTUN
GAZİANTEP DR. ERSİN ARSLAN EAH.
Assoc. Prof. Dr. K.A. TLEUBERGENOVA

KAZAKH NATIONAL WOMEN'S PEDAGOGICAL UNIVERSITY

Assoc. Prof. Dr. Mehmet Ali AKKAYA
İZMİR KÂTİP ÇELEBİ UNIVERSITY
Assoc. Prof. Dr. Mehmet Fırat BARAN
SİİRT UNIVERSITY

Assoc. Prof. Dr. Merivan ŞAŞMAZ
ADİYAMAN UNIVERSITY

Assoc. Prof. Dr. Murat EYVAZ
GEBZE TEKNİK UNIVERSITY

Assoc. Prof. Dr. Neslihan ŞAHİN
CUMHURİYET UNIVERSITY

Assoc. Prof. Dr. Syed Ali Raza NAQVI
GOVERNMENT COLLEGE UNIVERSITY FAİSALABAD

Dr. Fatma HAYIT
YOZGAT BOZOK UNIVERSITY

Dr. Figen CERİTOĞLU
SİİRT UNIVERSITY

Dr. Hakan ALTUNAY
SÜLEYMAN DEMİREL UNIVERSITY

Dr. Murat POLAT
DİCLE UNIVERSITY

Dr. Sema KAYAPINAR KAYA
MUNZUR UNIVERSITY

Dr. Serkan GÜLDAL
ADİYAMAN UNIVERSITY

Dr. Yaşar SUBAŞI
VAN YÜZÜNCÜ YIL UNIVERSITY

Dr. Amira TANDİROVİC GURSEL
DANA ALPARSLAN TÜRKEŞ SCIENCE AND TECHNOLOGY UNIVERSITY

Dr. Babak SAFAEI
TSİNGHUA UNIVERSITY

Dr. Bhavtosh AWASTHİ
JECRC UNIVERSITY INDIA

Dr. Faisal SULTAN
HAZARA UNIVERSITY

Dr. Ghanshyam BARMAN



UKA TARSADIA UNIVERSITY

Dr. Meryem GÖKTAŞ

BİLECİK ŞEYH EDEBALI UNIVERSITY

Dr. Muhammad IMRAN

GOVERNMENT COLLEGE UNIVERSITY FAİSALABAD

Dr. Şükrü KALAYCI

GAZİ UNIVERSITY

Dr. Turan YANARDAĞ

ANKARA UNIVERSITY



ISARC

**8. INTERNATIONAL
SCIENCES AND INNOVATION
CONGRESS**

14-15 OCTOBER 2023

**ANKARA
CONGRESS PROGRAM**

Join Zoom Meeting:

Meeting ID: **899 8977 3910**

Passcode: **655156**

[Join Zoom Meeting](#)

<https://us02web.zoom.us/j/89989773910?pwd=c0Y1Y0daQlM2dUZ2ZGhPdXNQRWFXdz09>

PARTICIPATING COUNTRIES

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syra/ Ukraine /U.K

**TOTAL NUMBER OF INTERNATIONAL PAPER: 50
PAPER FROM TURKEY: 47**

zoom



ÖNEMLİ, DİKKATLE 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.
- ❖ Zoom uygulaması ücretsizdir ve hesap oluşturmaya gerek yoktur.
- ❖ Zoom uygulaması kaydolmadan kullanılabilir.
- ❖ Uygulama tablet, telefon ve PC’lerde çalışıyor.
- ❖ Her oturumdaki sunucular, sunum saatinden 5 dk öncesinde oturuma bağlanmış olmaları gerekmektedir.
- ❖ Tüm kongre katılımcıları canlı bağlanarak tüm oturumları dinleyebilir.
- ❖ Moderatör – oturumdaki sunum ve bilimsel tartışma (soru-cevap) kısmından sorumludur.

DIKKATEDİLMESİ GEREKENLER- TEKNİK BİLGİLER

- ◆ Bilgisayarınızda mikrofon olduğuna ve çalıştığına emin olun.
- ◆ Zoom’da ekran paylaşma özelliğine kullanabilmelisiniz.
- ◆ Katılım belgeleri kongre sonunda tarafınıza pdf olarak gönderilecektir
- ◆ Kongre programında yer ve saat değişikliği gibi talepler dikkate alınmayacaktır

IMPORTANT, PLEASE READ CAREFULLY

- ❖ To be able to attend a meeting online, login via <https://zoom.us/join> site, enter ID “Meeting ID or Personal Link Name” and solidify the session.
- ❖ The Zoom application is free and no need to create an account.
- ❖ The Zoom application can be used without registration.
- ❖ The application works on tablets, phones and PCs.
- ❖ The participant must be connected to the session 5 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

- ◆ Make sure your computer has a microphone and is working.
- ◆ You should be able to use screen sharing feature in Zoom.
- ◆ Attendance certificates will be sent to you as pdf at the end of the congress.
- ◆ Requests such as change of place and time will not be taken into consideration in the congress program.

ÖNEMLİ NOT: SUNUMLARINIZI HEM TÜRKÇE HEM İNGİLİZCE HAZIRLAMANIZI RİCA EDERİZ

14.10.2023

SATURDAY / 09:00-11:00

SESSION-1 HALL-1

MODERATOR: Res. Assis. Dr. Hüseyin KÖSE

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syra/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Murat BAYRAKTAR Onur YÜKSEL	Zonguldak Bülent Ecevit University	Reliability Analysis On The Engine Room Systems Of The Ro-Ro Passenger Ship
Ogan Tanıl ORHUN Seniz R. KUSHAN AKIN	Cankaya University	Production of Silicon Nitride Ceramics with Functionally Graded Porosity for Biomedical Applications
Ceren ÇELİK Asst. Prof. Dr. Uğur GÜROL	İstanbul Gedik University	An Investigation Of The Weldability Of High- Strength Ballistic Armor Steel Plates Using Austenitic Stainless Steel Wire
Ramazan ÖZMEN	Karabük University	Effect Of Reinforcements On Elastic Mechanical Responses Of Strut-Based Lattice Structures
Res. Assis. Dr. Hüseyin KÖSE Asst. Prof. Dr. Deniz ARSLAN	Konya Technical University	Stability-Flow Analyses Of Asphalt Mixtures Prepared With Limit And Off-Limit Aggregate Gradations
Çağrı Gökhan TÜRK Asst. Prof. Dr. Mahmud TOKUR	Sakarya University	Investigation The Effects Of 2D Materials On The Cathode Performance Of Li-S Batteries

14.10.2023

SATURDAY / 09:00-11:00

SESSION-1 HALL-2

MODERATOR: Asst. Prof. Dr. Merve KAYACI ÇODUR

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Cihangir KOYCEGİZ Meral BUYUKYILDIZ	Konya Technical University	Detection Of Temporal Variability In Monthly And Annual Mean Streamflow Data Of Feke Station In Seyhan Basin
Cansu Hacer KAPLAN Meral BUYUKYILDIZ Cihangir KOYCEGİZ	Konya Technical University	Applicability Of Different Interpolation Methods In The Estimation Of Potential Evapotranspiration
Res. Assist. Esmâ KARAKOYUN YAŞAR	Niğde Ömer Halisdemir University	Klasik Osmanlı Mimarisinde Uzuncaova Camii
Dr. Memduh KÖSE	Kırşehir Ahi Evran University	Use Of Convolutionary Neural Network As Feature Extractor In Image Classification
Mustafa Ali Hussein HUSSEIN Dr. Memduh KÖSE Emre YAVUZER İbrahim ŞANLIALP	Kırşehir Ahi Evran University Niğde Ömer Halis Demir University	Using A Pre-Trained Convolutional Neural Network In Chicken Meat Classification
PhD Emine Feyza ŞÜKÜR	Samsun University	Mechanical And Thermal Performance of Epoxy/Clay Nanocomposites: Effect Of Na-Activated Bentonite Clay Content
Asst. Prof. Dr. Merve KAYACI ÇODUR	Erzurum Technical University	Machine Learning Approaches For Sustainable Planning: A Case Study Of Türkiye
Assoc. Prof. Dr. Sultan Sevinç KURT KONAKOĞLU Res. Assist. Dr. Tuğba ÜSTÜN TOPAL Res. Assist. Kadir Tolga ÇELİK	Amasya University Tekirdağ Namık Kemal University	A Study On Determining Recreational Area Usage Opportunities In The Coastal Strip Of Fatsa District, Ordu Province, Türkiye

14.10.2023

SATURDAY / 09:30-11:30

SESSION-2 HALL -3

MODERATOR: Asst. Prof. Dr. Demet GÖZAÇAN KARABULUT

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syra/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
İrem YELESER Prof. Dr. Mehmet Emin ERDAL	Mersin University	Investigation Of The Expression Levels Of Some Pluripotency Markers In Lung Cancer Patients Diagnosed With Adenocarcinoma And Squamous Cell Carcinoma
Asst. Prof. Dr. Demet GÖZAÇAN KARABULUT	Gaziantep Islam Science and Technology University	Physical Activity In Individuals With Cerebral Palsy: A Review
Asst. Prof. Dr. Demet GÖZAÇAN KARABULUT Prof. Dr. Mehmet İbrahim TURAN	Gaziantep Islam Science and Technology University	Investigation Of Nail Morphological Changes In Individuals With Cerebral Palsy
Elif Esra ALTUNER Fatih ŞEN	Kocaeli Health and Technology University Kutahya Dumlupınar	Development Of Fe ₃ O ₄ @ MWCNT Nanocomposite-Based Electrochemical Sensor For The Determination Of Cold Drug Containing The Active Ingredients Of Clavulanic Acid And Amoxicillin
Elif Esra ALTUNER Fatih ŞEN	Kocaeli Health and Technology University Kutahya Dumlupınar	Synthesis Of Active Carbon Supported Zinc Nanoparticles And Their Oxidation Against Methanol-Based Fuel Cells
Funda ASLANTAŞ BEYİN Ahmet KORKMAZ Haydar ÖZKAN	National Defence University Bursa Technical University	Brain Tumor Segmentation And Proportional Size Detection From MR Images

14.10.2023

SATURDAY / 09:30-11:30

SESSION-2 HALL -4
MODERATOR: Dr. Özhan ÇETİNDAG

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Lect. Dr. Melek AKGÜL Asst. Prof. Dr. Serkan ETLİ	Munzur University	Early Age Mechanical And Durability Properties Of Fiber Reinforced Micro Concretes
Dr. Özhan ÇETİNDAG	İzmir/Türkiye	Efficacy of Sinus Laser Treatment in Sacrococcygeal Pilonidal Sinus Disease
Res. Assis. Dr. Elif KARACAN YELDİR Assoc. Prof. Dr. Feyza KOLCU Prof. Dr. İsmet KAYA	Çanakkale Onsekiz Mart University	Synthesis And Characterization Of Poly(Diaminopyridine) Containing Bromine By Enzyme-Catalyzed Polymerization
Dr. Doğaç KARAGÜVEN Dr. Sefa AKTI	Ufuk University Cumhuriyet University	Kemik Metafizer Bölgesinde Drill Kullanımında Olası Riskler
İnanç ARTAÇ, MD	Kafkas University	The Prognostic Efficacy Of HALP Score For İn-Hospital Mortality Patients With Hospitalized Due To Heart Failure
Omar BENAMARI Hassan AMHAMDI	Abdelmalek Essaadi University, Morocco	Review Of The Protective Properties Of Medicinal Plants Against Diabetes-Related Heart Disease
Hafize Hilal KARGIN Dr. Fzt. Ata ELVAN	Dokuz Eylul University İzmir University of Economics	Endurance of Core Muscles and Postural Control



14.10.2023

SATURDAY / 09:30-11:30

SESSION-2 HALL -5
MODERATOR: Dr. Özgür ERDAĞ

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Dr. Aykut ASTAM Ömer KAYA	Erzincan Binali Yıldırım University	Effect Of Reaction Time On The Properties Of CuO Thin Films Deposited By Hydrothermal Method
Dr. Aykut ASTAM	Erzincan Binali Yıldırım University	Investigation Of Structural And Optical Properties Of β - MnO ₂ Thin Films Obtained By Hydrothermal Method
Dr. Özgür ERDAĞ	Kafkas University	The Mersenne-Padovan Sequence And Its Binet Formulas
Dr. Özgür ERDAĞ	Kafkas University	The Mersenne-Padovan Sequence Modulo m
Dr. Yeşim AKÜZÜM Ömür DEVECİ	Kafkas University	The Mersenne-Jacobsthal Sequence Modulo m
Dr. Yeşim AKÜZÜM	Kafkas University	The Representation And Finite Sums Of The Mersenne- Jacobsthal Sequence
Asst. Prof. Dr. Abdurrahman GÜNDAĞ	Bursa Uludağ University	On The Strain And Temperature Dependencies Of The Electric Susceptibility OF Silica Fiber Core



14.10.2023

SATURDAY / 09:30-11:30

SESSION-2 HALL-6

MODERATOR: Lect. Mehmet ZENCİRKIRAN

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Mustafa YAZICI Harun AYTAÇ	Kahramanmaraş Sütçü İmam University	A Study On The Application Of Arduino Supported Stem Activity In Teaching The Subject Of Respiratory System In 6th Grade Science Course
Mustafa YAZICI Tuğçe FİSTİK	Kahramanmaraş Sütçü İmam University	Descriptive Analysis Of Master Thesis Studies On Artificial Intelligence Technology In Science Education In Turkey Between 2020-2023
Zidan KAFABİH Muhammad Sultan MUBAROK Muhammad Taufiq ABADI Muhammad SHULTHONI	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Cultivating Tranquility: Stoicism's Approach to Overcoming Envy
Prof. Dr. Metin CANCI Gizem ALKAN KABAKCI	Yalova University	Consumer Preferences On Electric Vehicles: A Comparison Study Applying Multi Criteria Decision Analyses
Ananda MAJUMDAR	University of Alberta - /Canada	Enforcement Of Immigration And Implementation: A Narrative Of Nations Policies
Mustafa AYDIN Adil Can KAYA	Pamukkale University	Hull Design And Structural Analysis For An Autonomous Agricultural Unmanned Ground Vehicle
Mustafa AYDIN İsmail GÜRBÜZ	Pamukkale University	Characteristics Of A Lithium-Ion Battery Module For A Hybrid And Electric Vehicle
Lect. Mehmet ZENCİRKIRAN	Başkent University	Hidrojen Yakıtının Taşıtlarda Kullanımının Yaygınlaştırılması

14.10.2023

SATURDAY / 09:30-11:30

SESSION-2 HALL-7

MODERATOR: Assoc. Prof. Dr. Medine ÇOPUR DOĞRUSÖZ

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syra/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Independent Researcher, Gizem YENER Asst. Prof. Dr. Arzu SEÇER	Çukurova University	Determining The Factors Influencing Consumers' Intentions To Consume Organic Food Through The Mediation Of Organic Product Perception
Musa ÇEVİK Assoc. Prof. Dr. Medine ÇOPUR DOĞRUSÖZ	Yozgat Bozok University	Priming Application To Plant Seeds With Smoke Solution
Musa ÇEVİK Assoc. Prof. Dr. Medine ÇOPUR DOĞRUSÖZ	Yozgat Bozok University	Effect Of Legume Mixed Ratios On Quality In Hydroponic System
Kübra TEZEL Umut Rifat TUZKAYA	Yıldız Technical University	Improving Performance Efficiency With Overall Equipment Effectiveness: A Refrigerator Production Line Application
Dr. Ayşe Hilal ULUKARDEŞLER	Bursa Uludağ University	Experimental Investigation Of Biodiesel Production From Sunflower Oil Using Different Types Of Catalysts
Assoc. Prof. Dr. Semiha EREN Aliye AKARSU ÖZENÇ	Bursa Uludağ University	Utilization Of Microwave Energy In The Textile
Asst. Prof. Dr. Fatma ERGÜN	Kırşehir Ahi Evran University	Antioxidant Capacities Of Orange (<i>Citrus Aurantium</i>) Fruit Parts Collected From Adana And Hatay Regions



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-8

MODERATOR: Professor Said NOUIRA

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Khelef BOUICH	Teacher's Higher College- Mostaganem, Algeria	Analysis Of Higher Order Boundary Value Problem
Lecturer, Javeria Sheikh Prof. Dr. Amber Nawab Lecturer, Sobia Kamran Lecturer, Asra Mansoor Touba Waqar Iqra Sajjad Syeda Noor Zehra Sumaiya Mohsin	Jinnah University for Women, Karachi. Pakistan.	Impact Of Flouride Levels On Dental Health:
Lecturer, Javeria Sheikh Lecturer, Asra Mansoor Lecturer, Sobia Kamran Syeda Noor Zehra Naqvi Touba Waqar Iqra Sajjad Sumaiya Mohsin	Jinnah University for Women, Karachi. Pakistan	Fluoride And Dental Health: A Balance Between Prevention And Side Effects
Prof. Dr. Amber Nawab Lect. Dr. Javeria Rafiq Sheikh Prof. Dr. Subia Jamil Fakhra Mehar Nuzhat Naimatullah	Jinnah University for Women, Pakistan	"Strong Moms, Fragile Bones: Osteoporosis in Pregnancy"
Fenti FEBRIANI Khorisatul AMANAH Sulis SAPUTRA	UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia	The Interaction Of Ethics And Aesthetics In Human Decision-Making
Fani Alviyanto Metti Rahma Saniagi Istikomah Dwi Lestari Ade Gunawan	UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia	Islamic Mutual Funds In Indonesia
Fatma Azzahra Puspita SARI Qonita FITRIANI Riska Naila ZULFA Muhammad Sultan MUBAROK Ade GUNAWAN Ria Anisatus SHOLIHAH	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Benefits And Objectives Of Islamic Economic Philosophy
Adhi Riza AULIA Shafa Nissa AUDIA Asmitiya MEILINDA Karomatul IZZAH Muhammad Sultan MUBAROK Ade GUNAWAN	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Abdurrahman Wahid (Gusdur) Thoughts: Islamic Studies And People's Economics
Afolabi Tunde OWOLABI Seyi Samuel FATOLA	Osun State University, Nigeria/Far Eastern Federal University, Russia	Local Government And Socio-Economic Development In Nigeria: Case Study Of Ifedayo Local Government



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-9

MODERATOR: Research Scholar Fr. Baiju THOMAS

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Research Scholar Fr. Baiju THOMAS	Ramakrishna Mission Vivekananda Educational and Research Institute, Coimbatore	Improving the Impact of Shadow Education in Assisting Students with Autism Spectrum Disorders Thrive in Contemporary Educational Settings
Moses Adeolu AGOI Solomon Abraham UKPANA Oluwanifemi Opeyemi AGOI	Lagos State University of Education, Lagos Nigeria	A Content Review On The Role And Use Of Global Positioning System (Gps) In The Development Of Revolutionized Society
Niken Ning Tiyas Muhammad Zidan Maulana Muhammad Taufiq Abadi Etika Alina Putri Laeni Khazimah	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Sharia Venture Capital
Diana Zalfanur Erna Wijayanti Ega Vivia Fatikhah Ade Gunawan	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Understanding Islamic Insurance In Islamic Finance Theoretical Foundations And Literature Analysis
Laila Kholisa Azzahra Lizianil Azizah Aulia Nailis Slamah Ria Annisatus Solihah	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Sharia pension funds
Lia Olivia Zahara Ayu Andini Tia Syifana Intan Nadzifa Ade Gunawan	UIN KH. Abdurrahman Wahid Pekalongan, Indonesia	Sharia Cooperative
Issam AZGHAY Hassan AMHAMDI	Abdelmalek Essaadi University, Morocco	Computational Modeling Of The Corrosion Inhibition Mechanism Of Mild Steel By Two Schiff Bases



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-10

MODERATOR: Asst. Prof. Dr. Noreen SAJJAD

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Muhammad Taufiq Abadi Erna Wahyu Setianingsih Irfa Febriyani Sabina Sukma Mauldya Marlinda Effendi	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Islamic Bank Prepared To Fulfill Sharia Economic Institute Courses
Fadrika Hening Mangesti Neriza Apriani Okta Trifiana Ade Gunawan	UIN KH. Abdurrahman Wahid Pekalongan, Indonesia	Waqf And Zakat Institutions
Asst. Prof. Dr. Noreen SAJJAD Ayesha SADIQA Arif NAZIR Gulzar MUHAMMAD	University of Lahore Pakistan	Synthesis of Palladium nanoparticle using <i>opuntia ficus -indica</i> L mucilage and evaluation of antibacterial effects
Amin LAHHIT Hassan.AMHAMDIA	Abdelmalek Essaadi University, Morocco	An Investigation Employing Theoretical Approaches Such As Density Functional Theory (DFT) And Molecular Dynamics, Alongside An Experimental Comparative Study, Was Conducted To Assess The Effectiveness Of The New Molecules, PSB5 And PSB6, In Inhibiting The Corrosion Of Mild Steel In An HCl Environment
Linda Martalia Kholilah Amilatul Khasanah Sri Wahyuningsih Ade Gunawan M.M. Muhammad Taufiq Abadi	State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia	Analysis of the Duties and Authority of the Sharia Supervisory Board and the National Sharia Council
Dwi MUTIARA Riski FEBRIANA Dwi Sinta AMALIA Muhammad Sultan MUBAROK	State Islamic University K.H Abdurrahman Wahid Pekalongan, Indonesia	Teologi Ekonomi Islam



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-11

MODERATOR: Subhashish DEY

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Suciati FirdaYuliasari Fadila Salsa Faradiva Ade Gunawan	K.H Abdurrahman Wahid State Islamic University Pekalongan, Indonesia	Sharia Leasing In Indonesia
Heba A. Hashem Zohour I. Nabil Heba N. Gad EL-Hak	Suez Canal University, Egypt	Ameliorative Effect of Ashwagandha (Withania somnifera) Root Extract on Brain Oxidative Stress and Depression of Diabetic Rats
Skender Demaku Donika Sylejmani Ermond Frangu Arbnorë Aliu Dafina Mehmeti Diana Zabeli.	University of Pristina, Kosovo	Chemical, Physical And Biological Analysis Of River Water And Sediment; Sitnica, Ibri, Trepça and Drenica - Correlation With EU Standards - For Surface Waters
Fagbuaro Omotayo Ekundare Olugbemi Victor Amoo Raphael Oluwabanji	Ekiti State University, University of Ilesa, Nigeria	Chromosome Cytology of Africa Snakehead, Parachanna obscura from Egbe Reservoir, Ekiti State, Nigeria
Sundy Alagba OBAZI Chiamaka Eucharia UBACHUKWU Samuel Esheya ESHEYA	University of Nigeria/National Open University of Nigeria	Knowledge Of Farmers On Pesticide Safety Practices In Nsukka Local Government Area, Enugu State, Nigeria
Subhashish DEY	Gudlalleru Engineering College, India	Application of Biosorbents for Removal of Nitrites from Contaminated Water
Adinda UMUL Anton Bagus SANTOSO Muhammad Miftakhu SURUR Reny WIDIASTUTI Ria Anisatus SHOLIAH	State Islamic University K.H Abdurrahman Wahid Pekalongan, Indonesia	Duties And Authority Of The Sharia Supervisory Board And The National Sharia Board
Lawal, Abdulkarim, B.	University of Stirling, Scotland, UK./ Umaru Musa Yar'adua University, Katsina, Nigeria	Exposure of Nile Tilapia (Oreochromis niloticus) Preeeding Larvae To Aroclor 1254 and Benzo(a) Pyrene In A Laboratory Upregulate CYP P450 (A1) Gene Through AhR Pathway



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-12

MODERATOR: Vaibhav Kant SINGH

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
ARIGBO, Precious Obinna AGBO, Chidimma Marryann	University of Nigeria,	Nexus Of Livelihood Diversification On Food Security Status Among Rural Households In Agbani Agricultural Zone Of Enugu State, Nigeria
Vaibhav Kant SINGH Kapil Kumar NAGWANSHI Satyendra Singh THAKUR	Central University, India	Computer Vision for Agriculture
Vaibhav Kant SINGH	Central University, India	RDBMS for Food Management
Vaibhav Kant SINGH	Central University, India	Machine Learning for Animal Husbandry
Vaibhav Kant SINGH	Central University, India	Decision Tree for Agriculture
Gusdi Khamsaldin SJAFEI YAKUP Deddik BUDIANTA Firdaus SULAIMAN	Universitas Sriwijaya,	Adaptability Of Gogo Rice In Rubber Plant Area Produces
Samira MERADI, Miloud AOUACHRIA	Scientific and Technical Research Center on Arid Regions CRSTRA/Algeria	Potential Role Of Spices In Broiler Chickens Performance And Health
Dr. Omar MARDENLI	University of Aleppo, Syria	The Role And Importance Of The Bovine Genome In Enhancing Livestock Productivity
Saima ZAFAR Asma ASHRAF Sania BATOOL, Sehrish FATIMA	Government College University/Pakistan	Assessment Of Bioremediation Ability Of Klebsiella Pneumoniae PbS3A2 Strain In Oreochromis Niloticus



14.10.2023

SATURDAY / 10:30-12:30

SESSION-3 HALL-13

MODERATOR: Assoc. Prof. R. JOTHILAKSHMI

Algeria/Benin/Canada/Egypt/India/Indonesia/Kosova/Morocco/Nigeria/Pakistan/Russia/Syria/ Ukraine /U.K

AUTHORS	AFFILIATION	TOPIC TITLE
Pooja RASAL Gaurav KASAR	SNJB'S SSDJ College of Pharmacy. India	Hepatoprotective Effect of Curcumin Microsponges against Paracetamol- Induced Liver Toxicity in Rats
Ayu Ning Tiyas SULISTIOWATI Atinal Husna ADINIA M. Ishom MAARIF Muhammad Sultan MUBAROK, M.E	UIN K.H Abdurahman Wahid Pekalongan	The Relationship Between Islamic Philosophy And Other Islamic Sciences
B. Pharm, K. PUSHPARAJ Assoc. Prof. R. JOTHILAKSHMI Dean and Prof. Dr. R. SRINIVASAN B. Pharm, SELVAKUMAR	Bharath Institute of Higher Education and Research. Chennai, India	Peptides Against Infectious Diseases: From Antimicrobial Peptides To Vaccines
B. Pharm, SELVAKUMAR Assoc. Prof. R. JOTHILAKSHMI Dean and Prof. Dr. R. SRINIVASAN B. Pharm, K. PUSHPARAJ	Bharath Institute of Higher Education and Research. Chennai, India	Novel Anti-Cancer Agents Targeting Tumour Metastasis And Stemness
Muhammed, Y., Ajayi O. J., Tsado J. H. and Umar, I. S.	Federal University of Technology, Nigeria	Factors Influencing Utilization of Agricultural Technologies Transfer among Participants of Adopted Village Extension Project in Kaduna and Niger State, Nigeria
Gnihatin BAD, Akpo AB.	Université d'Abomey-Calavi, Bénin	Analysis of the length of dry periods for agricultural production using the Markov chain model: case of synoptic stations in Bénin
Elena SIERIKOVA, PhD Denys KRIUTCHENKO, leading engineer Nataliia VNUKOVA, Doctor of Technical Sciences	National University of Civil Defence of Ukraine, Kharkiv National Automobile Highway University, Ukraine	Increasing The Environmental Safety Level Of Liquid Storage Used In Agriculture

PHOTO GALERY

h3 İrem Yeleser ekranını görüntüyorsunuz Seçenekleri Görüntüle Giriş yapın Görüntüle

İrem Yeleser, Sunum (1).pdf - Adobe Acrobat Pro

Dosya Düzenle Görünüm Pencere Yardım

Aç Oluştur Araçlar Doldur ve İmzala Yorum

ÇALIŞMANIN AMACI

- Adenokarsinom ve skuamöz hücreli karsinom hastalarında ve sağlıklı örneklerinde *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeyleri araştırıldı.
- Seçilen genlerin, iki türü hasta-kontrol gruplarında ne düzeyde eksprese olduğu belirlenmeye çalışıldı.
- KHDAK türlerini birbirinden ayırt etmek için moleküler düzeyde kullanılacak bir belirteç olup olmadığı tespit edilmeye çalışıldı.

6

h3 AhmetKorkmaz

ISARC YASEMİN AĞAOĞLU

h3 İrem Yeleser

h3 Funda ASLA...

h3 Funda ASLANTAŞ BEYİN

S2-H3 Demet G...

S2-H3 Demet G.KARABULUT

Sesi aç Videoyu Başlat Katılımcılar 5 Sohbet Ekranı paylaş Kaydet Ara Odalar 1 Reaksiyonlar Uygulamalar Beyaz Tahtalar Odadan Çık

h7 Arzu Seçer ekranını görüntüyorsunuz Seçenekleri Görüntüle Giriş yapın Görüntüle

CONCEPTUAL FRAMEWORK

Table 1. Definitions of these factors

Factors	Explanations
Perception about organic food	Perception is an intertivist cognitive process through which individuals systematically organize and interpret the data conveyed by their sensory organs. This intricate process enables human beings to derive meaning from the various stimuli originating from the objects and events within their surrounding environment (White et al., 2019).
Subjective Norms	The term is defined as the pressure perceived by an individual to endorse or adopt a specific behavioral pattern, arising from the social dynamics in which the individual is situated or from individuals who share common social values with them (Ajzen, 1991).
Ability	Ability is seen as a complex entity which includes a combination of factors such as awareness, experience, knowledge, skills, accessibility to information, and financial resources (Ryan and Jepson, 2018)
Hedonism	Some consumers consider pleasure and happiness as a significant life goal and may shape their consumption preferences accordingly. Hedonism is referred as the behavior of continuously seeking pleasure and enjoyment from consumption or shopping (Tarka et al., 2022).
Openness to new experiences	This concept expresses the manner in which consumers engage with novel products, services, technologies, and ideas, and approach to these innovations (Tan, C. S., 2010; Gomes et al., 2022).

h7 Arzu Seçer

ISARC YASEMİN AĞAOĞLU

H7- Ayşe Hilal U...

h7 medine Çopur doğrusöz

H7- Ayşe Hilal Ulukardesler

h7 musa çevik

Kübra Hüma

h7 musa çevik

Kübra Hüma

ALİYE AKARSU...













Fatma ERGÜN H7

ALİYE AKARSU ÖZENÇ


Fatma ERGÜN H7

Sesi aç Videoyu Başlat Katılımcılar 8 Sohbet Ekranı paylaş Kaydet Ara Odalar 1 Reaksiyonlar Uygulamalar Beyaz Tahtalar Odadan Çık


h6 Harun Aytac ekranını görüntülüyorsunuz
Seçenekleri Görüntüle
Giriş yapın Görüntüle

	HC-SR04 Mesafe Sensörü		Yağmur Sensörü		HC-SR501 Hareket Sensörü (PIR)
	LM35 Sıcaklık Sensörü		Ses Seviye Sensörü		Ses Sensörü
	DHT11 Nem ve Sıcaklık Sensörü		Alev sensörü		HC-05 ve HC-06 Bluetooth Modülleri
	Toprak Nem Sensörü		Gaz Sensörleri		Gaz Sensörleri


- Arduino, sensörler yardımıyla çevreden aldığı dataları işleyerek, i şekilde çıktılar oluşturabilir(Mohapatra vd., 2020).
- Arduino can create outputs in accordance with its program by pr it receives from the environment with the help of sensors (Moha 2020).




s2 h6 Mehmet Zencirkiran




ISARC Yasemin AĞAOĞLU



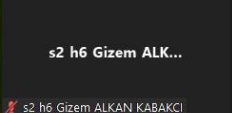
h6 Mustafa YAZICI



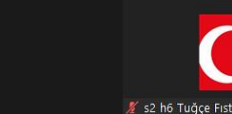
h6 Mustafa YAZICI




h6 Adil Can KAYA




h6 Mustafa YAZICI

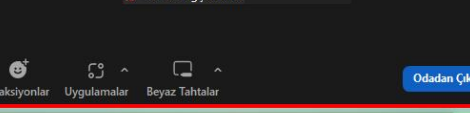


h6 Harun Aytac



s2 h6 Gizem ALK...

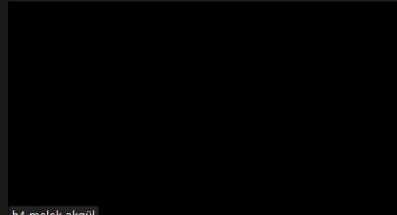





s2 h6 Tuğçe Fistik

Sesi aç
Videoyu Başlat
Katılımcılar
Sohbet
Ekranı paylaş
Kaydet
Ara Odalar
Reaksiyonlar
Uygulamalar
Beyaz Tahtalar
Odadan Çık


Zoom Toplantı - Oda 4
Giriş yapın Görüntüle




h4 melek akgül




ISARC Yasemin AĞAOĞLU



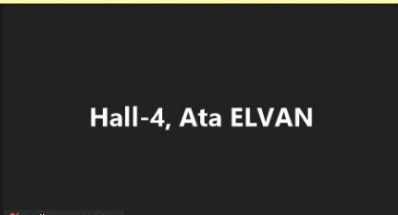
h4 ozhan çetindag



inanc Artac



h4 Elif KARACA...



Hall-4, Ata ELVAN

Sesize al
Videoyu Durdur
Katılımcılar
Sohbet
Ekranı paylaş
Kaydet
Ara Odalar
Reaksiyonlar
Uygulamalar
Beyaz Tahtalar
Odadan Çık

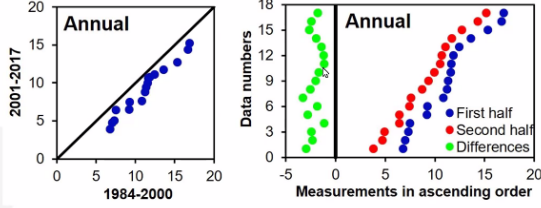
Ara
23°C Güneşli
09:39 14.10.2023

S1-H2 Cihangir KOYCEGİZ ekranını görüntüyorsunuz Seçenekleri Görüntüle Giriş yapın Görüntüle

Results

As shown in Figure 2.a, there is a monotonic decreasing trend in the annual average flow data since all points are in the triangular region below the 1:1 straight line for the period 1984-2017 according to Şen-ITA method. A similar trend is also observed in the VATA graph in Figure 2.b. In Figure 2.b, all the difference values are on the left side of the vertical trend line. This shows that there is a monotonic decreasing trend according to VATA. In the same graph, it is also possible to make this assessment as all of the second half values are on the right side of the first half values.

Figure 2. a) Classical Şen-ITA, b) VATA graph for annual average flow data

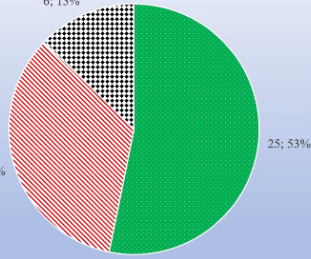


S1-H2 Cihangir KOYCEGİZ
ISARC Yasemin AĞAOĞLU
s1h2 memduh kose
SULTAN SEVİNÇ KUŞU
h2Ei Fevza Sukur
h2 Merve KAYA...
h2 Merve KAYACI ÇO...

Sesi aç Videoyu Başlat Katılımcılar 6 Sohbet Ekranı paylaş Kaydet Ara Odalar 12 Reaksiyonlar Uygulamalar Beyaz Tahtalar Odadan Çık

h1 MURAT BAYRAKTAR ekranını görüntüyorsunuz Seçenekleri Görüntüle Giriş yapın Görüntüle

METHODOLOGY AND SYSTEM DESCRIPTION



h1 MURAT BAYRAKTAR
ISARC Yasemin AĞAOĞLU
h1 Çağrı Gökhan...
h1 Ceren Celik
h1 Çağrı Gökhan Türk
h1 Seniz AKIN
s1 h1 Hüseyin K...
h1 Seniz AKIN
s1 h1 Hüseyin KÖSE
Ramazan ÖZMEN
Ramazan ÖZMEN

Sesi aç Videoyu Başlat Katılımcılar 7 Sohbet Ekranı paylaş Kaydet Ara Odalar 11 Reaksiyonlar Uygulamalar Beyaz Tahtalar Odadan Çık

	INDEX	
CONGRES ID		I-IV
PROGRAM		V-XIX
GALLERY		XX-XXII
INDEX		XXXI-XXXV

AUTHORS	TITLE	NO
Murat BAYRAKTAR Onur YÜKSEL	Reliability Analysis On The Engine Room Systems Of The Ro-Ro Passenger Ship	1-9
Ogan Tanıl ORHUN Seniz R. KUSHAN AKIN	Production Of Silicon Nitride Ceramics With Functionally Graded Porosity For Biomedical Applications	10-11
Ceren ÇELİK Uğur GÜROL	An Investigation Of The Weldability Of High-Strength Ballistic Armor Steel Plates Using Austenitic Stainless Steel Wire	12-13
Ramazan ÖZMEN	Effect Of Reinforcements On Elastic Mechanical Responses Of Strut-Based Cubic Lattice Structures	14-24
Hüseyin KÖSE Deniz ARSLAN	Stability-Flow Analyses Of Asphalt Mixtures Prepared With Limit And Off-Limit Aggregate Gradations	25-34
Çağrı Gökhan TÜRK Mahmud TOKUR	Investigation The Effects Of 2D Materials On The Cathode Performance Of Li-S Batteries	35-36
Cihangir KOYCEGİZ Meral BUYUKYILDIZ	Detection Of Temporal Variability In Monthly And Annual Mean Streamflow Data Of Feke Station In Seyhan Basin	37-46
Cansu Hacer KAPLAN Meral BUYUKYILDIZ Cihangir KOYCEGİZ	Applicability Of Different Interpolation Methods In The Estimation Of Potential Evapotranspiration	47-56
Esmâ KARAKOYUN YAŞAR	Klasik Osmanlı Mimarisinde Uzuncaova Camii	57-72
Memduh KÖSE	Use Of Convolutionary Neural Network As Feature Extractor In Image Classification	73-74
Mustafa Ali Hussein HUSSEIN Memduh KÖSE Emre YAVUZER İbrahim ŞANLIALP	Using A Pre-Trained Convolutional Neural Network In Chicken Meat Classification	75-76
Emine Feyza ŞÜKÜR	Mechanical And Thermal Performance Of Epoxy/Clay Nanocomposites: Effect Of Na-Activated Bentonite Clay Content	77-86
Merve KAYACI ÇODUR	Machine Learning Approaches For Sustainable Planning: A Case Study Of Türkiye	87-88

AUTHORS	TITLE	NO
Sultan Sevinç KURT KONAKOĞLU Tuğba ÜSTÜN TOPAL Kadir Tolga ÇELİK	A Study On Determining Recreational Area Usage Opportunities In The Coastal Strip Of Fatsa District, Ordu Province, Türkiye	89-96
İrem YELESER Mehmet Emin ERDAL	Investigation Of The Expression Levels Of Some Pluripotency Markers In Lung Cancer Patients Diagnosed With Adenocarcinoma And Squamous Cell Carcinoma	97-108
Demet GÖZAÇAN KARABULUT	Physical Activity In Individuals With Cerebral Palsy: A Review	109-113
Demet GÖZAÇAN KARABULUT Mehmet İbrahim TURAN	Investigation Of Nail Morphological Changes In Individuals With Cerebral Palsy	114-118
Elif Esra ALTUNER Fatih ŞEN	Development Of Fe ₃ O ₄ @ MWCNT Nanocomposite-Based Electrochemical Sensor For The Determination Of Cold Drugs Containing The Active Ingredients Of Clavulanic Acid And Amoxicillin	119-126
Elif Esra ALTUNER Fatih ŞEN	Synthesis Of Active Carbon Supported Zinc Nanoparticles And Their Oxidation Against Methanol-Based Fuel Cells	127-131
Funda ASLANTAŞ BEYİN Ahmet KORKMAZ Haydar ÖZKAN	Brain Tumor Segmentation And Proportional Size Detection From MR Images	132-141
Melek AKGÜL Serkan ETLİ	Early Age Mechanical And Durability Properties Of Fiber Reinforced Micro Concretes	142-153
Özhan ÇETİNDAG	Efficacy Of Sinus Laser Treatment In Sacrococcygeal Pilonidal Sinus Disease	154-155
Elif KARACAN YELDİR Feyza KOLCU İsmet KAYA	Synthesis And Characterization Of Poly (Diaminopyridine) Containing Bromine By Enzyme-Catalyzed Polymerization	156-168
Doğaç KARAGÜVEN Sefa AKTI	Kemik Metafizler Bölgesinde Drill Kullanımında Olası Riskler	169-170
İnanç ARTAÇ	The Prognostic Efficacy Of Halp Score For In-Hospital Mortality Patients With Hospitalized Due To Heart Failure	171-175
Omar BENAMARI Hassan AMHAMDI	A Review Of The Protective Properties Of Medicinal Plants Against Diabetes-Related Heart Disease	176

AUTHORS	TITLE	NO
Hafize Hilal KARGIN Ata ELVAN	Endurance Of Core Muscles And Postural Control	177-178
Aykut ASTAM Ömer KAYA	Effect Of Reaction Time On The Properties Of CuO Thin Films Deposited By Hydrothermal Method	179-187
Aykut ASTAM	Investigation Of Structural And Optical Properties Of β -MnO ₂ Thin Films Obtained By Hydrothermal Method	188-189
Özgür ERDAĞ	The Mersenne-Padovan Sequence And Its Binet Formulas	190-195
Özgür ERDAĞ	The Mersenne-Padovan Sequence Modulo m	196-200
Yeşim AKÜZÜM Ömür DEVECİ	The Mersenne-Jacobsthal Sequence Modulo m	201-205
Yeşim AKÜZÜM	The Representations And Finite Sums Of The Mersenne-Jacobsthal Sequence	206-212
Abdurrahman GÜNDAY	On The Strain And Temperature Dependencies Of The Electric Susceptibility Of Silica Fiber Core	213-214
Mustafa YAZICI Harun AYTAÇ	A Study On The Application Of Arduino Supported Stem Activity In Teaching The Subject Of Respiratory System In 6th Grade Science Course	215-222
Mustafa YAZICI Tuğçe FISTIK	Descriptive Analysis Of Master Thesis Studies On Artificial Intelligence Technology In Science Education In Turkey Between 2020-2023	223-234
Zidan KAFABİH Muhammad Sultan MUBAROK Muhammad Taufiq ABADI Muhammad SHULTHONI	Cultivating Tranquility: Stoicism's Approach To Overcoming Envy	235
Metin CANCI Gizem ALKAN KABAĞCI	Consumer Preferences On Electric Vehicles: A Comparison Study Applying Multi Criteria Decision Analyses	236-246
Ananda MAJUMDAR	Narrative Of Indigenous Community In Canada	247-257
Mustafa AYDIN Adil Can KAYA	Hull Design And Structural Analysis For An Autonomous Agricultural Unmanned Ground Vehicle	258-267
Mustafa AYDIN İsmail GÜRBÜZ	Characteristics Of A Lithium-Ion Battery Module For A Hybrid And Electric Vehicle	268-281
Mehmet ZENCİRİRAN	Hidrojen Yakıtının Taşıtlarda Kullanımının Yaygınlaştırılması	282-288
Gizem YENER Arzu SEÇER	Determination Of The Factors Affecting Consumers' Intention To Consume Organic Food As Mediated By Perception About Organic Products	289-297
Musa ÇEVİK Medine ÇOPUR DOĞRUSÖZ	Priming Application To Plant Seeds With Smoke Solution	298-309

AUTHORS	TITLE	NO
Musa ÇEVİK Medine ÇOPUR DOĞRUSÖZ	Effect Of Legume Mixed Ratios On Quality In Hydroponic System	310-316
Kübra TEZEL Umut Rifat TUZKAYA	Improving Performance Efficiency With Overall Equipment Effectiveness: A Refrigerator Production Line Application	317-326
Ayşe Hilal ULUKARDEŞLER	Experimental Investigation Of Biodiesel Production From Sunflower Oil Using Different Types Of Catalysts	327-333
Semiha EREN Aliye AKARSU ÖZENÇ	Utilization Of Microwave Energy In The Textile	334-340
Fatma ERGÜN	Antioxidant Capacities Of Orange (<i>Citrus Aurantium</i>) Fruit Parts Collected From Adana And Hatay Regions	341-349
Khelef BOUICH	Analysis Of Higher Order Boundary Value Problem	350
Javeria SHEIKH Amber NAWAB Sobia KAMRAN Asra MANSOOR Touba WAQAR Iqra SAJJAD Syeda Noor ZEHRA Sumaiya MOHSIN	Impact Of Flouride Levels On Dental Health	351-364
Javeria SHEIKH Asra MANSOOR Sobia KAMRAN Syeda Noor Zehra NAQVI Touba WAQAR Iqra SAJJAD Sumaiya MOHSIN	Fluoride And Dental Health: A Balance Between Prevention And Side Effects	365
Amber NAWAB Javeria Rafiq SHEIKH Subia JAMIL Fakhra MEHAR Nuzhat NAIMATULLAH	Strong Moms, Fragile Bones: Osteoporosis In Pregnancy	366-367
Fenti FEBRIANI Khorisatul AMANAH Sulis SAPUTRA	The Interaction Of Ethics And Aesthetics In Human Decision-Making	368
Fani ALVİYANTO Metti Rahma SANIAGI Istikomah Dwi LESTARI Ade GUNAWAN	Islamic Mutual Funds In Indonesia	369-378
Fatma Azzahra Puspita SARI Qonita FITRIANI Riska Naila ZULFA Muhammad Sultan MUBAROK Ade GUNAWAN Ria Anisatus SHOLIHAH	Benefits And Objectives Of Islamic Economic Philosophy	379-380
Adhi Riza AULIA Shafa Nissa AUDIA Asmitiya MEILINDA Karomatul IZZAH Muhammad Sultan MUBAROK Ade GUNAWAN	Abdurrahman Wahid (Gusdur) Thoughts: Islamic Studies And People's Economics	381
Afolabi Tunde OWOLABI Seyi Samuel FATOLA Moradeyo Oluwatobi ADEOYE	Local Government And Socio-Economic Development In Nigeria: Case Study Of Ifedayo Local Government	382-393
Fr. Baiju THOMAS	Improving The Impact Of Shadow Education In Assisting Students With Autism Spectrum Disorders Thrive In Contemporary Educational Settings	394-395

AUTHORS	TITLE	NO
Moses Adeolu AGOI Solomon Abraham UKPANA Oluwanifemi Opeyemi AGOI	A Content Review On The Role And Use Of Global Positioning System (GPS) In The Development Of Revolutionized Society	396-402
Niken Ning TIYAS Muhammad Zidan MAULANA Muhammad Taufiq ABADI Etika Alina PUTRI Laeni KHAZIMAH	Sharia Venture Capital	403-415
Diana ZALFANUR Erna WIJAYANTI Ega Vivia FATIKHAH Ade GUNAWAN	Understanding Islamic Insurance In Islamic Finance (Theoretical Foundations And Literature Analysis)	416-432
Laila KHOLISA Lizianil AZIZAH Aulia Nailis SLAMAH Ria Annisatus SOLIHAH	Sharia Pension Funds	433-444
Lia Olivia ZAHARA Ayu ANDINI Tia SYIFANA Intan NADZIFA Ade GUNAWAN	Sharia Cooperative	445-458
Issam AZGHAY Hassan AMHAMDI	Computational Modeling Of The Corrosion Inhibition Mechanism Of Mild Steel By Two Schiff Bases	459-460

RELIABILITY ANALYSIS ON THE ENGINE ROOM SYSTEMS OF THE RO-RO PASSENGER SHIP

Murat BAYRAKTAR

Marine Engineering Department, Maritime Faculty, Zonguldak Bülent Ecevit University Zonguldak
ORCID ID: 0000-0001-7252-4776

Onur YÜKSEL

Marine Engineering Department, Maritime Faculty, Zonguldak Bülent Ecevit University Zonguldak
ORCID ID: 0000-0002-5728-5866

ABSTRACT

To ensure sustainability in maritime transportation, ship operations should be carried out continuously. To provide continuity, the deck and machinery systems of marine vessels must be equipped with reliable ones. Especially, the reliability of engine room systems is quite critical for the propulsion of ships. Although engine room systems are quite robust and reliable, necessary parts must be replaced at regular intervals to smooth operation. It is quite challenging to predict and replace the components before they malfunction to prevent operations from interrupting. Reliability analysis has been carried out on the engine room systems using 1-year failure records of three Ro-Ro passenger ships. In the first stage, failures are classified according to their belonging systems via marine experts. According to the results, the cylinder of the main engine is the most unreliable equipment because the number of failures is the most and their repair time takes a long time. This is followed by generator, seawater, and separator systems. The reliability of the remaining systems is slightly higher than these systems. The reliability analysis performed on the Ro-Ro passenger ships will benefit ship operators for the planned maintenance strategies phase. In addition, continuous monitoring and measurement applications on the engine room systems throughout the operation of the ship will be useful in detecting failures that may occur for the first time.

Keywords: Reliability, Ro-Ro passenger, engine room systems, cylinder

1. INTRODUCTION

Maritime shipping has a critical role in facilitating cost-effective and reliable cargo transportation. Enhanced energy efficiency applications in this transportation mode contribute to the realization of sustainable development goals (Karatuğ and Arslanoğlu, 2022). Although marine vessels are equipped with robust propulsion systems to operate for long periods, to sustain shipping, the required parts should be changed regularly in the propulsion system after a certain period (Beiger, 2011). Considering the whole ship's propulsion equipment, failures in the main engine, steering gear, fuel system, cooling system, shafting, and diesel generator have interrupted the ship's operation (Brocken, 2016). Failures occurring in the main and auxiliary

engines can lead to irreversible consequences on the environment, human life, and loss of budget (Awal and Hasegawa, 2015; Balin et al., 2015). The biggest factors causing these failures are human errors, and improper and inadequate maintenance strategies (Brocken, 2016). Therefore, the high quality of the spare parts and skillful personnel should have been utilized to avoid disruption of operations (Misra et al., 2017). Although the use of unskilled labor and poor-quality spare parts reduces operating costs in the first stage, they cause costly malfunctions in the ship's propulsion system (Beiger, 2011).

Regular maintenance applications and the implementation of operational measures contribute to reducing malfunctions, extending the engine's service life, and increasing the operational efficiency of marine vessels (Misra et al., 2017; Göksu & Erginer, 2020). These provide cost savings and an augmented operational lifespan for the ship in an environmentally friendly way. (Misra et al., 2017). In addition to planned maintenance, technical innovations in marine engines play a pivotal role in mitigating or eliminating failures (Cicek & Celik, 2013). In particular, ongoing monitoring efforts, measurement, and data collection from the system are critical both in identifying faults and in the early intervention stage (Misra et al., 2017; Vizentin et al., 2017). Being able to predict failures that occur in the ship's propulsion system is quite important for the smooth ship because failures can be fixed before severe consequences occur (Brocken, 2016).

The root of engine malfunctions during operation can be traced back to the design stage, where inadequately designed engines and their components cause a multitude of malfunctions (Misra et al., 2017). Furthermore, the use of contaminated and inappropriate fuel, and prolonged and irregular operating periods have caused malfunctions, even if the engine is perfectly designed and manufactured (Misra et al., 2017). Throughout the ship's operation, unusually high-temperature levels at the exhaust outlet of the main engine, the surge in engine speed, the shutdown of the main engine, unexpectedly increased lubricating oil level, fire occurring in the scavenging area, insufficient, and irregular air pressure from the turbocharger are the main factors that lead engine failures in the ship (Balin et al., 2015). The low lubricating oil pressure, the lubricating oil pump failures, and more have limited the needed oil reaching the systems (Awal and Hasegawa, 2015). Inadequate lubrication during the operation of the main engine results in detrimental effects on critical main engine components such as piston, liner, cylinder, and more (Ceylan et al., 2022).

Beiger (2011) has investigated the main engine failures that occurred in the seismic research vessel. Although many factors lead to engine failures, timing gear, and piston-connecting rod systems failures have only been analyzed. The main factors causing failure are the use of poor-

quality spare parts and unqualified workers who performed the maintenance. Cicek and Celik (2013) have highlighted that a crankcase explosion occurred in the main engine of the ship has the potential to damage both the ship structure and ship crew. As the occurrence of a crankcase explosion is a highly intricate situation on board, fundamental causes of it have been identified through brainstorming, and these specified reasons have been utilized in the Failure Modes and Effects Analysis (FMEA) for thorough examination. The piston, stuffing box, and fuel valve are the most fundamental components because failures occurring in them have the highest adverse effect on the crankcase explosion. Excessive wear on the piston flame face is also the most critical failure that leads to crankcase explosion. Awal and Hasegawa (2015) analyzed Engine failures with Logic Programming Technique (LPT) and investigated their effect based on Deductive and Inductive Logic. In addition to engine failures, crew member actions have led to collusion. Balin et al. (2015) have utilized the Fuzzy Analytic Hierarchy Process (AHP) and VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje) to reveal and rank failures that occurred in diesel engines. Several main and sub-factors have led to engine failure and these failures have also affected the alternative system. While the air supply system is the least affected, the Cooling System is the most severely influenced system among the alternative systems. Vizentin et al. (2017) have assessed failures in the ship propulsion system. According to the results, fatigue failure is the most critical one, and torsional vibrations and geometric stress concentrations are the main causes of it and they have resulted in Constant load variation changes Göksu and Erginer, (2020) have analyzed failures that affect main engine operation directly and have determined intervals of failures by using ANN. 220 failures acquired from a 10-year failure history have been investigated in nine fundamental headings. Under the headings, the main Engine with 72 failures and the fuel System with 48 failures are the most critical ones because more than 50% of failures have occurred in these systems. Under the nine fundamental headings, the most number of failures have been obtained from fuel pumps of 20, exhaust valves of 12, main structural parts of 12, oil mist components of 11, piston rings of 10, and control parts of 10 respectively. To predict engine failure, Moon and Choi (2020) have used the Bayesian hierarchical B-spline on the Republic of Korea Naval ships and have acquired verified results. The results have been quite beneficial in the maintenance planning phase. Effective maintenance planning has cut down time downtime of the ship and has reduced operating expenses. Bayraktar and Nuran, (2022) have examined the number of 63 failures that interrupt the ship's propulsion system under three main headings boiler failure, main engine failure, and steering gear failure. Among the fundamental failures, main engine failures have a major impact on the operation of ship propulsions. Cylinder failures are the most common of

the subfactors. Therefore, to reduce cylinder failures, planned maintenance by qualified personnel and the use of reliable items are necessary. Ceylan et al., (2022) have revealed factors causing catastrophic ship main engine failure of the oil-chemical tanker using a systems theoretic accident model and processes (STAMP) analysis. Within the spectrum of factors causing malfunctions, the human factor has the biggest impact with 80%. Other factors belong to hardware & software factor with 13% and external factors with 7% respectively. Karatuğ and Arslanoğlu (2022) have developed a condition-based maintenance strategy using data from large-sized container ships. Main engine power, rpm of the shaft, variables related to fuel oil, and exhaust outlet temperatures have been utilized in ANN to create an engine performance model. Fault diagnosis have been performed using model output, constraints, real data, and more. The specified strategy gives quite realistic results at the diagnosis stage and provides gains in terms of both cost and energy efficiency for ship operators and ship owners. Kang et al. (2023) have utilized a hierarchical level fault detection and diagnosis (HL-FDD) method. Under this method, the engine ship has been classified into 5 subsystems which are the main engine, turbocharger, cooling, lubrication, fuel oil, air intake, and generator. 55 sensors are used for data collection to track the operation of the systems. Sensors are mostly used in the main machine. Lower and upper limits for the data coming from each sensor are determined to identify faults and their thresholds vary with engine load. In this way, failures are identified very easily for engineers, ship owners, manufacturers, and controllers. Moreover, the data to be acquired dynamic model will be very useful during the implementation of the planned maintenance system.

2. RESEARCH GAP AND MOTIVATION

Although there are several articles related to failures that occurred in ship propulsion systems and sub-systems, no study has been found to examine failures that occurred in ship engine systems of Ro/Ro Passenger vessels using data obtained from ships onboard. The potential use of this study in planned maintenance strategies of marine vessels is an important source of motivation for the authors. Predicting upcoming failures and developing appropriate planned maintenance strategies contributes to energy efficiency efforts and desired environment-friendly and cost-effective ship operation.

3. METHODOLOGY AND SYSTEM DESCRIPTION

The study has been carried out using the failure records of 3 Ro-Ro passenger vessels for 1 year. A total of 47 failures have occurred in the ship systems ship within one year. Recorded failures have been examined under three main headings: engine room, deck machinery, and

other system failures. The number of failures according to systems has been described in Figure 1.

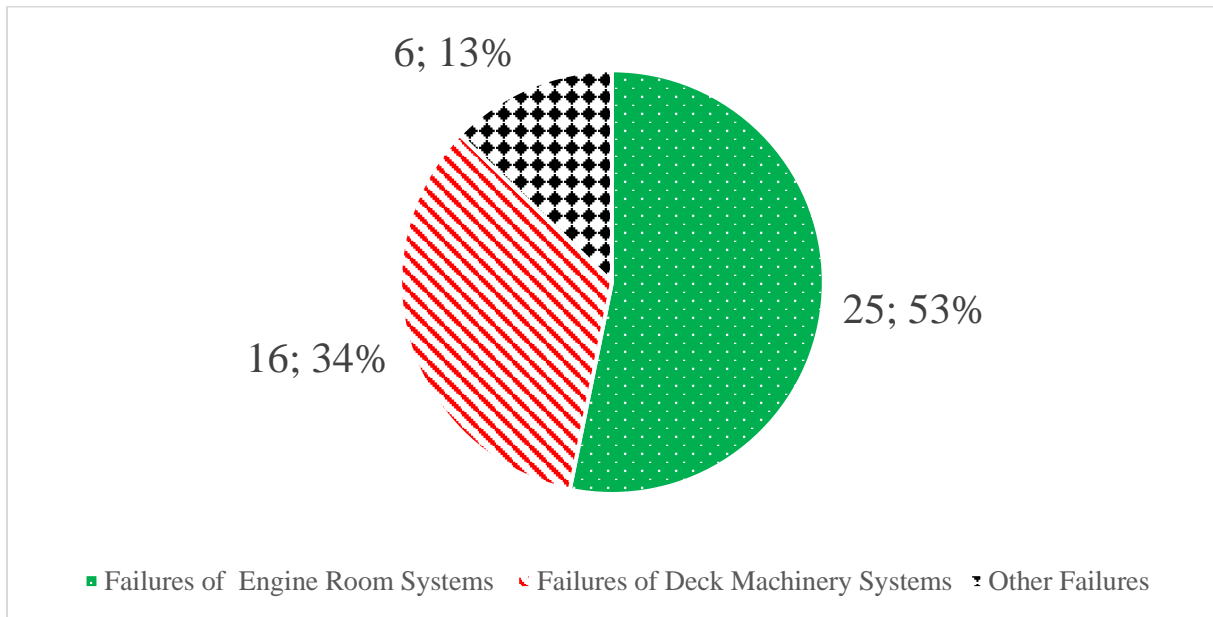


Figure 1. Failures of Ships based on ship systems

Excluding deck machinery and other system failures, only failures that occurred in engine room systems have been detailly examined in this study. 25 out of 47 failures belong to engine room systems. Failures that occurred in the engine room systems have been evaluated under 11 subheadings: Cylinder Failures, Exhaust Failures, Fuel System Failures, Control System Failures, Sea Water System Failures, Lubrication System Failures, Separator Failures, Boiler Failures, Fire Fighting System Failures, Compressor Failures, and Generator Failures. The number of failures that occurred in specified subheadings has been expressed in Figure 2.

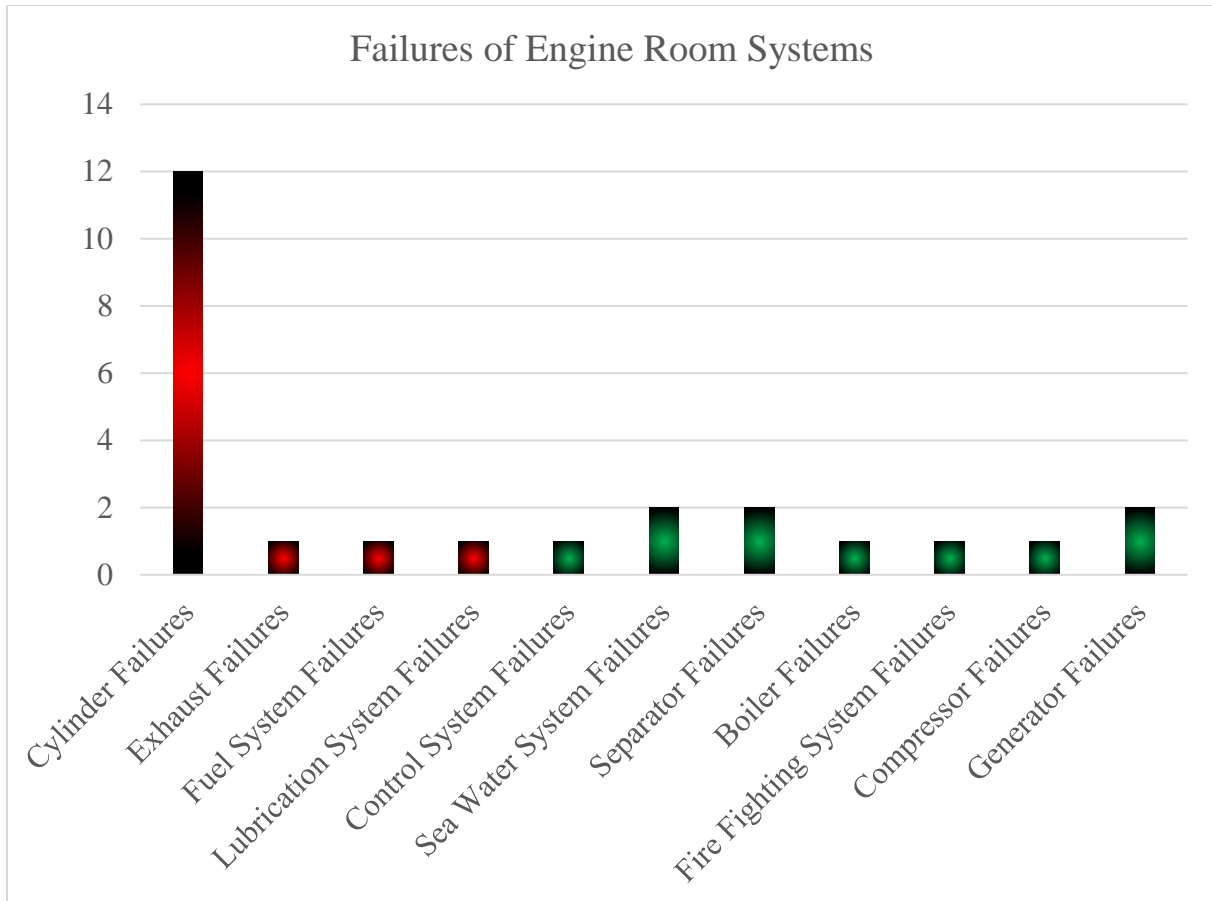


Figure 2. Failures of Engine Room Systems

An evaluation has been performed by using engine room system failure records of Ro/Ro Passenger vessels. The first four failures depicted in red color are directly related to the main engine. Records also include descriptions of failures, corrective actions on the failures, and used spare parts with their quantity. Obtained data has been utilized in the reliability analysis of each component under the engine room system. Failure rate (λ) and Mean Time Between Failures (MTBF) have been used in the calculation stage. Both λ and MTBF formula has been depicted in formula 1 as follows

$$\text{Failure Rate } (\lambda) = \frac{\text{Number of Failures}}{\text{Operating Time}} \quad \& \quad \text{MTBF} = \theta = \frac{\text{Operating Time}}{\text{Number of Failures}} \quad (1)$$

After the calculations of failure rates and MTBFs, the reliability of each component has been calculated based on Formula 2.

$$\text{Reliability} = R(t) = e^{-\lambda t} \quad (2)$$

4. LIMITATIONS

Throughout the analysis, specified limitations have been described as follows,

- Only one year's failure data of engine room systems has been utilized.

- Unrecorded small-scale errors have been neglected.
- The reliability of each component has been calculated in 10-hour intervals.
- The repair time for each failure has been determined by the marine expert.

The results section has been created by considering these limitations and the studies in the literature.

5. RESULTS AND DISCUSSIONS

Cylinder failures are the most occurred ones, among failures of engine room systems and they account for 48% of the failures. This is followed by seawater system failures, separator failures, and generator failures with 8% rates. Remain failures have occurred just one time throughout the year.

Failures fixed times ranging from 2 and 14 hours according to component type in light of marine expert opinion. The total fixed time of 25 failures has been calculated as 132 hours. During the fix of failures, the most time has been spent on fixing cylinder failures. The number of failures, operating time, and time interval have been utilized to create Figure 3 which describes the reliability of each component.

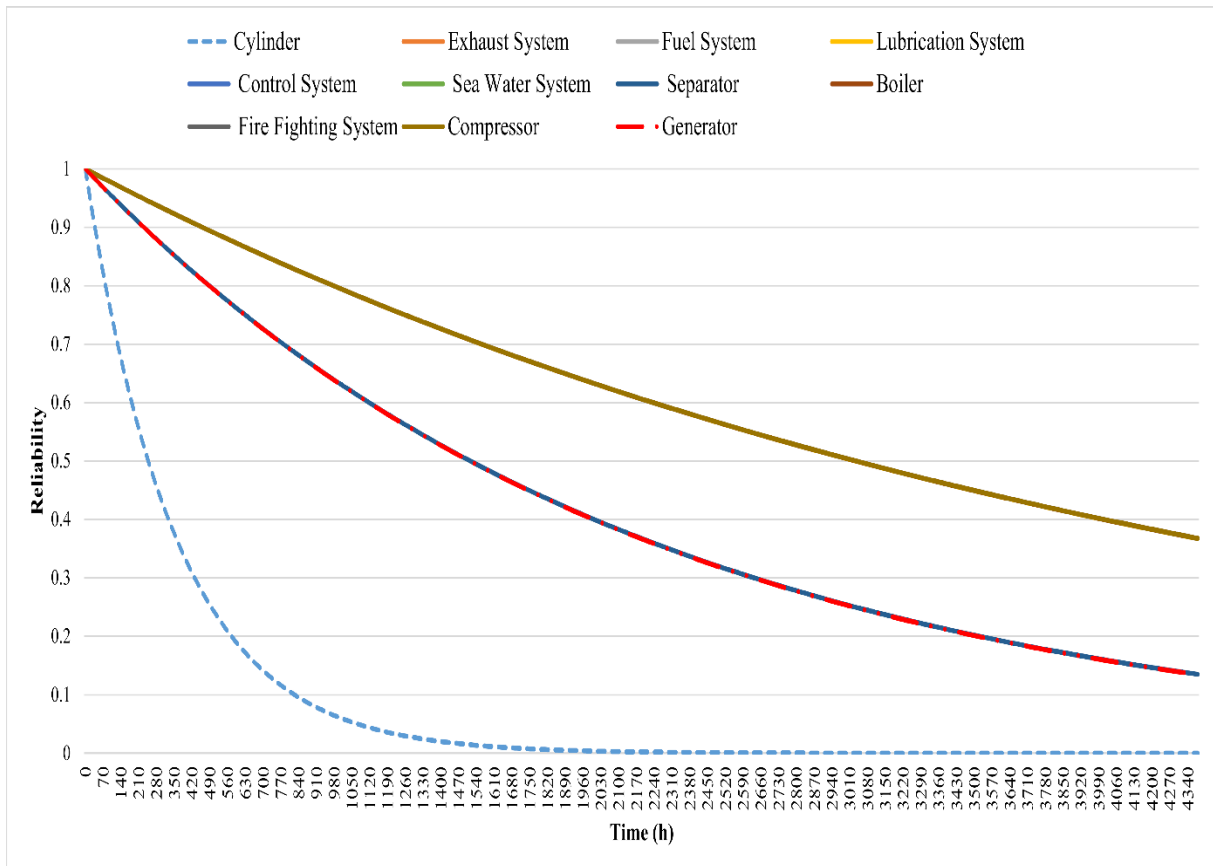


Figure 3. The reliability of each component existed in the engine room

Both the few number of failures and the short repair time make exhaust, fuel systems, control systems, firefighting systems, and compressor systems stand out in terms of reliability. Cylinders, generators seawater systems, and separators appear to be the least reliable systems respectively because of the number of failures and repair times.

6. CONCLUSIONS

Reliability analysis has been performed on the failures of engine room systems belonging to three Ro-Ro passenger ships considering the number of failures and mean time between failures.

The fundamental outputs of this study can be listed as follows.

- Regular checks and monitoring should be made to prevent failures from occurring in the cylinder of the main engine. According to the analysis results, the cylinder is the most malfunctioned and least reliable equipment. Malfunctions occurring in the cylinder directly increase the main engine oil consumption rate. In addition to excessive oil consumption rate, water leaks can be observed around the main engine cylinder due to cylinder failures. Excessive oil consumption and water leaks have been prevented by piston, liner, and cylinder overhauling.
- Oscillation of the alternator shaft in generators and water leaks to the crankcase oil negatively affect the reliability of the generator used in the ship. A significant amount of time, labor, and spare parts are needed to operate generators again.
- Repair of malfunctions in both separator and freshwater systems takes relatively less time than both the main engine and the generator. That's why their reliability level is a little bit higher than to main and auxiliary engines.
- Only one failure has occurred in each remaining system for the specified period. This enabled them to keep their reliability levels quite high.

Maritime transportation has the highest cargo handling share among transportation modes. The continuous and reliable operation of marine vessels plays a pivotal role in the realization of this. Therefore, failures in the engine room systems should be eliminated and their reliability should be increased by using robust spare parts, utilizing planned maintenance strategies, and appointment of qualified personnel.

REFERENCES

- Awal, Z. I., & Hasegawa, K. (2015). Analysis of Ship Accidents due to Marine Engine Failure- Application of Logic Programming Technique (LPT). *Marine Engineering*, 50(6), 744-751.
- Balin, A., Demirel, H., & Alarcin, F. (2015). A hierarchical structure for ship diesel engine troubleshooting problem using fuzzy AHP and fuzzy VIKOR hybrid methods. *Brodogradnja: Teorija i praksa brodogradnje i pomorske tehnike*, 66(1), 54-65.
- Bayraktar, M., & Nuran, M. (2022). Reliability, availability, and maintainability analysis of the propulsion system of a fleet. *Scientific Journals of the Maritime University of Szczecin, Zeszyty Naukowe Akademii Morskiej w Szczecinie*, (70).
- Beiger, A. (2011). An analysis of chosen engine failures of the " Seismic research" type ships. *Journal of Polish CIMAC*, 6(2), 9-14.
- Brocken, E. M. (2016). Improving the reliability of ship machinery: A step towards unmanned shipping.
- Ceylan, B. O., Akyuz, E., & Arslanoğlu, Y. (2022). Modified quantitative systems theoretic accident model and processes (STAMP) analysis: A catastrophic ship engine failure case. *Ocean Engineering*, 253, 111187.
- Cicek, K., & Celik, M. (2013). Application of failure modes and effects analysis to main engine crankcase explosion failure on-board ship. *Safety science*, 51(1), 6-10.
- Göksu, B., & Erginer, K. (2020). Prediction of ship main engine failures by artificial neural networks. *Journal of ETA Maritime Science*, 8(2).
- Kang, Y. J., Noh, Y., Jang, M. S., Park, S., & Kim, J. T. (2023). Hierarchical level fault detection and diagnosis of ship engine systems. *Expert Systems with Applications*, 213, 118814.
- Karatuğ, Ç., & Arslanoğlu, Y. (2022). Development of condition-based maintenance strategy for fault diagnosis for ship engine systems. *Ocean Engineering*, 256, 111515.
- Mishra, C. S., Ali, F., Adam, S., Tesfariam, A., Yemane, A., Amanuel, H., ... & Alem, Y. (2017). Study of the causes of engine failure in ship and maintenance required to prevent engine failure. *International Journal of Contemporary Research and Review*, 8(7), 20218-20241.
- Moon, H., & Choi, J. (2020). Hierarchical spline for time series forecasting: An application to Naval ship engine failure rate. *arXiv preprint arXiv:2012.01224*.
- Vizentin, G., Vukelić, G., & Srok, M. (2017). Common failures of ship propulsion shafts. *Pomorstvo*, 31(2), 85-90.

PRODUCTION OF SILICON NITRIDE CERAMICS WITH FUNCTIONALLY GRADED POROSITY FOR BIOMEDICAL APPLICATIONS

Ogan Tamil ORHUN
Seniz R. KUSHAN AKIN

Cankaya University, Department of Materials Science and Engineering, 06790, Ankara, Turkey

ABSTRACT

In this study; a functionally graded porous Si₃N₄ material was produced to strike a delicate balance between the mechanical and biological performances. To achieve this, Si₃N₄ bioceramic materials were produced with varying levels of porosity by gradually stacking powders with different amounts of pore-forming agents (carbamide). The resulting material was composed of three distinct layers: a highly porous, bioactive layer designed to promote integration with host tissue; a transition zone (interlayer) between the highly porous and dense layers; and a highly dense layer to provide appropriate mechanical properties. Scanning electron microscopy (SEM) images revealed a smooth, gradual transition in terms of porosity amount between the layers. The bioactivity of the samples was evaluated by observing hydroxyapatite (HAp) formation in Simulated Body Fluid (SBF). After 28 days of soaking, complete coverage of the porous sample surfaces and inner pore walls with a "Cauliflower-like" calcium phosphate layer was observed, while relatively less coating precipitation occurred in the non-porous samples. It is believed that the voids created by the pore-forming agents served as nucleation sites for the precipitation of calcium phosphate grains. Energy Dispersive X-Ray (EDX) spectra showed a Ca/P atomic ratio of 1.69 for this precipitated grains, which is very close to the HAp ratio of 1.67.

ÖZET

Bu çalışmada; mekanik ve biyolojik performanslar arasında hassas bir denge sağlamak üzere fonksiyonel olarak derecelendirilmiş Si₃N₄ malzeme üretilmiştir. Bunu gerçekleştirmek için, Si₃N₄ biyoseramik malzemeler farklı miktarlarda por oluşturu (karbamid) içeren toz karışımlarının aşamalı olarak istiflenmesiyle, farklı oranlarda poroziteye sahip olacak şekilde üretilmiştir. Sonuç olarak elde edilen malzeme üç farklı katmandan oluştu: konak doku ile entegrasyonu teşvik etmek için tasarlanmış olan yüksek poroziteye sahip bioaktif bir katman; yüksek poroziteli katman ve yoğun katman arasında bir geçiş bölgesi (arakatman); ve uygun mekanik özellikleri sağlamak için yüksek yoğunluklu katman. Taramalı elektron mikroskobu (SEM) görüntüleri, katmanlar arasında porozite miktarı açısından düzgün ve aşamalı bir geçişin olduğunu göstermiştir. Numunelerin biyoaktiviteleri, Yapay Vücut Sıvısı'nda (YVS) hidroksiapatit (HAp) oluşumunu gözlemleyerek değerlendirildi. Bu sıvıda 28 gün boyunca

bekletme sonrasında, gözenek yüzeyleri ve por iç duvarları "Karnabahar-benzeri" bir kalsiyum fosfat katmanı ile tamamen kaplanmış olup, gözeneksiz örneklerde nispeten daha az çökelmiş kaplama tabakası görülmüştür. Por yapıcıların oluşturduğu boşlukların, kalsiyum fosfat yapılarının çökmesi için çekirdek yerleri olarak hizmet ettiği düşünülmüştür. Enerji Yayımlı X-Işını (EDX) spektrumları, bu çökelmiş tanelerin Ca/P atomik oranının 1.69'a sahip olduğunu göstermiş olup, bu değer HAp oranı olan 1.67'ye çok yakındır.

YÜKSEK MUKAVEMETLİ BALİSTİK ZİRH ÇELİKLERİNİN ÖSTENİTİK PASLANMAZ ÇELİK TEL KULLANILARAK KAYNAKLANABİLİRLİĞİNİN İNCELENMESİ

Ceren ÇELİK

İstanbul Gedik University, Faculty of Engineering, Department of Mechanical Engineering, İstanbul

ORCID ID: 0000-0002-6449-739X

Uğur GÜROL

İstanbul Gedik University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, İstanbul

İstanbul Gedik University, Welding Technology Application and Research Center, İstanbul

ORCID ID: 0000-0002-3205-7226

ÖZET

Bu çalışmada V kaynak ağzına sahip 15 mm kalınlığındaki yerli üretim Protection 500 serisi yüksek mukavemetli balistik zırh çelikleri AWS A5.9 standardına göre östenitik yapıya sahip ~ER307 sınıfı gaz altı kaynak teli ile birleştirilmiştir. Kaynak işlemleri robotik MIG kaynak yöntemi toplamda 5 paso da gerçekleştirilmiştir. Kaynak sonrası yüzeysel ve hacimsel hataların tespiti için gözle muayene, sıvı penetrant muayene ve X-Ray radyografik muayene uygulanmıştır. Kaynaklı bağlantının mekanik özelliklerinin tespiti için darbe çentik ve çekme testleri uygulanmıştır. İlaveten, kaynak işlemleri esnasında oluşan termal döngüler nedeniyle sertlik değerlerindeki değişimin tespiti için alt, orta ve üst bölgelerinden kaynak kesiti boyunca 0.5 mm aralıklarla Vickers sertlik testi gerçekleştirilmiş olup sonuçları mikro yapı değişimleri ile kıyaslanmıştır. Sonuç olarak, kaynak bölgesindeki seyrelmenin azalması nedeniyle kaynaklı bağlantının yüz bölgesinden kök bölgesine doğru sertlik değerlerinin yaklaşık olarak %17 oranında arttığı tespit edilmiştir. Kaynak işlemleri esnasında seçilen düşük ısı girdisi değerleri nedeniyle üst yüzeyin ergime noktasından 8.5 mm sonra kaynaklı bağlantının sertliğinin MIL-A-46100 standardında belirtilen minimum 477 HB (509 HV)'ye ulaştığı ve ısı tesiri altındaki bölge genişliğinin standart gereksinimlerini karşıladığı görülmüştür. Enine çekme testleri sonucunda ise kaynaklı bağlantının akma ve çekme mukavemetleri sırasıyla ortalama 503 MPa ve 848 MPa olarak tespit edilmiştir. Bu da kaynaklı bağlantının çekme kapasitesinin ana malzemeye kıyasla ~%50 oranında azaldığını ortaya koymaktadır. Öte yandan, -40°C'de gerçekleştirilen darbe çentik testlerinde ise kaynak bölgesinde ortalama 83 J elde edilirken, ITAB bölgesinde bu değer 55J'e düştüğü görülmüştür. Fakat, her iki bölgede de MIL-A-46100 askeri standardında darbe çentik testi için belirtilen minimum değerlerin elde edilebildiği görülmüştür.

Anahtar Kelimeler: Balistik Zırh Çelikleri, Robotik MIG Kaynağı, Kaynak Yöntem Şartnamesi, Mekanik Testler, Mikroyapı Karakterizasyonu

AN INVESTIGATION OF THE WELDABILITY OF HIGH-STRENGTH BALLISTIC ARMOR STEEL PLATES USING AUSTENITIC STAINLESS STEEL WIRE

ABSTRACT

In this study, Protection 500 series high-strength ballistic armor steels having a wall thickness of 15 mm with V groove were joined with austenitic ~ER307 class of gas arc welding wire classified according to AWS A5.9 standard. The welding processes were carried out in a total of 5 passes using the robotic MIG welding method. Visual inspection, liquid penetrant inspection and X-Ray radiographic inspection were applied to detect surface and volumetric defects after welding. Charpy impact and tensile tests were applied to determine the mechanical properties of the welded joint. Additionally, in order to determine the change in hardness values due to thermal cycles occurring during the welding process, Vickers hardness tests were carried out at 0.5 mm intervals along the weld cross-section at the bottom, middle and upper regions and the results were compared with the microstructure changes. As a result, it was found that the hardness values from the face region of the welded joint to the root region increased by approximately 17% due to the decrease in dilution in the welding area. Due to the low heat input values selected during the welding process, it was observed that the hardness of the welded joint reached the minimum 477 HB (509 HV) specified in the MIL-A-46100 standard at the 8.5 mm after the fusion line of the face surface and confirmed that the width of the heat-affected zone met the standard requirements. As a result of transverse tensile tests, the yield and tensile strengths of the welded joint were determined to be 503 MPa and 848 MPa on average, respectively. This reveals that the tensile capacity of the welded joint is reduced by ~50% compared to the base material. On the other hand, in the impact notch tests performed at -40°C, an average of 83 J was obtained in the weld region, while this value decreased to 55 J in the HAZ region. However, it was observed that the minimum values specified for the impact notch test in the MIL-A-46100 military standard can be achieved in both regions.

Keywords: Ballistic Armor Steels, Robotic MIG Welding, Welding Procedure Specification, Mechanical Tests, Microstructure Characterization

EFFECT OF REINFORCEMENTS ON ELASTIC MECHANICAL RESPONSES OF STRUT-BASED CUBIC LATTICE STRUCTURES

Ramazan ÖZMEN

Department of Mechatronics Engineering, Karabuk University, Karabuk, Turkey

ABSTRACT

Recently, there has been a growing interest in investigating lattice structures created through additive manufacturing. Due to their ability to customize and optimize for desired mechanical properties, three-dimensional lattices have broad application fields involving lightweight structures, impact energy absorbers and biomedical devices. The mechanical performances of these entities are subject to various influencing factors, including parent material, cell topology, and relative density. To this end, the current study examined strut-based lattices with the finite element (FE) method to elucidate their deformation mechanisms and mechanical performance. For this purpose, three strut-based lattice structures were modelled, and the effect of additional horizontal and vertical support struts on the mechanical properties of these structures was examined. It was concluded in the study that additional support struts made a significant contribution to the rigidity of the structure. In this context, while using basic lattice structures as filling geometry in designs requiring low rigidity is appropriate (i.e. biomedical devices), it would be better to use horizontal and vertical support elements in high-rigidity applications.

Keywords: Finite element, lattice, unit cell

1. Introduction

Cellular structures are solid materials with empty spaces, such as voids or air gaps. Bee cells, coral reefs, bones, and tree wood naturally have these structures. Using cellular materials aims to make strong, lightweight components, parts, and devices [1]. Thus, aerospace, vehicle production, crashworthiness assessments, thermal systems, and biomedical implants use these materials [2,3]. Cellular solids include periodic structures (i.e., honeycomb and lattice structures) and non-periodic structures (i.e., metal foams and sponges). Replicating a unit cell several times and arranging them in a regular sequence creates periodic cellular formations. However, stochastic cell distribution causes non-periodic cellular formations with discrete cell shapes and dimensions. Both structures can be made using standard methods. Among the production methods, additive manufacturing (AM) cost-effectively makes complicated parts with intended mechanical qualities, including architectural lattice systems [4,5]. Besides, the

lattice structures' topology can be specialized with the AM for various purposes involving a diverse kind or direction of loading behaviour [6].

The mechanical properties of lattice structures have attracted substantial attention owing to their extensive applications. Consequently, many numerical and experimental investigations have been performed on these structures. One of the primary benefits of conducting experimental testing is obtaining results that accurately depict the behaviour of the studied material, permitting for direct application to actual conditions. However, some constraints restrict the experimental study, such as the range of design options, substantial time and higher costs needed for the sample production, post-machining procedures, and subsequent testing. In contrast, analytical models possess the capability to explore a considerably broader spectrum of design possibilities within a timeframe that is both cost-effective and time-efficient [7].

Numerous analytical models have been devised to investigate the mechanical characteristics of lattice structures from the level of individual unit cells to the whole lattice [8–10]. Among these methods, the FE method has been frequently employed to assess the mechanical characteristics of lattice structures. The FE method was used in [11] to calculate the mechanical responses of a lattice structure based on a body-centered cubic (BCC) lattice unit cell occupied a frame structure cell. Lei et al. [10] developed an FE model to investigate the influence of inherent imperfections and the number of layers on BCC and BCCZ strut-based multi-layered lattice sandwich panels' overall mechanical performance and energy absorption capability. Guo et al. [12] developed beam element-based FE models to predict compressive responses of BCC 316L stainless steel lattice structures. They stated that beam element-based FE models can calculate the lattice structure's performance more effectively by providing a lower computational effort than the solid element-based FE model. In some studies, lattice structures were designed based on bioinspired forms [13]. A bioinspired lattice structure was topologically optimized in [14] for an orthopedic hip implant using the FE method by raising its porosity and lessening its weight without losing its mechanical behaviour. In the studies of Sharma and Hiremath [15], they designed a lattice structure by approximating the architecture of a sea sponge and investigated its quasi-static energy absorption response experimentally and numerically.

In this study, the mechanical behaviour of a cellular lattice structure with/without a reinforcement made of different unit cells was investigated. To this end, the body-centred cubic (BCC), the all-face-centred cubic (AFCC), and Octahedron unit cell types were considered for

the base lattice structures. Besides, to study the effect of reinforcements on the mechanical behaviour of the structure, a T-shaped reinforcement made of vertical and horizontal struts was added to the base lattice structures. In the FE model, the lattice structures were modelled with solid elements instead of beam elements. The compression process of these lattice structures with the mentioned unit cells was simulated by the FE method, and the results were calculated and compared for the addition of reinforcements on the mechanical property contribution. Finally, the best lattice structure was proposed for the desired applications.

2. Finite Element Modeling

The current study concentrates on basic lattice structures with a unit cell assembled by various strut configurations inside a cube. The CREO software was used in the strut-based unit cells' 3D CAD modelling step. Later, the finite element software of ABAQUS/Standard software was utilized to model the compression test simulations of different unit cell combinations within the elastic limit to predict the compressive mechanical properties of the lattice structures. To compare lattice structures' mechanical properties, samples with dimensions of 40 x 40 x 40 mm, consisting of 4 x 4 x 4 unit cells with dimensions 10 x 10 x 10 mm for a single strut-based unit cell, were modelled. In the CAD design of lattices, the nominal strut diameter of the cells was defined as 0.5 mm. In the study, even though the FDM printed samples have an anisotropic behaviour [16], the material behaviour of the PLA lattices was defined as isotropic-homogeneous for simplifying the FE modelling. The post yielded material properties of PLA defined in Table 1 with the properties of density $\rho=1.024 \text{ Mg/mm}^3$, elasticity modulus of $E=2200 \text{ MPa}$, and Poisson's ratio of $\nu=0.33$.

Table 1 The post-yield true stress vs true strain material properties of PLA [17].

<i>Yield stress (MPa)</i>	43.4	45.8	46.2	47.1	47.6
<i>Plastic Strain</i>	0	0.0021	0.0029	0.0054	0.0067

Due to the complex geometries of the lattices, C3D10 quadratic tetrahedron elements are used to mesh the structures. Furthermore, mesh sensitivity analysis was performed on a single unit BCC cell with an application of 3 mm displacement under compressive load. In this process, the mesh size of the unit cell was varied from 0.5 mm to 0.3 mm, and its effect on the force-displacement response was compared as given in Fig. 1. Based on the force-displacement variations for different mesh sizes, the proper mesh size was decided approximately as 0.32 mm from the mesh convergence study. This mesh size value was taken similarly for all

modelled lattice structures to shorten computation duration without influencing the accuracy of results.

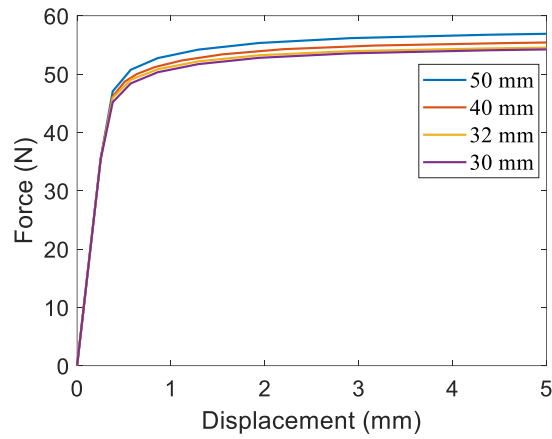


Figure 1 Mesh convergence study of the single BCC unit cell.

During the FE simulations, the applied boundary conditions are arranged as the lower plate is fixed, and the upper plate is moved vertically by 10 mm (25% strain).

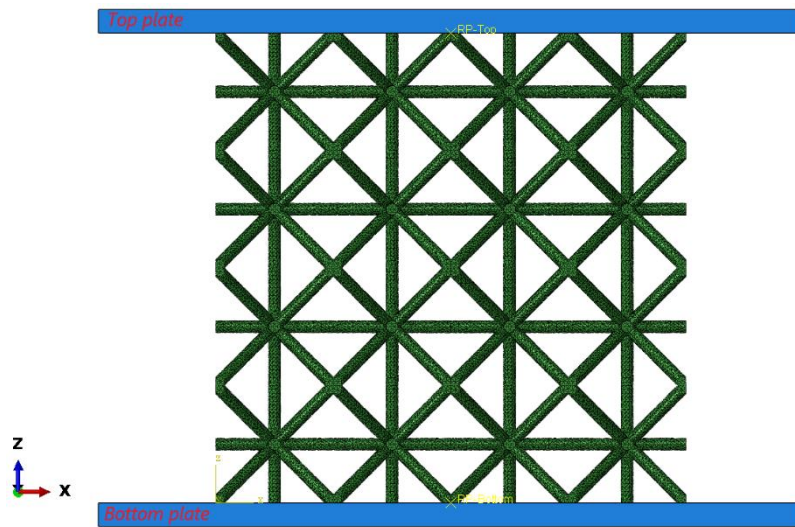


Figure 2. FE model of the BCC unit cell lattice structure

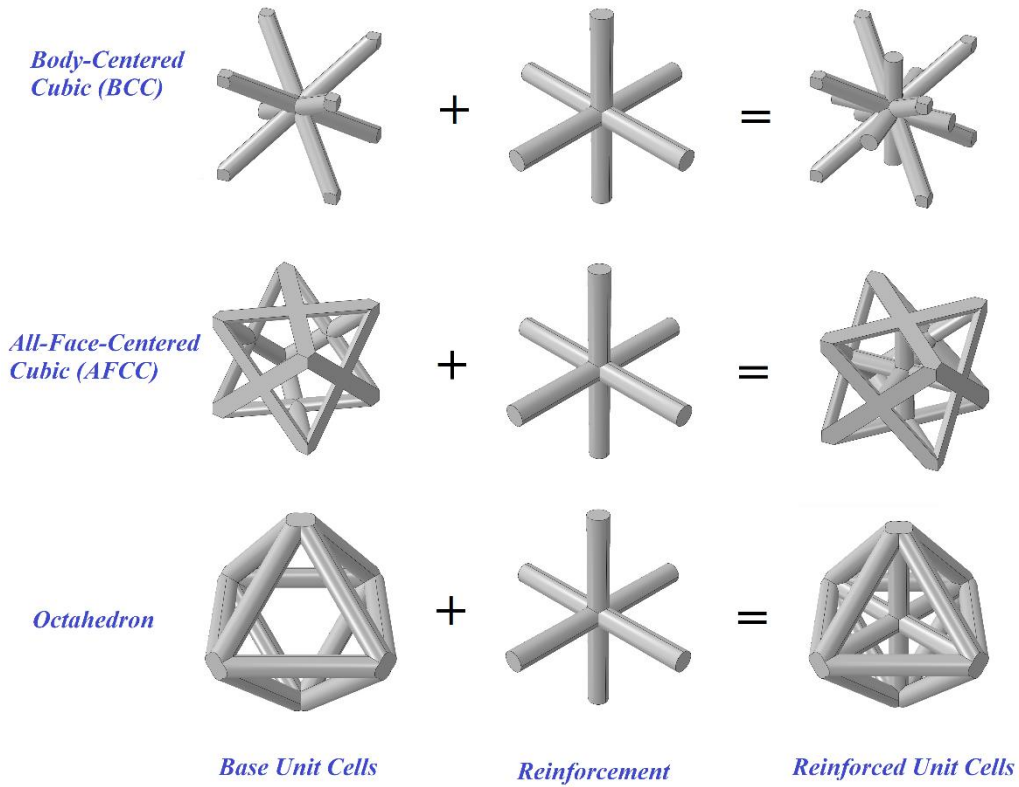


Figure 3. CAD models of strut based unit cells

Results and Discussions

For the evaluation of compressive mechanical properties of the designed lattice structures, the force-displacement variations of each design were obtained from the FE analyses. Then, the force-displacement values of the lattices were converted to the stress-strain data to estimate the elasticity modulus and yield strength of each lattice structure by using Eq. 2 given below [7]:

$$\sigma = \frac{F}{A_0} \quad (2)$$

$$\varepsilon = \frac{\Delta l}{l_0}$$

According to the Eq. 2, the reaction force F is obtained from the reference point of the upper plate divided by the lattice structure's plain cross-sectional area A_0 for the calculation of stress data. On the other hand, the strain ε was decided by dividing the upper plate's Δl displacement by the initial l_0 height of the structure. Each lattice structure's elasticity modulus and yield stresses were obtained from the converted stress-strain graph. To this end, the elasticity modulus of the lattice structure was calculated with a regression analysis considering the linear region of the stress-strain curve. Besides, the yield strength was estimated by offsetting the

linear-elastic curve at 0.2% strain due to the lack of a distinctive peak stress value. The stress-strain graphs of the lattices are given in Figs. 4a-b.

From Fig. 4a, the elasticity modulus of the base lattice structures was calculated as 1.068 MPa, 19.667 MPa and 19.569 MPa for the BCC, AFCC, and Octahedron unit lattice structures, respectively. Besides, the base lattices' yield strengths are calculated as 0.079 MPa, 0.8 MPa and 0.81 MPa for the BCC, AFCC, and Octahedron lattice structures. Considering the results, the lattice structures' stiffnesses from highest to lowest were obtained as AFCC, Octahedron, and BCC. The base lattices were reinforced with vertical and horizontal struts in the study's second case. For the base lattice structures' reinforcement case, the converted stress-strain graph of each design is given in Fig. 4b. From Fig. 4b, the elasticity modulus of the reinforced lattice structures was, in turn, calculated as 26.062 MPa, 38.432 MPa and 40.579 MPa for the BCC, AFCC, and Octahedron lattice structures with horizontal and vertical struts. Besides, the yield strengths of the reinforced lattices are also calculated as 0.5 MPa, 0.95 MPa and 1.02 MPa for the BCC, AFCC, and Octahedron lattice structures. From the results, the lattice structures' stiffnesses from highest to lowest were obtained as Octahedron, AFCC, and BCC as same in the base structures. However, reinforcements add more stiffness to the base lattice structures. To this end, the increment ratio of the lattice structures' yield strength with the reinforcement is 532.9 %, 18.75 %, and 25.92 % for BCC, AFCC, and Octahedron lattice structures. As a result of FE-based compression tests applied to lattice structures, AFCC and Octahedron unit cell lattice structures depicted close mechanical behaviour in terms of stress-strain data for base lattices. However, this closeness diverges a bit for reinforced structures. This closeness can be attributed to the relative porosity ratios of the lattice structures.

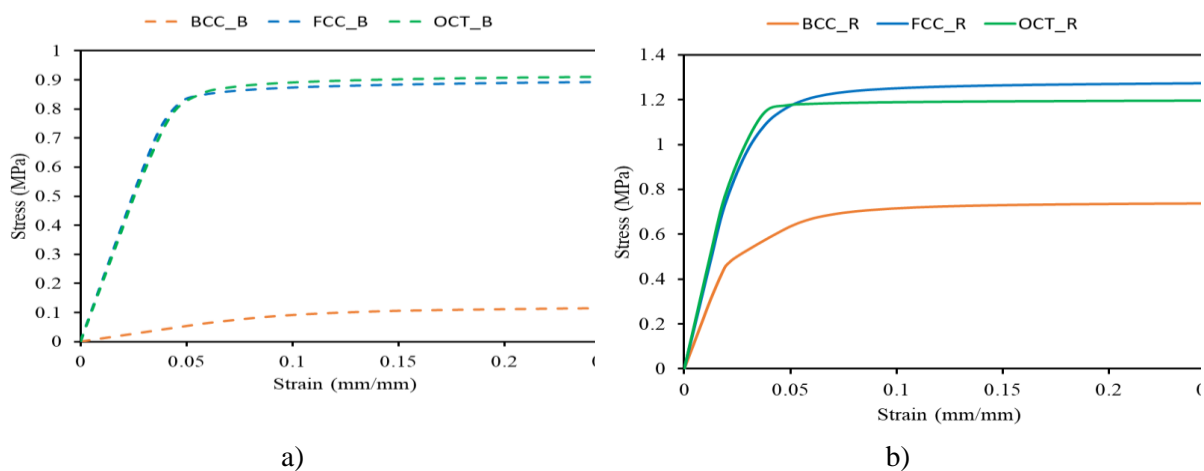


Figure 4 Stress-strain diagrams of a) base b) reinforced lattice structures

From Fig. 4, the strut arrangement of lattice structures affects their force-displacement response. The AFCC and Octahedron lattice structure's compressive yield stresses are greater than the BCC unit lattice owing to the lattice structure's load distribution resulting from different strut arrangements. In this context, as stated in [18], the vertical struts of the AFCC unit lattice oriented to the compression direction withstand greater loads than the BCC lattice structure, causing more increased compressive yield stress. Besides, all the lattice structures' stress-strain curves demonstrated continuously increasing long behaviour by accommodating considerable compressive strain at lower stresses, which is suitable for energy absorbers. As the elasticity modulus and compressive yield stress of the BCC lattice structure are lower than the AFCC and Octahedron lattice structures, the BCC lattice structures are more suitable for biomedical applications required for lowering the stress-shielding effects in implants and structural applications demanding weight lowering. However, the high stiffness of AFCC and Octahedron lattice structures makes them suitable for infill geometries in lightweight and high-stiffness structures [19]. The deformation pictures received from the FE simulations of lattices are depicted in Figs. 5-6 for the base (Fig. 5) and reinforced (Fig. 6) lattices for particular strains.

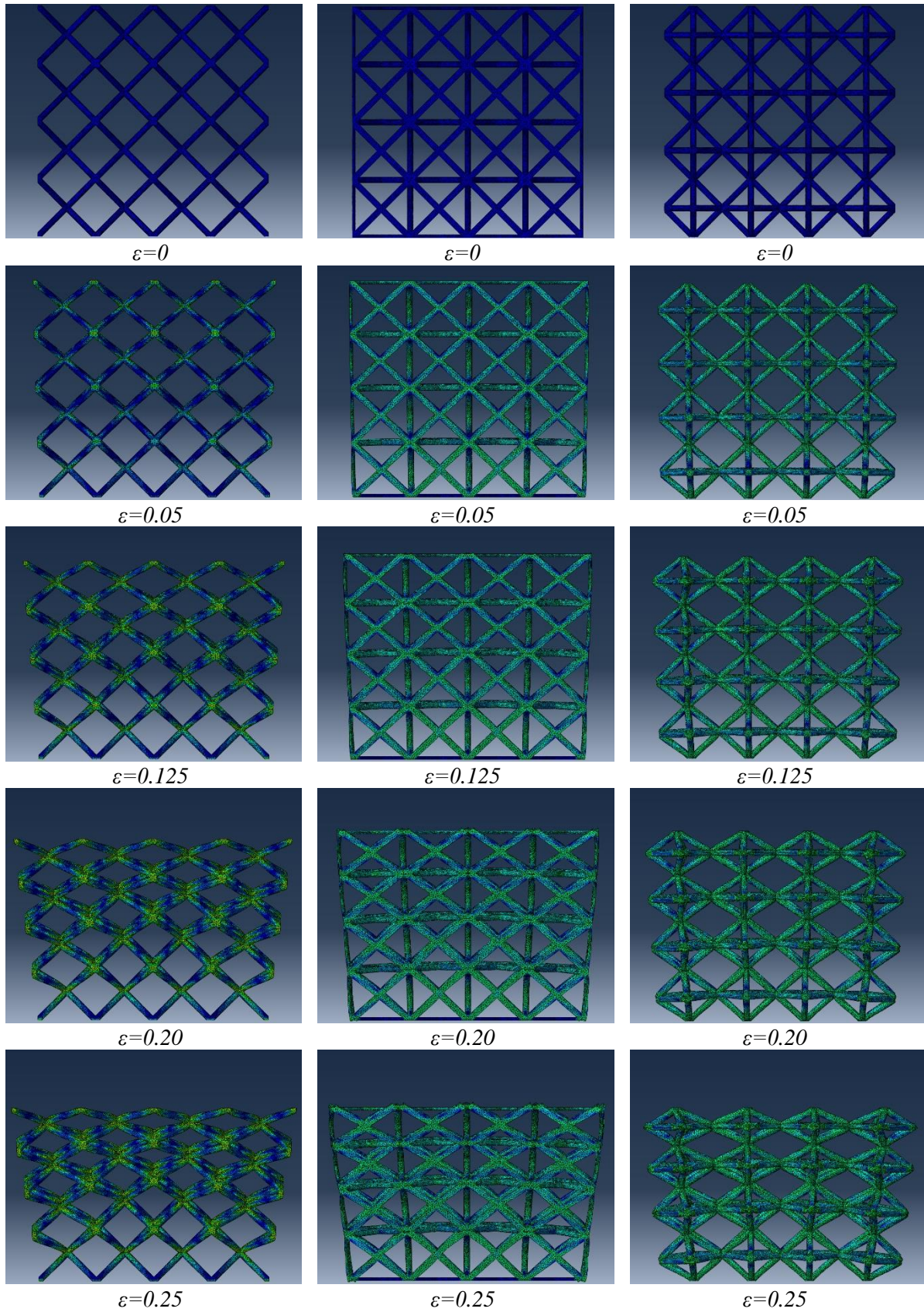


Figure 5 Deformation patterns of base lattice structures

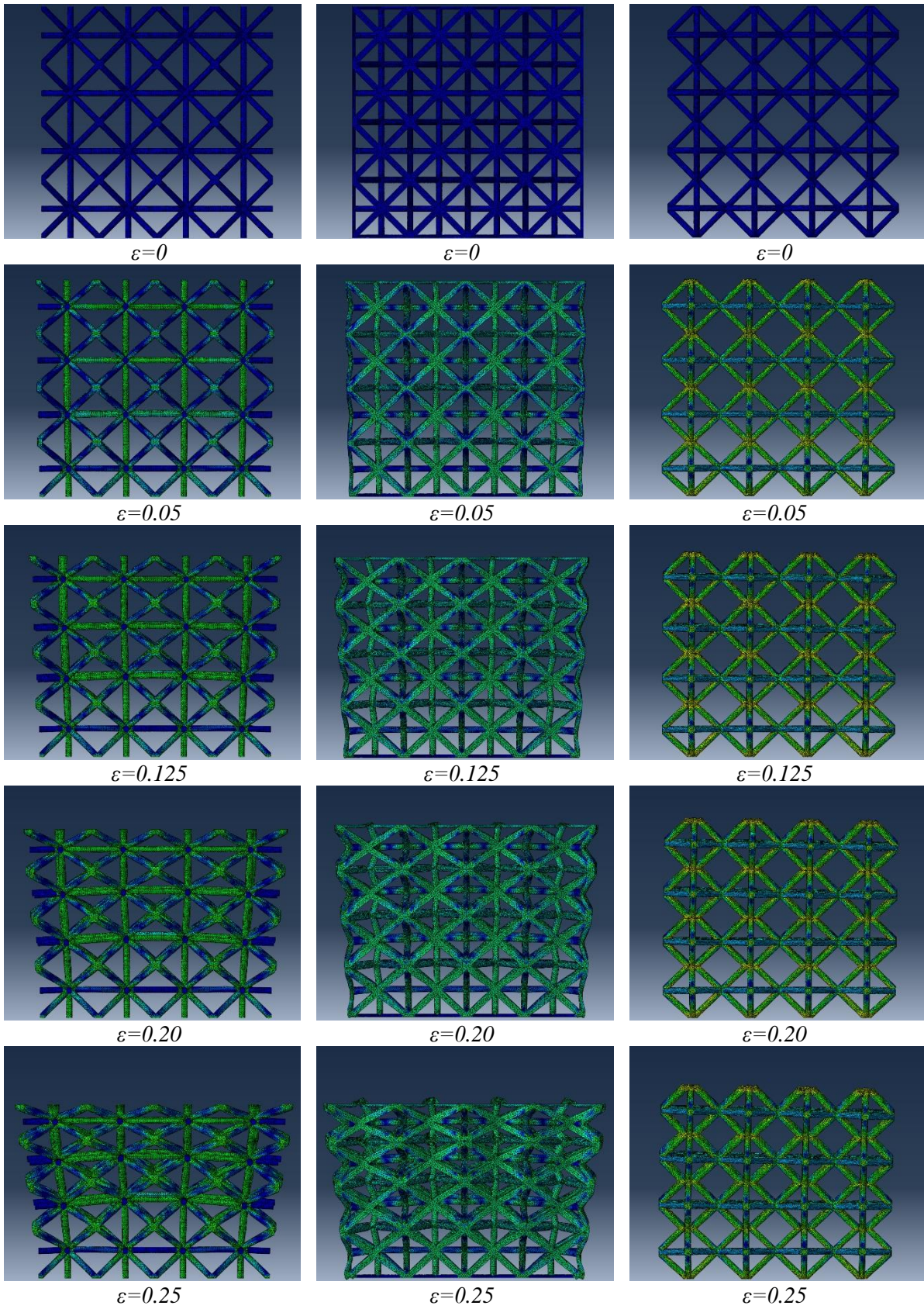


Figure 6 Deformation patterns of reinforced lattice structures

Conclusions

This study investigates the mechanical behaviour of cellular lattice structures with/without a reinforcement made of different unit cells. To this end, BCC, AFCC, and Octahedron unit cell types were considered for the base lattice structures. Besides, to study the effect of reinforcements on the mechanical behaviour of the structure, a T-shaped reinforcement made of vertical and horizontal struts was added to the base lattice structures. The compression process of these lattice structures with the mentioned unit cells was simulated by the FE method, and the results were calculated and compared for the addition of reinforcements on the mechanical property contribution. The lowest elasticity modulus was obtained in the BCC lattice for the base lattice structures. Besides, close elasticity modulus values were obtained for AFCC and Octahedron lattices. Accordingly, the lattice structures' stiffnesses from highest to lowest were obtained as AFCC, Octahedron, and BCC for base lattices. Similar behaviour was seen for reinforced lattice structures when sorting elasticity modulus values. The reinforcement added more stiffness to all unit cells. However, with the reinforcement, more stiffness increment was obtained in the BCC lattice structure. To this end, the increment ratio of the lattice structures' yield strength with the reinforcement is 532.9 %, 18.75 %, and 25.92 % for BCC, AFCC, and Octahedron lattice structures. As the elasticity modulus and compressive yield stress of the BCC lattice structure are lower than the AFCC and Octahedron lattice structures, the BCC lattice structures are more suitable for biomedical applications required for lowering the stress-shielding effects in implants and structural applications demanding weight lowering. However, the high stiffness of AFCC and Octahedron lattice structures makes them suitable for infill geometries in lightweight and high-stiffness systems and energy absorbers.

References

- [1] Abdulhadi HS, Mian A. (2019).Effect of strut length and orientation on elastic mechanical response of modified body-centered cubic lattice structures. *Proc Inst Mech Eng Part L J Mater Des Appl*;233:2219–33.
- [2] Parthasarathy J, Starly B, Raman S. (2011).A design for the additive manufacture of functionally graded porous structures with tailored mechanical properties for biomedical applications. *J Manuf Process*;13:160–70.
- [3] Fadeel A, Abdulhadi H, Srinivasan R, Mian A. (2021). A Computational Approach in Understanding the Low-Velocity Impact Behavior and Damage of 3D-Printed Polymer Lattice Structures. *J Mater Eng Perform* 2021;30:6511–21.
- [4] Alaña M, Cutolo A, Ruiz de Galarreta S, Van Hooreweder B. (2021). Influence of relative density on quasi-static and fatigue failure of lattice structures in Ti6Al4V produced by laser powder bed fusion. *Sci Rep*;11:19314.
- [5] Gibson LJ, Ashby MF. (2014).Cellular solids: Structure and properties, second edition.

- [6] Červinek O, Werner B, Koutný D, Vaverka O, Pantělejev L, Paloušek D. (2021). Computational Approaches of Quasi-Static Compression Loading of SS316L Lattice Structures Made by Selective Laser Melting. *Materials (Basel)*;14:2462.
- [7] Ruiz de Galarreta S, Jeffers JRT, Ghouse S. (2020). A validated finite element analysis procedure for porous structures. *Mater Des*;189:108546.
- [8] Smith M, Guan Z, Cantwell WJ. (2013). Finite element modelling of the compressive response of lattice structures manufactured using the selective laser melting technique. *Int J Mech Sci*;67:28–41.
- [9] Gümrük R, Mines RAW. (2013). Compressive behaviour of stainless steel micro-lattice structures. *Int J Mech Sci*;68:125–39.
- [10] Lei H, Li C, Meng J, Zhou H, Liu Y, Zhang X, et al. (2019). Evaluation of compressive properties of SLM-fabricated multi-layer lattice structures by experimental test and μ -CT-based finite element analysis. *Mater Des*;169:107685.
- [11] Alwattar TA, Mian A. (2020). Developing an Equivalent Solid Material Model for BCC Lattice Cell Structures Involving Vertical and Horizontal Struts. *J Compos Sci*;4:74.
- [12] Guo H, Takezawa A, Honda M, Kawamura C, Kitamura M. (2020). Finite element simulation of the compressive response of additively manufactured lattice structures with large diameters. *Comput Mater Sci*;175:109610.
- [13] Manno R, Gao W, Benedetti I. (2019). Engineering the crack path in lattice cellular materials through bio-inspired micro-structural alterations. *Extrem Mech Lett*;26:8–17.
- [14] Kladovasilakis N, Tsongas K, Tzetzis D. (2020). Finite Element Analysis of Orthopedic Hip Implant with Functionally Graded Bioinspired Lattice Structures. *Biomimetics*;5:44.
- [15] Sharma D, Hiremath SS. (2022). Bio-inspired repeatable lattice structures for energy absorption: Experimental and finite element study. *Compos Struct*;283:115102.
- [16] Chacón JM, Caminero MA, García-Plaza E, Núñez PJ. (2017). Additive manufacturing of PLA structures using fused deposition modelling: Effect of process parameters on mechanical properties and their optimal selection. *Mater Des*;124:143–57.
- [17] Gorgularslan RM, Gungor OU, Yıldız S, Erem E. (2021). Energy absorption behavior of stiffness optimized graded lattice structures fabricated by material extrusion. *Meccanica*;56:2825–41.
- [18] Pramanik S, Hoyer K-P, Schaper M. (2023). Experimental and finite element method investigation on the compression behaviour of FCCZ and BCC lattice structures of additively manufactured Fe-3Si samples. *Rapid Prototyp J*.
- [19] Kang D, Park S, Son Y, Yeon S, Kim SH, Kim I. (2019). Multi-lattice inner structures for high-strength and light-weight in metal selective laser melting process. *Mater Des*;175:107786.

STABILITY-FLOW ANALYSES OF ASPHALT MIXTURES PREPARED WITH LIMIT AND OFF-LIMIT AGGREGATE GRADATIONS

Hüseyin KÖSE

Konya Technical University, Faculty of Engineering and Natural Science, Department of Civil
Engineering

ORCID ID: 0000-0003-2533-6769

Deniz ARSLAN

Konya Technical University, Faculty of Engineering and Natural Science, Department of Civil
Engineering

ORCID ID: 0000-0001-9493-2826

ABSTRACT

Aggregate gradation is one of the factors directly affecting the properties of asphalt mixtures. In this study, the effects of aggregate gradation variations on the asphalt mixture's mechanical properties were investigated. The gradation limits defined for wearing course (Type 2) according to the Turkish Highway Technical Specification were taken as basis. In the study, five different gradations were created: The lower and upper gradations, which were formed using recommended limit values of the specification; the middle gradation, which passed through these limits' midpoints; and the super lower and super upper gradations, which were created by shifting the limits by 7%. Using Marshall Design method, stability-flow analyses were conducted on the asphalt mixtures prepared with 5 different gradations. The test results show that the highest stability was obtained in the lower graded mix. The flow values of the mixtures were decreased as the gradation became finer. On the other hand, maximum Marshall Quotient values were obtained in the upper graded mix. Furthermore, off-limit graded mixtures, although not outperforming the limit graded mixtures, have results within the specification limits. All of these findings point out the possibility of expanding the gradation envelope for wearing course (Type 2).

Keywords: Gradation limits, super lower, super upper, stability-flow, Marshall Quotient

LİMİT VE LİMİT DIŞI AGREGA GRADASYONLARI İLE HAZIRLANAN ASFALT KARIŞIMLARIN STABİLİTE-AKMA ANALİZLERİ

ÖZET

Agrega gradasyonu, asfalt karışımların özelliklerini doğrudan etkileyen faktörlerden biridir. Bu çalışmada, agrega gradasyonundaki değişimlerin asfalt karışımların mekanik özellikleri üzerindeki etkileri araştırılmıştır. Çalışmada, Karayolu Teknik Şartnamesi'nde yer alan aşınma tabakası (Tip 2) için tanımlanan gradasyon limitleri esas alınarak beş farklı gradasyon oluşturulmuştur. Bunlar, şartnamede önerilen limit değerler kullanılarak oluşturulan alt ve üst gradasyonlar, bu limitlerin orta noktalarından geçen orta gradasyon ve limitlerin %7 oranında ötelenmesi ile oluşturulan süper alt ve süper üst gradasyonlardır. Marshall Tasarım yöntemi kullanılarak, 5 farklı gradasyonla hazırlanan asfalt karışımlar üzerinde stabilite-akma analizleri yapılmıştır. Test sonuçları, en yüksek stabilitenin alt gradasyonlu karışımda elde edildiğini göstermektedir. Karışımların akma değerleri gradasyon incelikle azalmıştır. Öte yandan, maksimum Marshall Oranı üst gradasyonlu karışımda elde edilmiştir. Ayrıca, limit dışı gradasyonlu karışımlar, limit gradasyona sahip karışımlardan daha iyi performans göstermese de, şartname limitleri dahilinde sonuçlar vermiştir. Tüm bu bulgular, aşınma tabakası (Tip 2) için gradasyon zarfının genişleme potansiyeline sahip olduğunu göstermiştir.

Anahtar Kelimeler: Gradasyon limitleri, süper alt, süper üst, stabilite-akma, Marshall Oranı

1. INTRODUCTION

The distribution of particle size described as a percentage of total sample weight is known as aggregate gradation (Fwa, 2006). Here, particles with a diameter larger than 4.75 mm, which are referred to as coarse aggregate, form the skeletal structure of the mixture by providing stone-stone interlocking, while fine aggregates (particles between 0.075 mm and 4.75 mm in diameter) and mineral fillers (material passing through a 0.075 mm sieve opening) fill the voids produced by coarse aggregates and densify the mixture. Therefore, the amount of each aggregate group directly affects the performance characteristics of the mixture.

On the other hand, different gradation types can be obtained by changing the amounts in aggregate groups or not using them at all. Among these, dense gradation, which includes all sizes of materials from fine aggregates to coarse aggregates, is the type commonly used in traditional asphalt concrete. In addition, uniform gradation using aggregates of a single size, gap gradation where aggregates of a certain size are not used at all and open gradation in which

filler or fine size grains are not used are other gradations used in mixtures produced for different purposes.

A typical flexible pavement consists of wearing course, binder, base and sub-base layers (Robinson and Tagesen, 2004). In order for each layer to fulfil its specific tasks, the aggregate gradation must be determined within certain limits. In Turkey, upper and lower limits for aggregate gradation are determined in the Highway Technical Specification (HTS, 2013) and generally the line passing through the middle of these two limits is preferred as the gradation of the relevant layer. Designs can also be made by selecting different gradations within these limits. However, it should be kept in mind that each different gradation will have different effects on the physical characteristics of the mixture.

Researchers investigated the effects of aggregate gradation variations on the mechanical properties of asphalt mixes. For example, Aodah et al. (2012) reported that in mixtures where lower and upper limit and medium gradations were used, maximum stability was obtained at the lower limit gradation. In addition, there are studies (Golalipour et al., 2012; Maharjan & Tamrakar, 2017; Khairandish et al., 2021) indicating that the stability increases as the gradation gets finer (i.e. as the amount of fine aggregate in the mixture increases), and it is also possible to encounter the study (Banerji et al., 2014) that reach maximum stability with middle gradation. On the other hand, although Sangsefidi et al. (2016) found that the maximum stability was achieved with the middle gradation, it was determined that the best results were not in the middle gradation when other parameters were taken into consideration. In the same study, flow values were reported to be increased as the gradation became finer. Afaf (2014) prepared asphalt mixtures using 3 different aggregate types (dolomite, basalt and limestone) and 3 different gradations (lower limit, medium and upper limit). While the maximum stability was reached at the upper limit gradation in mixtures where dolomite and basalt aggregates were used, the highest stability was obtained at the lower limit gradation in mixtures containing limestone aggregate.

In this study, the effects of aggregate gradation variation on the mechanical properties of asphalt mixtures were investigated. A total of 5 different gradations were used in the asphalt mixtures, including the upper and lower limit gradations specified for wearing course type 2 in Highway Technical Specification, the middle gradation determined by averaging these limits and two different out-of-limit gradations (super upper and super lower). Out-of-limit gradations were selected 7% beyond the limit gradations. Stability-flow analyses were performed on the

prepared mixtures using the Marshall method. The effects of gradation change on the mixtures were evaluated in terms of stability, flow and Marshall Quotient (MQ) parameters.

2. RESEARCH AND FINDINGS

2.1. Materials and Method

Limestone type aggregate and base bitumen (with 50/70 penetration degree) were used in the asphalt mixtures prepared within the scope of the study. Various physical properties of the materials are shown in Table 2.1 and Table 2.2.

Table 2.1. Specific gravity values of the aggregates

Properties	Coarse Aggregate	Fine Aggregate	Filler
Bulk Specific Gravity	2.690	2.727	-
Apparent Specific Gravity	2.713	2.745	2.722

Table 2.2. Various physical properties of the bitumen

Properties	Value	Standard
Penetration (dmm)	52.4	ASTM D5
Softening Point (°C)	51.5	ASTM D36
Specific Gravity, 25°C	1.031	ASTM D70
Viscosity (mPa.s) @135°C	380.4	ASTM D4402
Viscosity (mPa.s) @150°C	210.7	ASTM D4402

In the study, asphalt mixtures were prepared in 5 different gradations. Three of these gradations are upper limit, lower limit and middle gradations of wearing course (Type 2). Two of them are out-of-limit gradations, namely super upper (7% above the upper limit) and super lower (7% below the lower limit). Figure 2.1 shows the gradation types used in the study.

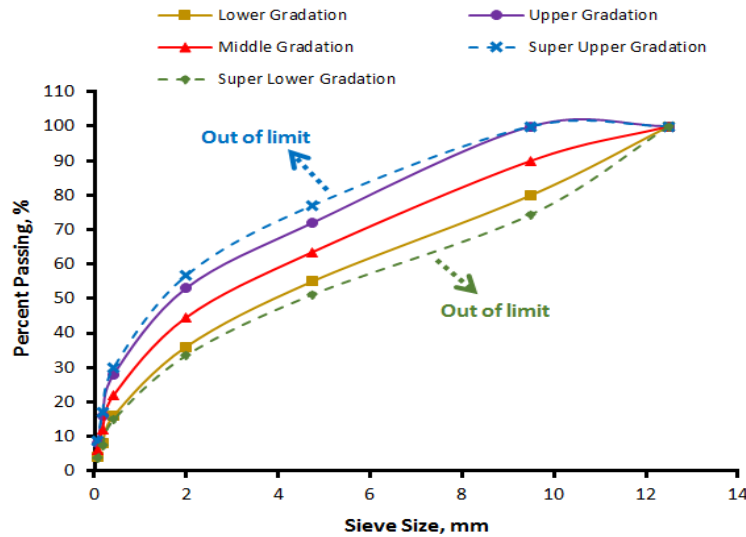


Figure 2.1. Gradation curves of the asphalt mixtures

The effects of aggregate gradation variation on the asphalt mixture were investigated using stability-flow analysis by Marshall design method in accordance with ASTM D6926-27. Marshall specimens were prepared at 155-160°C using 1200 g aggregate and bitumen at a ratio ranging from 4% to 5.5% by weight of the aggregate (0.5% increment). The prepared specimens were placed into molds with a diameter of 4" and compacted with 75 blows on both sides with a Marshall hammer. The specimens were then subjected to a stability-flow test and stability, flow and Marshall quotient (MQ) values were obtained.

2.2. Results and Discussions

2.2.1. Effects of aggregate gradation on mixture stability

Figure 2.2 plots the bitumen content versus the stability. In all mixtures, the stability value first increased and then decreased with increasing bitumen content. The maximum stability value of the upper graded mixture was obtained at 5% bitumen, while the other mixtures reached maximum stability at 4.5% bitumen. It is also observed that even the minimum stability values of the mixtures are above the specification limit of 8.83 kN (900 kg). The mixture with lower gradation had the highest stability with 14.51 kN, followed by super lower gradation with 14.15 kN, middle gradation with 13.35 kN and upper gradation with 12.86 kN. The mixture with the lowest stability was super upper gradation with 11.93 kN. From the results, it is understood that higher stability values were obtained in the case of shifting towards the lower side of the gradation envelope. When the literature was reviewed, it was seen that Maharjan and Tamrakar (2017) also observed the highest stability in the lower gradation. However, it is possible to encounter studies with different results in the literature. For example, Banerji et al. (2014) found that the highest stability was obtained with middle gradation. On the other hand, the studies by

Elliott et al. (1991) and Golalipour et al. (2012) showed that the stability of mixtures with a high amount of fine material was higher. Tessema and Ponnurangam (2019) determined that fine gradation increased stability in mixtures using limestone and basalt. In the same study, when they used rhyolite type aggregate, they found that the mixture with high amount of coarse aggregate had the highest stability value. Therefore, it is understood that contradictory results have been obtained in the literature on this subject.

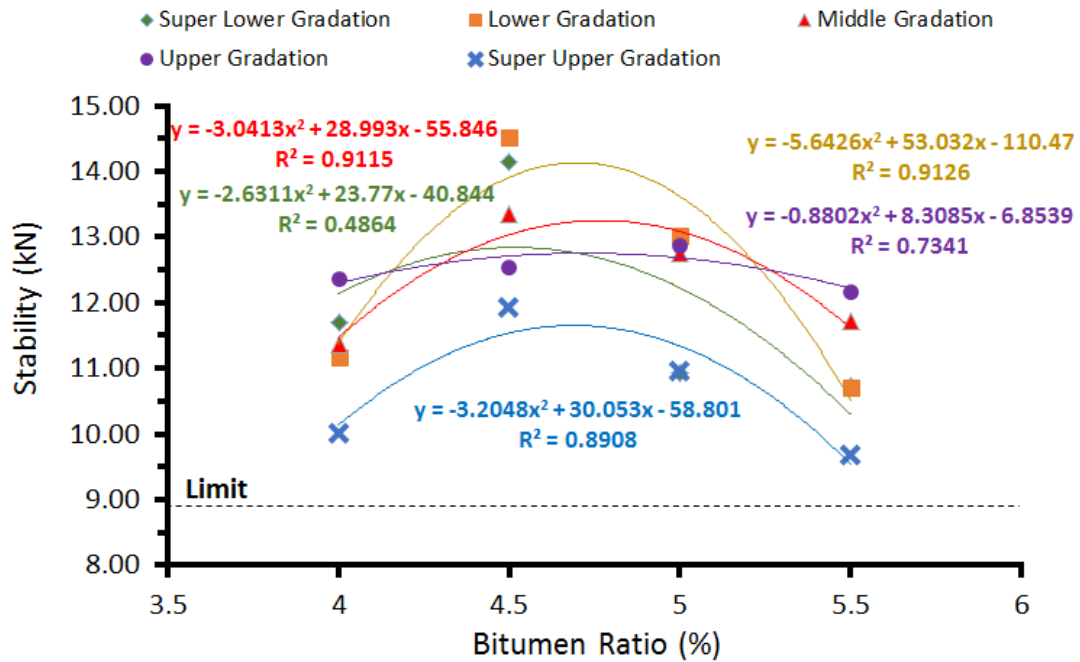


Figure 2.2. Marshall stability results of the mixtures

2.2.2. Effects of aggregate gradation variation on the mixes' flow results

It is seen from the graphs in Figure 2.3 that the flow value (The Marshall Test specimen's total deformation at maximum load) increases as the bitumen content increases in the mixtures. On the other hand, the flow values of the mixtures were found to be decreased significantly as the gradation became finer (i.e. as you move towards the top of the gradation envelope). For all gradation types, flow values are higher than 2 mm in all bitumen contents. In addition, it is observed that all mixtures meet the specification limit of 4 mm at 4-4.5-5% bitumen rates. At 5.5% bitumen ratio, flow values higher than 4 mm were observed in all mixtures except super upper and upper gradation. In the literature, it was observed that contradictory findings were obtained in flow values as well as in stability. For example, Tessema and Ponnurangam (2019) determined that the flow values were higher in mixtures with a high proportion of fine aggregate than in mixtures with other gradations, regardless of aggregate type. A similar conclusion was reached in the study by Banerji et al. (2014). Maharjan and Tamrakar (2017), on the other hand, concluded that flow values were lower in the upper gradation like in this study.

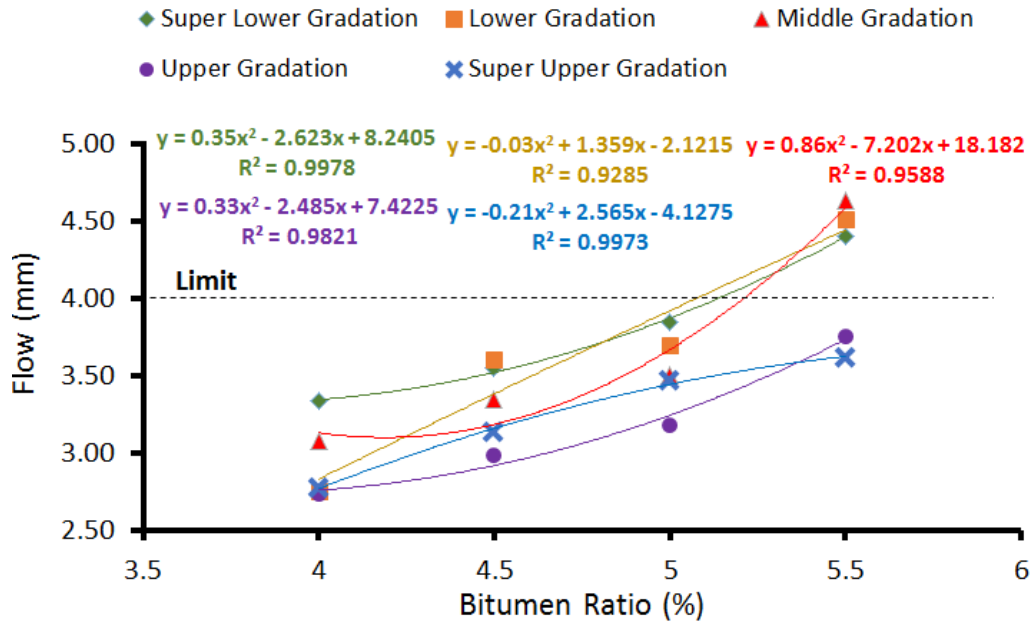


Figure 2.3. Marshall flow results of the mixtures

2.2.3. Effects of aggregate gradation on the Marshall Quotient (MQ) of the mixtures

MQ is a coefficient used to assess the stiffness of the mixture (Sengul et al., 2013). It is thought that as this value increases, the deformation resistance of the mixtures will increase (Morova et al., 2016; Arslan and Bayırtepe, 2018). MQ is obtained by the ratio of stability to flow. Figure 2.4 shows the MQ values of each mixture.

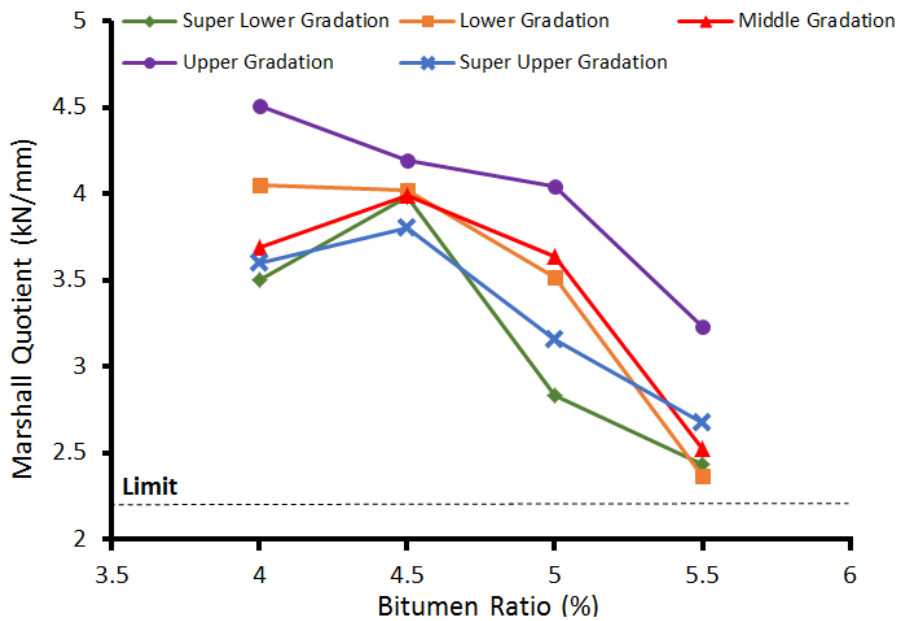


Figure 2.4. Marshall Quotient values of the mixtures

It is seen from Figure 2.4 that the MQ values of the mixtures decrease when the bitumen content exceeds 4.5% in all mixtures except the lower and upper gradation (continuously decreasing from 4% to 5.5% bitumen content). When the mixtures are compared with each other, it is understood that upper graded mixture, which has a 4.51 kN/mm at 4% bitumen ratio, has the highest MQ. Although this value decreases with increasing bitumen content, it is higher than all other mixtures at all bitumen contents. The upper gradation was followed by the lower gradation with a value of 4.05 kN/mm (at 4% bitumen). However, it was observed that the MQ values of the lower and middle gradation approach each other around 4.5% bitumen content and then the middle gradation gives higher results. Apart from this, although the super lower graded mixture approached the middle and upper gradation by reaching MQ value of approximately 4 kN/mm at 4.5% bitumen content, it gave results even lower than the super upper gradation at other bitumen contents. Moreover, it was observed that all mixtures had MQ above 2.21 kN/mm, which can be considered as a limit value at each bitumen ratio. Please note that this value is obtained by the ratio of minimum stability (8.83 kN) to maximum flow (4 mm).

3. CONCLUSIONS

This study looked into the effect of aggregate gradation variations on the mechanical characteristics of the asphalt mixtures. For this purpose, asphalt mixtures with 5 different gradations (lower, upper, middle, super lower and super upper) were prepared by considering the wearing course type 2 limits in accordance with HTS (2013). Among these gradations, super lower and super upper are the gradations determined 7% outside the limits. The stability-flow analyses were conducted on the mixtures prepared with these gradations according to the Marshall method and the results obtained are presented below:

- The highest stability was achieved with the lower gradation. While the stability results of the super lower, middle and upper graded mixes were close to each other, the super upper graded mix had the lowest stability. On the other hand, all mixes had stability higher than the specification minimum value of 8.83 kN.
- The flow values of the mixtures were decreased as the gradation became finer. While the upper and super upper graded mixtures perform within the specification limits at all bitumen ratios, the other mixtures exceeded specification limits at 5.5% bitumen content.

- MQ values of the upper graded mixture are higher than other mixtures. In addition, it was observed that the mixtures with out-of-limit gradations had the lowest MQ values. However, it should be noted here that all mixtures have sufficient MQ value at all bitumen ratios (due to results above the limit value of 2.21 kN/mm).

When all the results are analyzed together, it is understood that the results of the mixtures prepared with off-limit gradations do not violate the specification limits. For this reason, it can be said that there may be a potential for expansion of the gradation envelope in both directions. However, it is recommended that designers should be more careful if they move up the gradation envelope, since the mixture with super upper gradation gives results closer to the limits compared to other mixtures.

REFERENCES

- Afaf, A. H. M. (2014). Effect of aggregate gradation and type on hot asphalt concrete mix properties. *Journal of Engineering Sciences*, 42(3), 567-574. DOI: 10.21608/JESAUN.2014.115005
- Aodah, H. H., Kareem, Y. N. A., & Chandra, S. (2012). Effect of aggregate gradation on moisture susceptibility and creep in HMA. *World Academy of Science and Technology*, 6, 12-28. DOI: 10.5281/zenodo.1057882.
- Arslan, D., & Bayırtepe, H. (2018). BİTÜMLÜ SICAK KARIŞIMLARA AİT AKMA DEĞERİNİN REGRESYON MODELLERİ İLE TAHMİNİ. *Gazi University Journal of Science Part C: Design and Technology*, 6(1), 45-53. DOI:10.29109/http-gujsc-gazi-edu-tr.310405
- ASTM D5. (2013). Standard test method for penetration of bituminous materials.
- ASTM D36. (2014). Standard test method for softening point of bitumen.
- ASTM D70. (2018). Standard test method for density of semi_solid asphalt binder (pycnometer method).
- ASTM D4402. (2015). Standard test method for viscosity determination of asphalt at elevated temperatures using a rotational viscometer.
- ASTM D6926. (2016). Standard practice for preparation of asphalt mixture specimens using Marshall apparatus.
- ASTM D6927. (2015). Standard test method for Marshall stability and flow of asphalt mixtures.
- Banerji A.K., Das A., Mondal A., Biswas R. & Obaidullah M. (2014). Influence of Variation in the Aggregate Gradation Range on Mix Design Properties of Bituminous Concrete (BC) Mixes used as Wearing Course, *International Journal of Engineering Research & Technology*, 3(9): 1258-1262. DOI : 10.17577/IJERTV3IS091138
- Elliott, R. P., Ford Jr, M. C., Ghanim, M., & Tu, Y. F. (1991). Effect of aggregate gradation variation on asphalt concrete mix properties. *Transportation Research Record*, (1317).
- Fwa, T.F. (2006). *The handbook of highway engineering*, CRC Press Taylor & Francis Group, Florida, 7.1-40.
- Golalipour, A., Jamshidi, E., Niazi, Y., Afsharikia, Z., & Khadem, M. (2012). Effect of aggregate gradation on rutting of asphalt pavements. *Procedia-Social and Behavioral Sciences*, 53, 440-449. <https://doi.org/10.1016/j.sbspro.2012.09.895>
- Highway Technical Specification (HTS). (2013). General Directorate of Highways in Turkey (In Turkish).
- Khairandish, M. I., Chopra, A., Singh, S., Chohan, J. S., & Kumar, R. (2021). Effect of gradation and morphological characteristics of aggregates on mechanical properties of bituminous concrete and dense bituminous macadam. *Iranian Journal of Science and Technology, Transactions of Civil Engineering*, 1-15. <https://doi.org/10.1007/s40996-021-00609-8>
- Maharjan R. & Tamrakar G.B.S. (2017). Effect of Aggregate Gradation Variation on the Marshall Mix Properties of Asphalt Concrete, *Proceedings of IOE Graduate Conference, Nepal* 213-219.

- Morova, N., Serin, S., Terzi, S., Saltan, M., Kucukcapraz, D. O., Karahancer, S. S., & Eriskin, E. (2016). Utility of polyparaphenylene terephthalamide fiber in hot mix asphalt as a fiber. *Construction and Building Materials*, 107, 87-94. <https://doi.org/10.1016/j.conbuildmat.2015.12.193>
- Robinson, R. & Tagesen, B. (2004). *Road Engineering for Development*, Second edition, *Spon Press Taylor & Francis Group, London and Newyork* ,251-253.
- Sangsefidi E., Ziari H. & Sangsefidi M. (2016). The Effect of Aggregate Gradation Limits Consideration on Performance Properties and Mixture Design Parameters of Hot Mix Asphalt, *KSCE Journal of Civil Engineering*, 20 (1): 385-392. DOI: 10.1007/s12205-015-0265-8
- Sengul, C. E., Oruc, S., Iskender, E., & Aksoy, A. (2013). Evaluation of SBS modified stone mastic asphalt pavement performance. *Construction and Building Materials*, 41, 777-783. <https://doi.org/10.1016/j.conbuildmat.2012.12.065>
- Tessema, G. T., & Ponnurangam, P. (2019). Investigation the Effect of Aggregates on Hot Mix Asphalt (HMA) Performance-A Case Study. *International Journal Of Engineering Research And Development*, 15(1), 31-40.

2D MALZEMELERİN Li-S PİLLERİN KATOT PERFORMANSINA ETKİLERİNİN İNCELENMESİ

Çağrı Gökhan TÜRK

Sakarya University, Institute of Natural Sciences, Esentepe Campus, 54050, Sakarya, Türkiye
Sakarya University, Research, Development and Application Center (SARGEM), Esentepe Campus,

ORCID ID: 0000-0001-9940-6948

Mahmud TOKUR

Sakarya University, Research, Development and Application Center (SARGEM), Esentepe Campus,
Sakarya University, Department of Metallurgical & Materials Engineering, Esentepe Campus, 54050
NESSTEC Energy & Surface Technologies A.S., Technology Development Zones, 54050, Sakarya

ORCID ID: 0000-0003-3612-5350

ÖZET

Li-S piller sadece gelecek nesil enerji depolama sistemlerinde devrim yaratma potansiyeline sahip olmakla kalmayıp aynı zamanda yüksek teorik kapasitesinden dolayı da ilgi çekmektedir (Li: 3860 mAh/g ; S: 1675 mAh/g). Sülfürün doğada katı, ekonomik, bol ve çevre dostu olması gelecek nesil bataryalarda katot malzemesi olarak kullanılabilir en güçlü adaylardan birisi yapmaktadır. Bu kadar avantajının aksine hala çözilemeyen mekik etkisi sorunu nedeniyle ticarileşmeye hala uygun değildir. Bu sorun sülfürün lityum iyonları ile reaksiyona girmesi sonucu ortaya çıkan yan ürünlerin (polisülfidler) anot ve katot arasında göç ederken istenmeyen yan reaksiyonların gerçekleşmesi ile sonuçlanan bir mekanizma olarak tanımlanmaktadır (Li_2S_x , $4 \leq x \leq 8$). Bundan dolayı sülfür kaynaklı polisülfidleri toplamak ve tekrardan dönüşüm reaksiyonlarına teşvik etmek çok önemli olmaktadır. Katı elektrolitlerin Li-S pil sistemine dahil edilmesiyle birlikte enerji yoğunluğundan ödün vermeden mekik etkisi mekanizmasında oluşan performans kaybını minimuma indirebileceği gözlemlenmiştir. Katotun sülfür olmasından dolayı oksit tipi, polimer tipi, halojenür tip katı elektrolitler yerine sülfür tipli katı elektrolit tercih edilmiştir. Yüksek iyonik iletkenlik vermesi ve sülfür katot ile çok iyi bir kimyasal kararlılık göstermesi nedeni ile katı elektrolit olarak $Li_7P_3S_{11}$ (LPS) bileşiminin daha uygun olacağını literatür çalışmaları da göstermiştir. Katot olarak ise 2D yapıların kullanımının iyonik hareketliliğe daha rahat izin vereceğinden dolayı doğrudan elementel sülfür aktif malzemesi yerine iki boyutlu MoS_2 ve farklı oranlarda kullanılan iki boyutlu borofen parametrik olarak çalışmış ve elektrokimyasal performans üzerindeki etkiler incelenmiştir.

Anahtar Kelimeler: Enerji Depolama, Lityum Sülfür Piller, Borofen

INVESTIGATION THE EFFECTS OF 2D MATERIALS ON THE CATHODE PERFORMANCE OF Li-S BATTERIES

ABSTRACT

Li-S batteries not only have the potential to revolutionize next-generation energy storage systems but also attract attention due to their high theoretical capacity (Li: 3860 mAh/g; S: 1675 mAh/g). The fact that sulfur is solid, economical, abundant, and environmentally friendly makes it one of the promising candidates to be used as cathode material in next-generation batteries. Despite all these advantages, it still needs to be more suitable for commercialization due to the still unresolved shuttle effect problem. This problem is defined as a mechanism that results in undesirable side reactions during the formation of polysulfides resulting from the reaction of sulfur with lithium ions migrating between the anode and cathode (Li_2S_x , $4 \leq x \leq 8$). Therefore, it is crucial to collect sulfur-derived polysulfides and encourage reversible reactions. It has been observed that using solid electrolytes in the Li-S battery system can minimize the performance loss in the shuttle effect mechanism without compromising energy density. Since the use of sulfur candidates in the cathode sides, sulfur-type solid electrolytes were preferred instead of oxide, polymer, or halide-type solid electrolytes in this study. Literature studies have also shown that $\text{Li}_7\text{P}_3\text{S}_{11}$ (LPS) composition would be more suitable as a solid electrolyte due to its high ionic conductivity and excellent chemical stability with the sulfur cathode. Since using 2D structures as the cathode will allow ionic mobility more easily, MoS_2 and borophene with different combinations were studied parametrically instead of the elemental sulfur active material directly, and the effects on the electrochemical performance were examined.

Keywords: Energy Storage, Lithium Sulfur Batteries, Borophene

Acknowledgments

This work is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) under the contract number 120N492. The authors thank the TUBITAK workers for their financial support.

The authors also thank to Scientific and Technological Research Council of Turkey (TUBITAK) for 2210-C (1649B022107389) funding program.

We also acknowledge support from Research Fund of the Sakarya University under projects no: 2022-7-24-133.

DETECTION OF TEMPORAL VARIABILITY IN MONTHLY AND ANNUAL MEAN STREAMFLOW DATA OF FEKE STATION IN SEYHAN BASIN***Cihangir KOYCEGIZ**

Konya Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, Konya, Türkiye

ORCID ID: 0000-0002-0510-1164**Meral BUYUKYILDIZ**

Konya Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, Konya, Türkiye

ORCID ID: 0000-0003-1426-3314**ABSTRACT**

As in many hydrometeorological parameters, climate change also makes its impact felt in river flow data. For this reason, it is of great importance to know the possible trends in river flows, especially in terms of climate change adaptation and effective realization of water resources management strategies. In this study, the temporal variability of the annual and monthly average flow data of the Feke flow observation station numbered D18A019 on the Asmaca Stream in the Seyhan Basin in Turkey for the period 1984-2017 was analyzed by graphical and statistical methods. For this purpose, Şen-Innovative Trend Analysis (Şen-ITA) and Vertical Axis Trend Analysis (VATA), which is a modified version of this method, were used. The results obtained from these methods were also compared with the results of the classical Mann-Kendall (MK) trend method. The applied graphical trend methods show a holistic decreasing trend in the annual average flow data for the months other than January, February, and March. The average flow data for January and February show a non-cohesive increasing trend, while the March flow data show a coherent increasing trend. Both graphical trend methods have consistent results with each other. The results of the statistical MK method are also generally consistent with the graphical methods. According to the MK trend analysis method, increasing trends were obtained in February and March average flow data, while decreasing trends were obtained in other months and annual average flow data. MK results show that there are statistically significant trends only in the flow data of September, November, and December.

Keywords: Climate Change, Seyhan Basin, Streamflow, Trend Analysis

SEYHAN HAVZASI FEKE İSTASYONU AYLIK VE YILLIK ORTALAMA AKIM VERİLERİNDEKİ ZAMANSAL DEĞİŞKENLİĞİN TESPİTİ

ÖZET

İklim değişikliği pek çok hidrometeorolojik parametrede olduğu gibi nehir akımı verilerinde de etkisini hissettirmektedir. Bu nedenle nehir akımlarındaki muhtemel trendlerin bilinmesi, özellikle iklim değişikliğine uyum ve su kaynaklarının yönetimi stratejilerinin etkili bir şekilde gerçekleştirilebilmesi açısından büyük önem taşımaktadır. Bu çalışmada Türkiye’de Seyhan Havzasında bulunan Asmaca Çayı üzerindeki D18A019 numaralı Feke akım gözlem istasyonunun 1984-2017 periyodundaki yıllık ve aylık ortalama akım verilerinin zamansal değişkenliği grafiksel ve istatistiksel metotlarla incelenmiştir. Bu amaçla trend varlığının görsel olarak değerlendirilmesini sağlayan Şen-Yenilikçi Trend Analizi (Şen-ITA) ve bu metodun değiştirilmiş bir versiyonu olan Düşey Eksenli Trend Analizi (VATA) metodu kullanılmıştır. Bu metotlardan elde edilen sonuçlar ayrıca klasik Mann-Kendall (MK) trend metodu sonuçları ile de karşılaştırılmıştır. Uygulanan grafiksel trend metotları Ocak, Şubat ve Mart dışındaki aylara ait ve yıllık ortalama akım verilerinde bütüncül azalma trendi göstermektedir. Ocak ve Şubat ayları ortalama akım verileri bütüncül olmayan artış trendi, mart akım verileri ise bütüncül artış trendi göstermektedir. Her iki grafiksel trend metodu da birbiriyle uyumlu sonuçlara sahiptir. İstatistiksel MK metodu sonuçları da genel olarak grafiksel metotlarla uyumludur. MK trend analiz metoduna göre Şubat ve Mart ayı ortalama akım verilerinde artan, diğer aylar ve yıllık ortalama akım verilerinde ise azalan trendler elde edilmiştir. MK sonuçları sadece Eylül, Kasım ve Aralık aylarına ait akım verilerinde istatistiksel olarak anlamlı trendler olduğunu göstermektedir.

Anahtar Kelimeler: İklim Değişikliği, Seyhan Havzası, Nehir Akımı, Trend Analizi

1. INTRODUCTION

The effects of climate change occurring on a global scale vary locally and regionally (Trajkovic and Kolakovic, 2009). While climate change causes flood events in some regions as a result of intense precipitation, it also causes severe droughts in some regions as a result of extreme temperature increases and precipitation decreases. In the Mediterranean Basin, where Turkey is located, global climate change is causing drought, water scarcity, loss of agricultural yield, decrease in agricultural and tourism revenues, increase in forest fires, and loss of biodiversity (Muluk et al., 2013). In Turkey, where many sub-climate types prevail, it is predicted that the effects of climate change will pose a serious threat in the future if necessary, precautions are not taken (URL-1).

Many researchers have focused on studies aiming to reveal the effects of climate change on hydrometeorological parameters and to investigate possible adaptation strategies. These studies are of great importance for the planning and management of water resources. These studies generally focus on examining the temporal and spatial changes of hydrometeorological parameters such as precipitation (Wang et al., 2022; Koycegiz and Buyukyildiz, 2019; Koycegiz and Buyukyildiz, 2021; Koycegiz and Buyukyildiz, 2022), temperature (Shi et al., 2018; Koycegiz and Buyukyildiz, 2020), evaporation (Jaswal et al., 2008; Rodrigues et al., 2021) and streamflow (Anand et al., 2018; Chen et al., 2016; Soydan et al., 2016; Saplıoğlu and Güçlü, 2022). For this purpose, trend analyses are widely used in the literature.

Streamflow is one of the most important parameters of the hydrological cycle and is greatly affected by climate change. Determination of temporal and spatial variability in flows is of great importance in agricultural management as well as in the planning and operation of water resources. Average and low flows are important in the calculation of the capacity of dam reservoirs and dam operation, and high flows are important in the design and operation of flood structures. In addition, low flows are also important in water quality control and water supply projects (Gümüş et al., 2016).

In this study, trend analysis of annual and monthly average streamflow data of Feke observation station numbered D18A019 in Seyhan Basin, Turkey for the period 1984-2017 was carried out. For this purpose, in addition to the classical Şen Innovative Trend Analysis (Şen-ITA) method, which has been frequently used in recent years, the Vertical Axis Trend Analysis (VATA) method, which provides a different visual interpretation of this method, was used. The results obtained were also compared with the results of the Mann-Kendall (MK) method, which is used as a robust method in trend analysis studies in the literature.

2. STUDY AREA AND DATA

In this study, annual and monthly streamflow data of Feke station numbered D18A019 in Seyhan Basin were used. Feke station is located on the Asmaca Stream in the Göksu River Sub-basin of Seyhan Basin and is operated by State Hydraulic Works. It is located at 550 m altitude, 37°49' north latitude and 35°54' east longitude. The rainfall area is 619 km². In this study, the data of the Feke streamflow observation station for the period 1984-2017 were used. The time series of annual and monthly flow data for the period analyzed are shown in Figure 2.1. The highest monthly average flow values are observed in March, April, and May, which cover the spring season, while the lowest flow values are generally observed in summer and fall. It is thought that the increase in precipitation in this season as well as snowmelt is effective on the high flow amounts in the spring months.

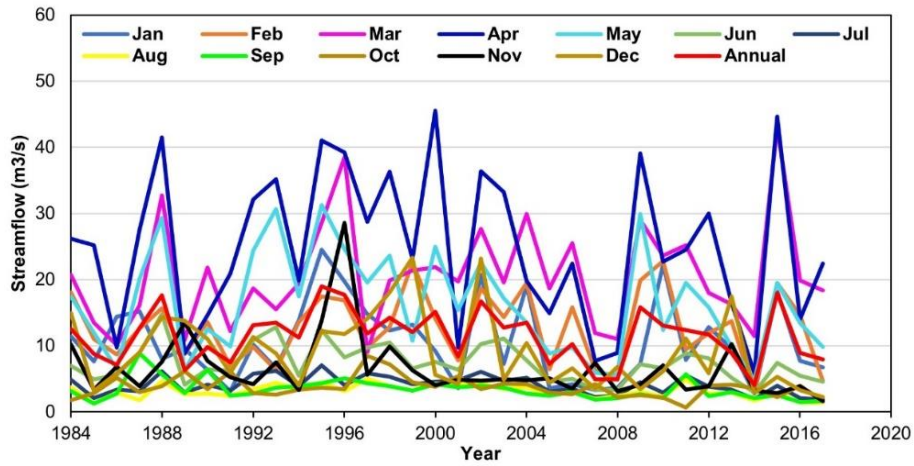


Figure 2.1. Time series of annual and monthly flow data for the period 1984-2017

Table 2.1 illustrates the statistical characteristics of the flow values for the period 1984-2017. The lowest (highest) mean value of monthly streamflow values is observed in August (April). The months with the lowest and highest minimum (maximum) streamflow values occurred in October (August) and March (April), respectively. August is the month with the lowest standard deviation and skewness in the flow data. The months with the highest standard deviation and skewness were April and November, respectively.

Table 2.1. The statistical characteristics of monthly and annual mean streamflow values for the period 1984-2017

STREAMFLOW (m ³ /s)					
	Mean	Minimum	Maximum	Standard Deviation	Skewness
January	10.61	2.79	24.50	6.00	0.66
February	12.70	2.92	22.80	5.34	0.08
March	20.59	9.07	43.10	7.98	0.91
April	24.95	5.82	45.50	11.55	0.08
May	16.33	4.79	31.30	7.80	0.39
June	7.36	2.94	14.80	2.89	0.69
July	4.08	1.90	7.02	1.40	0.21
August	3.14	1.30	5.01	1.02	0.01
September	3.41	1.27	8.88	1.56	1.55
October	3.72	0.69	8.48	1.59	0.99
November	6.49	1.62	28.60	4.88	3.12
December	9.09	2.22	23.30	5.71	0.98
Annual	11.46	4.06	19.01	4.00	0.04

The mean, minimum, and maximum values in the 34-year flow data for the period 1984-2017 are 11.46, 4.06, and 19.01 m³/s, respectively. The standard deviation value is 4 m³/s and the

skewness value is 0.04 for annual flows. In monthly and annual flow values, except for September and November, skewness values are less than 1 and there is a distribution close to normal distribution.

3. METHODOLOGY

3.1. Şen Innovative Trend Analysis (Şen-ITA)

This method, which has been the most widely used graphical trend method in recent years, was proposed by Şen (2012). In the application of this method, the time series is divided into two equal groups, and each group is sorted from smallest to largest (or vice versa). The values are marked in the cartesian coordinate system with the first sub-series on the horizontal and the second sub-series on the vertical axis. A 1:1 straight line is also drawn on the graph. According to the distribution of the points marked on the graph, five different trend interpretations can be made monotonically increasing (decreasing), non-monotonically increasing (decreasing), and no trend. Detailed explanations of the Şen-ITA method are available in many studies in the literature (Şen, 2012; Wu H, Qian H (2017; Ali et al., 2019; Buyukyildiz, 2023; Saphioğlu and Güçlü, 2022).

3.2. Vertical Axis Trend Analysis (VATA)

Vertical axis trend analysis (VATA) is a new visualization version of the classical Şen-ITA method and was proposed by Güçlü (2022). In the application of this method, the time series with N data are divided into two equal groups. Each sub-series is sorted from smallest to largest. Then, the difference values series is obtained by subtracting the values of the sorted first series from the sorted second series. The two sorted sub-series and the difference values series are represented on the horizontal axis, while the vertical axis represents the data number in each group (N/2). In the resulting graph, the decreasing (increasing) trend region is represented by the region on the left (right) side of the vertical axis line ($x=0$). For detailed explanations about this method, see Güçlü (2022).

3.3. Mann-Kendall (MK) Trend Analysis

Mann-Kendall test (Mann, 1945; Kendall, 1948), which is a nonparametric method, is a method frequently used in the literature to determine whether there is a trend in hydrometeorological time series. The MK test statistic (Z_{MK}) value obtained because of the application of the MK method is compared with the $Z_{critical}$ value corresponding to the significance level α to assess whether the trend is statistically significant. In this method, a positive (negative) Z_{MK} (or S) value indicates an increasing (decreasing) trend. It should be checked whether there is a serial correlation in the analyzed time series and if there is, the MK method should be applied after

eliminating it. A more detailed explanation of the MK method and serial correlation control is available in the literature (Köycegiz and Buyukyildiz, 2023; Güçlü, 2020; Ali et al., 2019).

4. RESULTS

In the application of both classical Şen-ITA and VATA methods to the streamflow of Asmaca Creek Feke streamflow observation station numbered D18A019 in Seyhan Basin for the period 1984-2017 (34 years), firstly, both monthly and annual average flow series were separated into two groups. The first group covers the period 1984-2000 and the second group covers the period 2001-2017. The time series divided into two subgroups were sorted in ascending order and Şen-ITA graphs were drawn. For the VATA method, the difference values of the sorted series were also calculated. For both monthly and annual scales, VATA graphs were drawn using the first sub-series, second sub-series, and difference values. The Şen-ITA graph for the annual scale is presented in Figure 4.1a and the VATA graph is presented in Figure 4.1b.

As shown in Figure 4.1a, there is a monotonic decreasing trend in the annual average flow data since all points are in the triangular region below the 1:1 straight line for the period 1984-2017 according to the Şen-ITA method. A similar trend is also observed in the VATA graph in Figure 4.1b. In Figure 4.1b, all the difference values are on the left side of the vertical trend line. This shows that there is a monotonic decreasing trend according to VATA. In the same graph, it is also possible to make this assessment as all of the second-half values are on the right side of the first-half values.

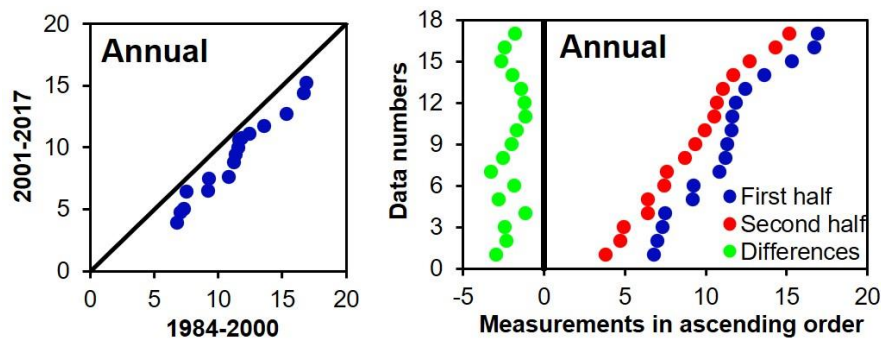


Figure 4.1. a) Classical Şen-ITA, b) VATA graph for annual average flow data

Figure 4.2 shows the Şen-ITA and VATA graphs obtained for the average streamflow values in each month. According to the Şen-ITA graphs, there is a general non-monotonic increase trend (increase in high flow values and decrease in low and medium flow values) in January and February. However, for January, there is also a downward trend in high flow values over several years. January and February VATA graphs also support the trend evaluation obtained

from the classical Şen-ITA graphs. In general, the graphs of both methods show an increasing trend in high flow values in more years in February than in January.

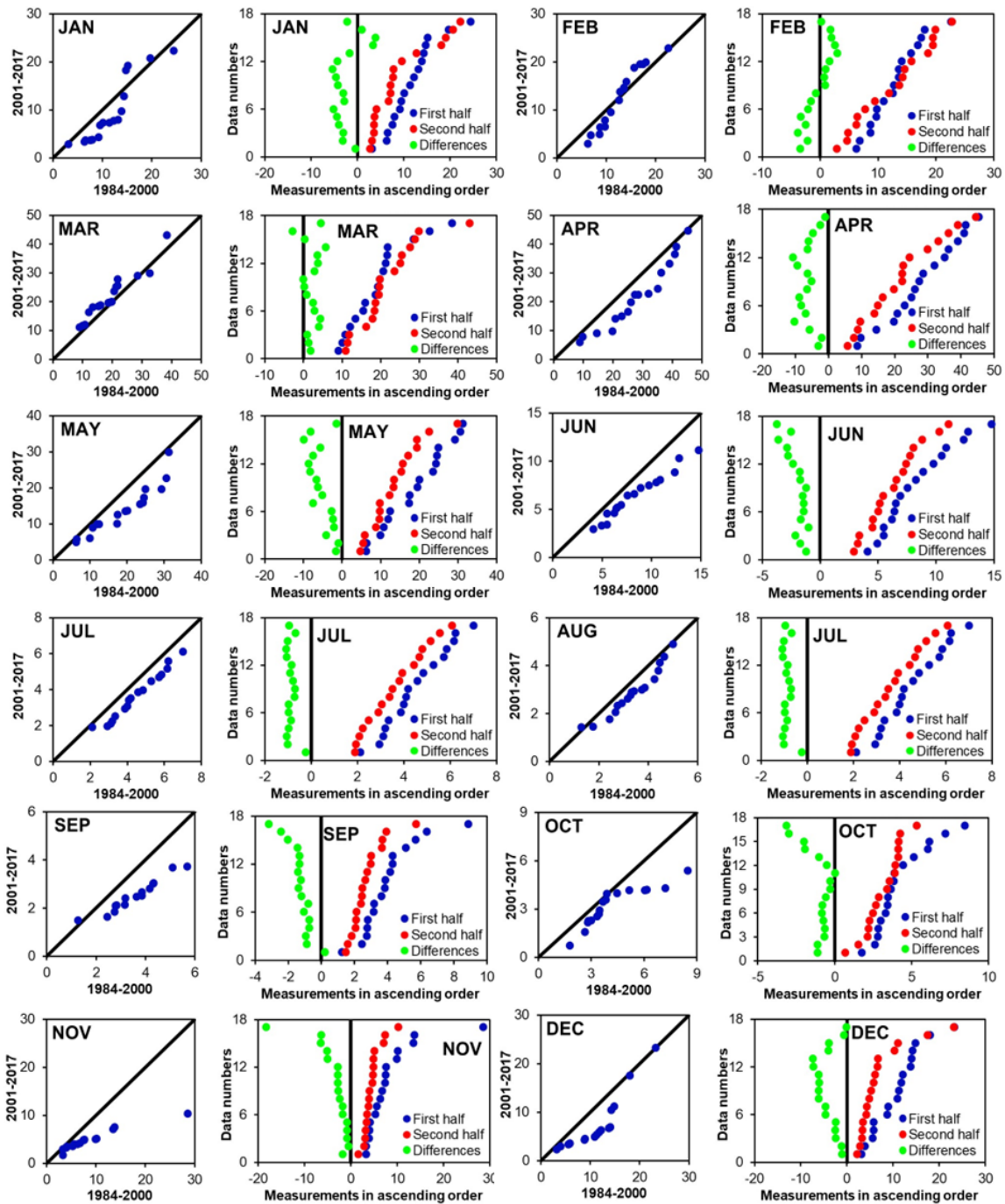


Figure 4.2. Classic Şen-ITA and VATA graph for monthly average flow data

Şen-ITA and VATA graphs show that there is a general upward trend in the flow value in March except for a few years. Both graphs show a decreasing trend in average flow values in all other months. According to the Şen-ITA and VATA graphs, it is seen that June, July, September, and November are the months with the highest decrease trend in average streamflow values. In these

months, the points in the decreasing trend region in the Şen-ITA graphs are farther away from the 1:1 line and the distribution of the difference values in the VATA graphs is farther away from the vertical trend line, indicating that the decreasing trend is greater than the other months. Especially in September, October, and November, it is seen in both Şen-ITA and VATA graphs that the decrease in high flow values is quite high.

To apply the MK method to the monthly and annual flow data for the period 1984-2017, it was first examined whether there is a serial correlation. The autocorrelation coefficients (r_1) obtained for lag number $k=1$ are shown in Table 4.1. Since these r_k values are between -0.366 and 0.306, there is no serial correlation in both annual and monthly flow values. Therefore, the MK method was applied directly to the flow data.

Table 4.1. Şen-ITA and MK trend analysis results

	r_1	Z_{MK}	$D_{Şen-ITA}$
Annual	0.027	-0,65	-1,84
January	0.068	-0,89	-1,97
February	-0.114	0,06	-0,25
March	-0.161	0,86	-1,15
April	-0.141	-0,76	-2,16
May	0.122	-1,56	-2,73
June	0.203	-1,63	-2,41
July	0.153	-1,84	-1,91
August	0.152	-1,65	-1,45
September	0.213	-2,89	-3,14
October	0.264	-1,42	-2,54
November	0.190	-2,83	-4,42
December	0.069	-2,18	-3,5

Table 4.1 shows the MK test statistic (Z_{MK}) and Şen-ITA indicator ($D_{Şen-ITA}$) values. According to the results of the Z_{MK} method, there are insignificant increasing trends in the flow values in February and March and decreasing trends in the other months and annual flow values. According to the MK method, the decreasing trends in September, November, and December are significant at $\alpha=0.05$ level. According to the values of $D_{Şen-ITA}$, there is a decreasing trend in all monthly and annual flow values. According to these values, the months with the lowest decrease trend were obtained in February and March flow values. This situation can be associated with the detection of a non-monotonic increasing trend as a result of visual examination of the Şen-ITA and VATA graphs of February and March. In September, November, and December, when the MK values are high, the values of $D_{Şen-ITA}$ are also high.

As a result, the trend results of the MK and Şen-ITA methods are generally consistent with each other.

5. CONCLUSION

In this study, the classical Şen-ITA method, and a new visualized version of this method, the VATA method, were used for trend analysis of annual and monthly flow data of Feke flow observation station D18A019 in Seyhan Basin. The results of these methods, which provide visual trend interpretation, were also compared with the MK method. In the study conducted for the period 1984-2017, the results of both Şen-ITA and VATA, which provide visual analysis, and MK methods support each other. According to the results of the three methods used, a general decreasing trend was obtained in the annual and monthly flow data of Feke station for the period analyzed.

The results obtained are of great importance as they will benefit decision-makers to determine the strategies for adaptation at the most appropriate level to combat climate change and to transform them into rational policies.

REFERENCES

- Ali, R., Kuriqi, A., Abubaker, S., & Kisi, O. (2019). Long-term trends and seasonality detection of the observed flow in Yangtze River using Mann-Kendall and Sen's innovative trend method. *Water*, 11(9), 1855.
- Anand, J., Gosain, A. K., Khosa, R., & Srinivasan, R. (2018). Regional scale hydrologic modeling for prediction of water balance, analysis of trends in streamflow and variations in streamflow: The case study of the Ganga River basin. *Journal of Hydrology: Regional Studies*, 16, 32-53.
- Buyukyildiz, M. (2023). Evaluation of annual total precipitation in the transboundary Euphrates–Tigris River Basin of Türkiye using innovative graphical and statistical trend approaches. *Applied Water Science*, 13(2), 38.
- Chen, Y., Guan, Y., Shao, G., & Zhang, D. (2016). Investigating trends in streamflow and precipitation in Huangfuchuan Basin with wavelet analysis and the Mann-Kendall test. *Water*, 8(3), 77.
- Güçlü, Y. S. (2020). Improved visualization for trend analysis by comparing with classical Mann-Kendall test and ITA. *Journal of Hydrology*, 584, 124674.
- Güçlü, Y. S. (2022). Dikey Eksende Eğilim Çözümlemesi Yöntemi . *Doğal Afetler ve Çevre Dergisi* , 8 (1), 134-141.
- Gümüş, V., Yenigün, K., & Kırkgöz, M. S. (2016). Göksu Nehri–Himmetli İstasyonu Aylık Ortalama Akım Gidişlerinin Belirlenmesi. *Çukurova Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi*, 26(1), 27-36.
- Jaswal, A. K., Rao, G. P., & De, U. S. (2008). Spatial and temporal characteristics of evaporation trends over India during 1971-2000. *Mausam*, 59(2), 149-158.
- Kendall MG (1975) Rank Correlation Methods. London: Griffin
- Koyceğiz, C., & Buyukyildiz, M. (2019). Temporal trend analysis of extreme precipitation: a case study of Konya Closed Basin. *Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi*, 25(8), 956-961.

- Koyceğiz, C., & Buyukyildiz, M. (2020). Determination of change point and trend analysis of annual temperature data in Konya Closed Basin (Turkey). *Niğde Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi*, 9(1), 393-404.
- Koyceğiz, C., & Buyukyildiz, M. (2021). Assessment of Concentration, Erosivity and Seasonality of Precipitation Data for 1970-2019 Period of Karataş Gauging Station. *Avrupa Bilim Ve Teknoloji Dergisi*, (32), 118-125.
- Koycegiz, C., & Buyukyildiz, M. (2022). Investigation of precipitation and extreme indices spatiotemporal variability in Seyhan Basin, Turkey. *Water Supply*, 22(12), 8603-8624.
- Koycegiz, C., & Buyukyildiz, M. (2023). Investigation of spatiotemporal variability of some precipitation indices in Seyhan Basin, Turkey: monotonic and sub-trend analysis. *Natural Hazards*, 116(2), 2211-2244.
- Mann HB (1945) Nonparametric tests against trend. *Econometrica* 13(3): 245-259
- Muluk, Ç.B., Kurt, B., Turak, A., Türker, A., Çalışkan, M.A., Balkız, Ö., Gümrükçü, S., Sarıgül, G., Zeydanlı, U. (2013) Türkiye’de Suyun Durumu ve Su Yönetiminde Yeni Yaklaşımlar: Çevresel Perspektif, İş Dünyası ve Sürdürülebilir Kalkınma Derneği-Doğa Koruma Merkezi
- Rodrigues, I. S., Costa, C. A. G., Neto, I. E. L., & Hopkinson, C. (2021). Trends of evaporation in Brazilian tropical reservoirs using remote sensing. *Journal of Hydrology*, 598, 126473.
- Saplıoğlu, K., Güçlü, Y. S., (2022). Combination of Wilcoxon test and scatter diagram for trend analysis of hydrological data. *Journal of Hydrology*, 612: 128132.
- Shi, J., Cui, L., Ma, Y., Du, H., & Wen, K. (2018). Trends in temperature extremes and their association with circulation patterns in China during 1961–2015. *Atmospheric Research*, 212, 259-272.
- Soydan, N. G., Gümüş, V., Şimşek, O., Gerger, R., & Berivan, A. Ğ. U. N. (2016). Seyhan Havzası aylık ortalama akım ve yağış verilerinin trend analizi. *Dicle Üniversitesi Mühendislik Fakültesi Mühendislik Dergisi*, 7(2), 319-327.
- Şen, Z., (2012). Innovative trend analysis methodology. *Journal of Hydrologic Engineering*, 17(9): 1042-1046.
- Trajkovic, S., & Kolakovic, S. (2009). Wind-adjusted Turc equation for estimating reference evapotranspiration at humid European locations. *Hydrology Research*, 40(1), 45-52.
- URL1.https://webdosya.csb.gov.tr/db/destek/editordosya/Iklim_Degisikligi_Uyum_Stratejisi_ve_Eylem_Plani.pdf
- Wang, S., Cao, Z., Luo, P., & Zhu, W. (2022). Spatiotemporal variations and climatological trends in precipitation indices in Shaanxi Province, China. *Atmosphere*, 13(5), 744.
- Wu H, Qian H (2017) Innovative trend analysis of annual and seasonal rainfall and extreme values in Shaanxi, China, since the 1950s. *Int J Climatol* 37(5):2582–2592

APPLICABILITY OF DIFFERENT INTERPOLATION METHODS IN THE ESTIMATION OF POTENTIAL EVAPOTRANSPIRATION

Cansu Hacer KAPLAN

Konya Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, Konya, Türkiye

ORCID ID: 0000-0001-8149-4249

Meral BUYUKYILDIZ

Konya Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, Konya, Türkiye

ORCID ID: 0000-0003-1426-3314

***Cihangir KOYCEGIZ**

Konya Technical University, Faculty of Engineering and Natural Sciences, Department of Civil Engineering, Konya, Türkiye

ORCID ID: 0000-0002-0510-1164

ABSTRACT

One of the important parameters for the study of climate change is potential evapotranspiration (PET). Accurate estimation of PET is of great importance in the planning and management of agricultural activities and water resources in a basin, in rainfall-runoff models, in determining the water budget, and in combating climate change impacts. Various empirical equations and artificial intelligence models have been widely used to estimate the amount of PET. In this study, the usability of spatial interpolation methods in estimating the monthly PET amount was investigated. For this purpose, firstly, potential evapotranspiration (PET) values were calculated by the Oudin method using the temperature data of 11 meteorological stations located in the Konya Closed Basin between 1971 and 2019. Using the PET values obtained with the Oudin method, the success of spatial interpolation methods in PET estimation was evaluated. In the study where 8 different interpolation methods were used, PET data from 8 of the 11 stations in the basin were used in the areal distribution while 3 stations were used to test the success of the interpolation methods. The PET estimation success of the interpolation methods including geostatistical and deterministic methods was tested with root mean square error (RMSE), mean absolute error (MAE), coefficient of determination (R^2), and Nash-Sutcliffe efficiency coefficient (NSE) performance criteria. As a result of the study, it was determined that the NSE values of the most successful interpolation methods for PET estimation for the period 1971-2019 at the test stations were above 0.996 and showed very good success.

Keywords: IDW, Interpolation, Kriging, Potential Evapotranspiration, Spline

POTANSİYEL EVAPOTRANSPIRASYONUN TAHMİNİNDE FARKLI ENTERPOLASYON YÖNTEMLERİNİN UYGULANABİLİRLİĞİ

ÖZET

İklim değişikliğinin incelenmesi için önemli parametrelerden biri de potansiyel evapotranspirasyon (PET)'dir. Bir havzadaki tarımsal faaliyetlerin ve su kaynaklarının planlanmasında ve yönetiminde, yağış akış modellerinde, su bütçesinin belirlenmesinde ve iklim değişikliği etkileri ile mücadelede PET miktarının doğru şekilde tahmin edilmesi büyük önem taşımaktadır. PET miktarının tahmininde çeşitli ampirik denklemler ve yapay zekâ modelleri yaygın olarak kullanılmaktadır. Bu çalışmada ise aylık PET miktarının tahmin edilmesinde alansal enterpolasyon metotlarının kullanılabilirliği incelenmiştir. Bu amaçla öncelikle Konya Kapalı Havzasında yer alan 11 meteoroloji istasyonunun 1971-2019 yılları arasındaki sıcaklık verileri kullanılarak Oudin metoduyla potansiyel evapotranspirasyon (PET) değerleri hesaplanmıştır. Oudin metodu ile elde edilen PET değerleri kullanılarak alansal enterpolasyon metotlarının PET tahminindeki başarısı değerlendirilmiştir. 8 farklı enterpolasyon metodunun kullanıldığı çalışmada havzadaki 11 istasyonun 8'ine ait PET verileri alansal dağılımda kullanılırken 3 istasyon ise enterpolasyon metotlarının başarısının test edilmesinde kullanılmıştır. Jeostatistik ve deterministik yöntemleri içeren enterpolasyon metotlarının PET tahmin başarısı karekök ortalama karesel hata (RMSE), ortalama mutlak hata (MAE), determinasyon katsayısı (R^2) ve Nash-Sutcliffe etkinlik katsayısı (NSE) performans kriterleri ile test edilmiştir. Çalışma sonucunda ise test istasyonlarında 1971-2019 periyodu için PET tahmininde en başarılı enterpolasyon metotlarına ait NSE değerlerinin 0.996'nın üzerinde ve çok iyi düzeyde başarı gösterdiği tespit edilmiştir.

Anahtar Kelimeler: IDW, Enterpolasyon, Kriging, Potansiyel Evapotranspirasyon, Spline

1. INTRODUCTION

Climate parameters are used in studies carried out in many different fields such as hydrology, meteorology, geology, hydrogeology, ecology, etc. Accurate climatic data can only be obtained as point data where there are meteorological observation stations. It is both difficult and costly to establish an observation station everywhere on earth (Akacak and Taş, 2021). In addition, climate parameters with spatial distribution are needed in many studies. Spatial or point hydrometeorological parameter estimates can be calculated by methods such as regression analysis, trend analysis, Thiessen polygon, and arithmetic mean. However, estimates performed by these methods are generally inadequate and may produce biased results (Tabios III and Salas, 1985). In some cases, it may not be feasible to perform analyses such as frequency and risk

analyses on the hydrometeorological parameter under investigation due to the quantitative and qualitative insufficiency of the available data. In this case, interpolation methods that take into account the location of the points where observations are made and the correlation between observations are used.

In basin management planning, the spatial distribution of climate data can be produced with point observation values in a Geographic Information Systems (GIS) environment. Interpolation methods used for spatial distribution of point data are widely used in many fields such as meteorological, hydrological, geological, hydrogeological, and climatological (Rata et al., 2020; Koycegiz et al., 2023a, Antal et al., 2021; Koycegiz et al., 2023b; Che and Jia, 2019; Karlović et al., 2021)

Interpolation methods are frequently used in hydrological studies to complete missing data, predict future data, determine drought trends, hydrological modeling, etc. (Burgess and Webster, 1980; Goovaerts, 2000; Basistha et al., 2008; Koycegiz and Buyukyildiz, 2020; Çobaner et al., 2011; Ly et al., 2013).

In this study, the usability of deterministic and geostatistical interpolation methods in estimating the monthly potential evapotranspiration (PET) in the Konya Closed Basin (KCB) between 1971 and 2019 was investigated.

2. STUDY AREA AND DATA

Konya Closed Basin (KCB), one of the driest basins in Turkey, was selected as the study area in this study in which the estimation of PET amount by interpolation methods was investigated. Oudin (Oudin et al., 2005) method was used for the calculation of PET values required to determine the prediction success of interpolation methods. In this method, the daily temperature data required for PET calculation and the latitude values of the station location were obtained from the State Meteorological Service.

11 meteorological stations in the KCB were used in the study. Table 2.1 shows the information about the meteorological observation stations used in the study and Figure 2.1 shows their locations in the KCB. For the period 1971-2019, 8 stations (Aksaray, Niğde, Çumra, Beyşehir, Kulu, Konya, Ereğli and Karaman stations) were used in the areal distribution while 3 stations (Seydişehir, Cihanbeyli and Karapınar stations) were used in the test phase (Table 2.1, Figure 2.1).

Table 2.1. Information on the meteorological stations used

Station Name	Station Number	Latitude	Longitude
Aksaray ^x	17192	38°22'13.80"N	33°59'55.32"E
Niğde ^x	17250	37°57'30.60"N	34°40'46.20"E
Çumra ^x	17900	37°33'56.88"N	32°47'24.00"E
Beyşehir ^x	17242	37°40'39.72"N	31°44'46.68"E
Kulu ^x	17754	39° 4'43.68"N	33° 3'56.52"E
Konya ^x	17244	37°59'1.32"N	32°34'26.40"E
Ereğli ^x	17248	37°31'31.80"N	34° 2'54.60"E
Karaman ^x	17246	37°11'35.5"N	33°13'12.7"E
Seydişehir ^y	17898	37°25'36.12"N	31°50'56.40"E
Cihanbeyli ^y	17191	38°39'2.08"N	32°55'18.70"E
Karapınar ^y	17902	37°42'58.72"N	33°31'33.60"E

^x: Stations used in spatial distribution in the period 1971-2019

^y: Test stations used in the period 1971-2019

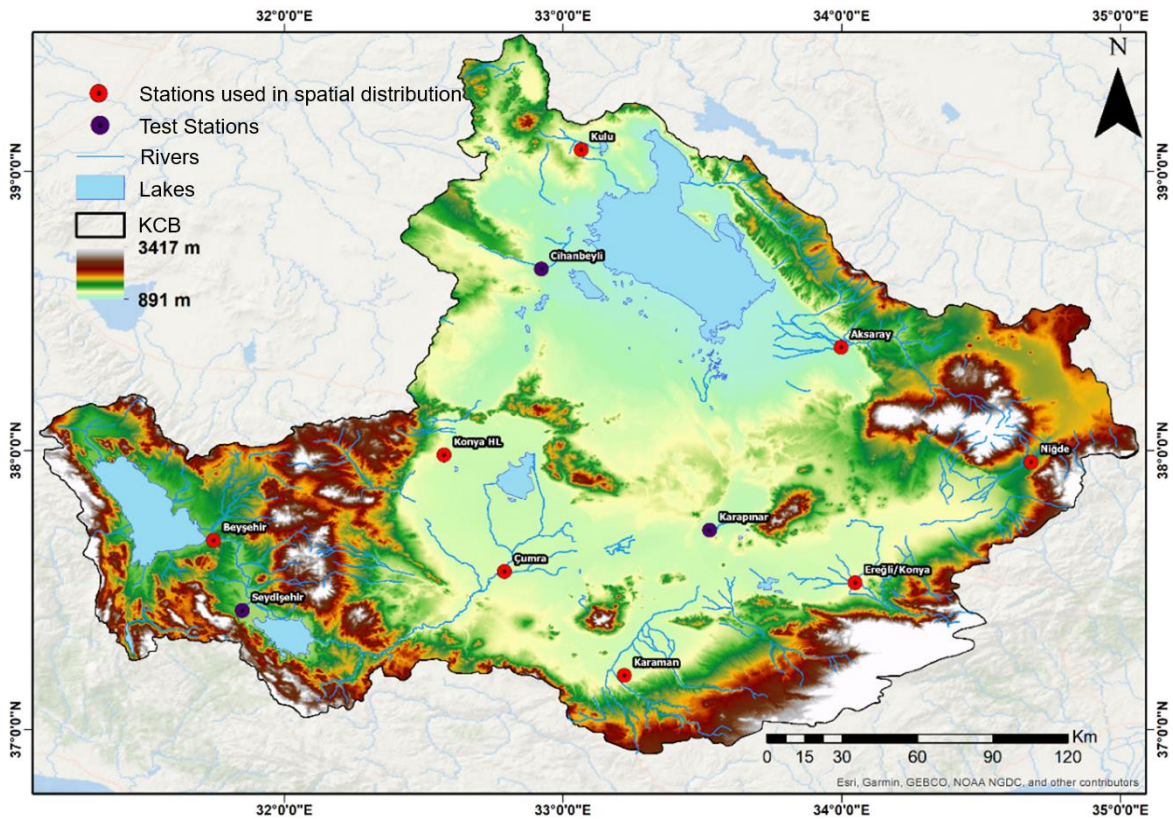


Figure 2.1 Location of the stations used in the study in KCB

3. METHODOLOGY

Geo-interpolation algorithms are frequently used to distribute point data spatially and to gather information in places where measurements are unavailable. Deterministic and geostatistical interpolation approaches were used in this study. Inverse distance weighted (IDW) and Spline algorithms are deterministic methods. Kriging was employed as a geostatistical technique.

The IDW approach employs an interpolation technique in which locations closest to the point data are weighted more heavily than those further away. The weight coefficient decreases as you travel away from the point data source. As a result, the effect is diminished. It is commonly used to interpolate weather data at unmeasured sites (Koycegiz and Buyukyildiz, 2023b; Koycegiz and Buyukyildiz, 2022). It is preferred in spatial analysis due to its simplicity and ease of usage (Chen and Liu, 2012; Doğan et al., 2013).

By fitting a minimum curvature surface to point data, the spline approach attempts to extract data about unmeasured points. This method is often used to gather spatial data for altitude, air pollution, and water depth. It might not work well for parameters that change quickly over small distances (Ly et al., 2013). The mathematical curvature surface, which is based on point data, produces successful results at locations without measurements (Bakış et al., 2021). In this study, two different versions of the Spline method, Regularized Spline (Sp-R) and Tension Spline (Sp-T), were used.

Kriging is a popular geostatistical interpolation method. It, like IDW, is based on stochastic modeling, with the influence decreasing as one moves away from the point data (Khan et al., 2023; Ly et al., 2013). Universal Kriging (UK) and Ordinary Kriging (OK) were used in this study. One of the most important inputs of the OK method is semivariogram models.

In this study, four different semivariogram models were used in the OK method. These semivariograms are spherical (OK-S), Gaussian (OK-G), Circular (OK-C), and Exponential (OK-E). Minimizing the error variance provides an important advantage. A stable semivariogram model was used for the UK method.

4. RESULTS

The performance of the interpolation methods applied to estimate the monthly PET amount for the period 1971-2019 was evaluated by the coefficient of determination (R^2), Nash-Sutcliffe efficiency coefficient (NSE), mean absolute error (MAE), and root mean square error (RMSE). The performance results of the interpolation methods are given in Table 4.1. The most successful model for each test station is identified by the maximum NSE value and shown in bold font in Table 4.1. Among the models with the same maximum NSE value, the model with the lowest RMSE value was selected as the most successful model.

Table 4.1. Performance values of PET models

Station Name	Model Name	R ²	NSE	MAE (mm)	RMSE (mm)
17898 Seydişehir	IDW	0.999	0.993	3.323	4.062
	Sp-R	0.996	0.984	4.600	6.108
	Sp-T	0.998	0.990	3.713	4.786
	UK	0.997	0.995	2.511	3.474
	OK-C	0.998	0.995	2.672	3.375
	OK-E	0.998	0.995	2.801	3.457
	OK-G	0.998	0.996	2.436	3.047
	OK-S	0.999	0.995	2.691	3.366
17191 Cihanbeyli	IDW	0.997	0.997	1.868	2.829
	Sp-R	0.998	0.998	1.759	2.394
	Sp-T	0.998	0.998	1.622	2.382
	UK	0.998	0.998	1.681	2.276
	OK-C	0.992	0.992	1.846	4.506
	OK-E	0.991	0.990	1.849	4.845
	OK-G	0.998	0.998	1.670	2.325
	OK-S	0.997	0.997	2.000	2.909
17902 Karapınar	IDW	0.999	0.997	2.018	2.436
	Sp-R	0.998	0.993	3.370	4.092
	Sp-T	0.999	0.994	3.149	3.698
	UK	0.999	0.998	1.716	2.166
	OK-C	0.998	0.996	2.171	2.977
	OK-E	0.999	0.997	2.134	2.564
	OK-G	0.972	0.971	3.889	8.254
	OK-S	0.999	0.997	2.178	2.643

From Table 4.1, it is seen that in all three test stations, very high NSE values were obtained in PET prediction for all interpolation methods. For the Seydişehir station, the OK-G model with NSE=0.996 was the method with the highest estimation success. For the OK-G model, R²=0.998, MAE=2.436 mm, and RMSE=3.047 mm was obtained. The model with the lowest estimation success at this station was the Sp-R model with the lowest R² (=0.984) and NSE (=0.996) and the highest MAE (=4.6 mm) and RMSE (=6.108 mm) values.

The models with the highest NSE (=0.998) values in the estimation of PET values of Cihanbeyli station by interpolation methods were Sp-R, Sp-T, UK, and OK-G. Therefore, the UK model, which has the lowest RMSE (=2.276 mm) value among these models, is considered the best-performing model for Cihanbeyli station. The interpolation method with the lowest PET prediction success at this station was the OK-E model with NSE=0.990.

The model with the best performance in PET estimation for Karapınar station is the UK model, which has NSE=0.998, R²=0.999, MAE=1.716 mm, and RMSE=2.166 mm. The OK-G model

was obtained as the method with the lowest success in PET estimation of Karapınar station with $NSE=0.971$.

Figure 4.1 shows the observed and predicted monthly total PET time series and scatter diagrams for the highest-performing methods at the test stations in KCB. It can be seen from the time series of all three stations that the interpolation methods successfully represent the PET behavior. This is also reflected in the scatter diagrams.

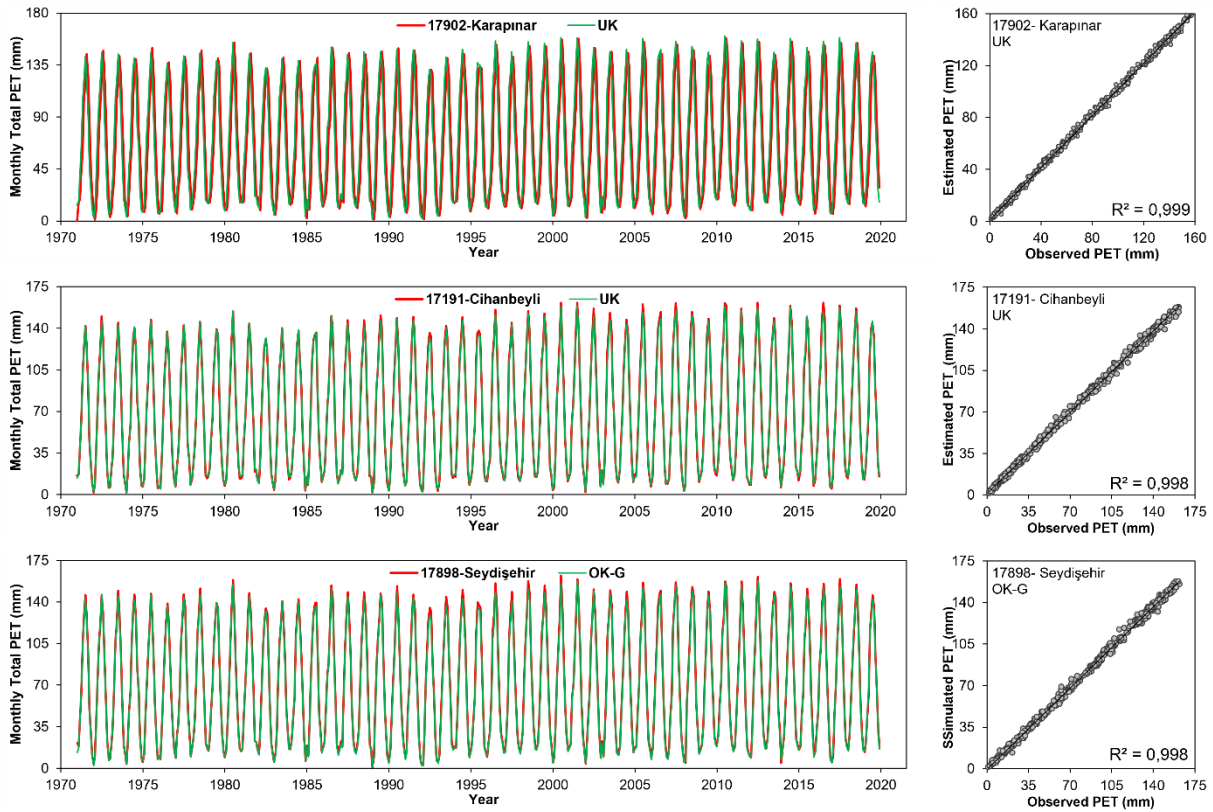


Figure 4.1. Monthly total PET time series and scatter diagrams of observations and model for the period 1971-2019

Maps of the spatial distribution of monthly total PET data in the KCB obtained with the interpolation methods applied for the period 1971-2019 are given in Figure 4.2. The location of the stations used in the spatial distribution of monthly total PET in this period is shown in the IDW map in Figure 4.2. Figure 4.2 shows that the monthly total PET amount varies between 66 and 72 mm in the IDW method. In the IDW model, the maximum amount of PET is around the Aksaray and Karaman stations, while the minimum amount of PET is around the Kulu and Beyşehir stations. According to Figure 4.2, each of the Spline methods (Sp-R and Sp-T) shows a similar spatial distribution. In these methods, PET amounts for each of the three test stations

fall in the same class range. Each of the Kriging methods also shows a similar distribution. In these models, PET amounts also fall into the same class range for each of the three test stations.

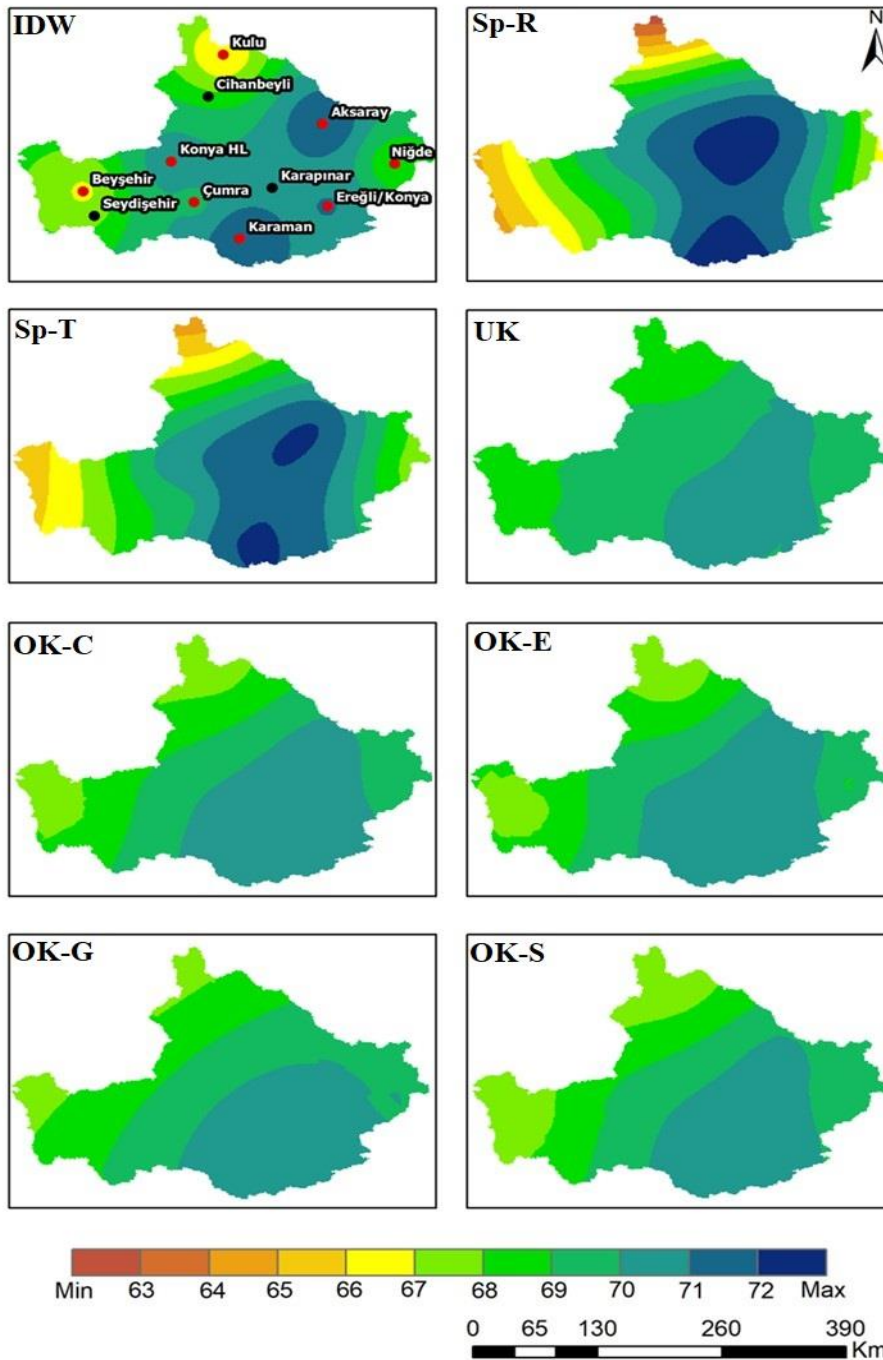


Figure 4.2. Spatial distribution maps of monthly total PET for the period 1971-2019

5. CONCLUSION

In this study, the usability of deterministic and geostatistical interpolation methods in the estimation of monthly PET amount in KCB for the period 1971-2019 was investigated. For this purpose, 8 of the 11 stations in the KCB were taken into consideration in the spatial distribution

and 3 of them were taken as test stations to determine the success of the interpolation methods. PET values were estimated with 8 different interpolation methods.

The interpolation methods used to estimate the amount of PET in the 1971-2019 period showed a high success rate of over 96% according to the NSE values for all three test stations. It is thought that the Oudin method used in the calculation of PET values is effective in the high prediction success of interpolation methods in PET predictions. The only hydrometeorological parameter used in the Oudin method is the mean temperature. For this reason, a realistic heterogeneity in PET physics cannot be achieved. However, the Oudin method is a very effective method used in models with large computational load and for preliminary prediction purposes. In this study, it was preferred due to its easy applicability. It is recommended for future studies to re-evaluate the spatial achievements by using methods such as Penman-Monteith, which provide effective heterogeneity in PET calculation in a basin with a relatively small surface area such as KCB.

ACKNOWLEDGMENTS

This study proceeded from Cansu Hacer KAPLAN's M. Sc. Thesis

REFERENCES

- Akacak, A. K., & Taş, İ. (2021). Farklı Mekânsal Enterpolasyon Yöntemleriyle Alansal Yağış Hesaplanması: Kuzey Ege Havza Örneği. *Türk Tarım ve Doğa Bilimleri Dergisi*, 8(2), 528-539.
- Antal, A., Guerreiro, P. M., & Cheval, S. (2021). Comparison of spatial interpolation methods for estimating the precipitation distribution in Portugal. *Theoretical and Applied Climatology*, 145(3-4), 1193-1206.
- Bakış, R., Bayazıt, Y., Ahmady, D. M. & Çabuk, S. N. (2021). Analysis and Comparison of Spatial Rainfall Distribution Applying Different Interpolation Methods in Porsuk River Basin, Turkey. *Eskişehir Teknik Üniversitesi Bilim ve Teknoloji Dergisi B - Teorik Bilimler*, 9 (1) , 1-14
- Burgess, T. M., & Webster, R. (1980). Optimal Interpolation and Isarithmic Mapping of Soil Properties I, The Semivariogram and Punctual Kriging. *Journal of Soil Science*, 31(3), 315–331.
- Basistha, A.; Arya, D.S.; Goel, N.K. (2008) "Spatial distribution of rainfall in Indian Himalayas: a case study of Uttarakhand Region, *Water Resources Management*, 22, 1325–1346
- Che, D., & Jia, Q. (2019). Three-dimensional geological modeling of coal seams using weighted Kriging method and multi-source data. *IEEE Access*, 7, 118037-118045.
- Chen, F. W., & Liu, C. W. (2012). Estimation of the spatial rainfall distribution using inverse distance weighting (IDW) in the middle of Taiwan. *Paddy and Water Environment*, 10(3), 209–222.
- Çobaner, M., Çakar, A., Çetin, M., & Yurtal, R. (2011). Göksu Deltasında Bazı Yeraltı Suyu Kalite Ögelerinin Probabilistik ve Jeostatistik Yöntemlerle İrdelenmesi, *İMO Teknik Dergi*, yazı 341, 5259-5283.

Doğan, H. M., Yılmaz, D. S. & Kılıç, O. M. (2013). Orta Kelkit Havzası'nın Bazı Toprak Özelliklerinin Ters Mesafe Ağırlık Yöntemi (IDW) ile Haritalanması ve Yorumlanması. *Gaziosmanpaşa Bilimsel Araştırma Dergisi*, (6), 46-54.

Goovaerts, P. (2000). Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall. *Journal of Hydrology*, 228, 113–129

Kaplan, C. H. (2023). Hidrolojik verilerin alansal dağılımında farklı enterpolasyon yöntemlerinin karşılaştırılması: Uygulama Konya Kapalı Havzası. Yüksek Lisans Tezi, Konya Teknik Üniversitesi.

Karlović, I., Marković, T., Vujnović, T., & Larva, O. (2021). Development of a hydrogeological conceptual model of the Varaždin alluvial aquifer. *Hydrology*, 8(1), 19.

Khan, M., Almazah, M. M. A., Ellahi, A., Niaz, R., Al-Rezami, A. Y., & Zaman, B. (2023). Spatial interpolation of water quality index based on Ordinary kriging and Universal kriging. *Geomatics, Natural Hazards and Risk*, 14(1). <https://doi.org/10.1080/19475705.2023.2190853>

Koycegiz, C., & Buyukyildiz, M. (2020). Determination of change point and trend analysis of annual temperature data in Konya Closed Basin (Turkey). *Niğde Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi*, 9(1), 393-404.

Koycegiz, C., & Buyukyildiz, M. (2022). Investigation of precipitation and extreme indices spatiotemporal variability in Seyhan Basin, Turkey. *Water Supply*, 22(12), 8603-8624.

Koycegiz, C., Sen, O. L., & Buyukyildiz, M. (2023a). An analysis of terrestrial water storage changes of a karstic, endorheic basin in central Anatolia, Turkey. *Ecohydrology & Hydrobiology*. <https://doi.org/10.1016/j.ecohyd.2023.07.002>

Koycegiz, C., & Buyukyildiz, M. (2023b). Investigation of spatiotemporal variability of some precipitation indices in Seyhan Basin, Turkey: monotonic and sub-trend analysis. *Natural Hazards*, 116(2), 2211-2244.

Ly, S., Charles, C., & Degré, A. (2013). Different methods for spatial interpolation of rainfall data for operational hydrology and hydrological modeling at watershed scale. A review. *Biotechnologie, Agronomie, Société et Environnement*, 17(2), 392–406.

Oudin, L., Hervieu, F., Michel, C., Perrin, C., Andreassian, V., Anctil, F., & Loumagne, C., (2005). Which Potential Evapotranspiration input for a rainfall-runoff model? Part 2- Towards a simple and efficient PE model for rainfall-runoff modelling, *Journal of Hydrology*, 303(1-4), 290-306.

Rata, M., Douaoui, A., Larid, M., & Douaik, A. (2020). Comparison of geostatistical interpolation methods to map annual rainfall in the Chéiff watershed, Algeria. *Theoretical and Applied Climatology*, 141, 1009-1024.

Tabios III, G. Q., & Salas, J. D. (1985). A comparative analysis of techniques for spatial interpolation of precipitation. *JAWRA Journal of the American Water Resources Association*, 21(3), 365-380.

KLASİK OSMANLI MİMARİSİNDE UZUNCAOVA CAMİİ**Arş. Gör. Esmâ KARAKOYUN YAŞAR**

Niğde Ömer Halisdemir Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, Niğde

ORCID ID: 0000-0001-8307-1610**ÖZET**

Dünya üzerinde bütün devletler tekvin ettikleri ilmi, mimari, sanatsal vb. eserlerle, dönemlerini betimleyerek varlığını korumuştur. Bu kapsamda mimari eserler; biçim, fonksiyon, doku, boyut, malzeme ve teknikleriyle bir dönemin en iyi tanımlama aracı ve sembolleri olarak yorumlanmaktadır. Osmanlı Devleti de özgün mimari eserleriyle günümüzde hâlâ rol model olarak kabul edilen önemli bir dönemi simgelemektedir. Türk mimarlığının önemli temsilcilerinden Mimar Sinan bu dönemde birçok yapının inşa ve onarımına imzasını atmış ve dokunduğu her yapıda kendine ait tanımlayıcı değerler bırakmıştır. Bu sebeptir ki hemen hemen bilinen bütün eserleri araştırmalara konu edilerek günümüz literatüründe yer edinmiştir. Bunun yanı sıra Mimar Sinan'ın arka planda kalmış, çeşitli isimlerle anılmış ve sınıflandırılması mümkün olamamış yapıları da bulunmaktadır. Kesin tarihi bilinmemekle beraber 15. yüzyıl sonu ya da 16. yüzyıl başlarında Bulgaristan' da yaptığı Uzuncaova Camii de bu yapıların başlıca örneklerinden olmakla beraber içerisinde cami ve kervansaray gibi yapı kütlelerinin olduğu bilinen bir külliye çerçevesinde inşa edilmiştir. Bu külliye günümüze yalnızca belirtilen cami ile kervansarayın giriş kapısı süregelmiştir. Yapı, müze ve ortak din mabedi bağlamında kullanılmakta ve bu özelliğiyle alanında tek Mimar Sinan camisi olduğuna ulaşılmaktadır. Uzuncaova Camii mimari, sosyokültürel, tarihi ve fonksiyonel açıdan önem arz etmektedir. Çalışma kapsamında, 1906 yılından beri özgün işlevini yitirdiği bilinen Uzuncaova Camii; vaziyet planı, kat planı, cephe özellikleri, yapı elemanları ve süsleme özellikleri kontekstinde irdelenerek mimari özellikleri, malzeme ve yapım tekniği; değerlendirilmiştir. Uzuncaova Camii'nin yapı elemanı tipleri ve süslemeleri tablolştırılmıştır. Çalışmanın Türk mimarlığının mihenk taşı olan Mimar Sinan'a ait eserler doğrultusunda literatürde yer edinmesi, Uzuncaova Camii'nin tanınırlığının artırılması ve sonraki çalışmalara yardımcı olması hedeflenmektedir.

Anahtar Kelimeler: Klasik Osmanlı Mimarisi, Mimar Sinan Camileri, Uzuncaova Kilisesi**ABSTRACT**

All the states in the world have created scientific, architectural, artistic, etc. with the works, he has preserved his existence by depicting his periods. In this context, architectural works are interpreted as the best identification tools and symbols of a period with their form, function, texture, size, materials, and techniques. The Ottoman State also symbolizes an important period

that is still considered a role model today with its original architectural works. Mimar Sinan, one of the important representatives of Turkish architecture, signed the construction and repair of many structures during this period and left his own defining values in every structure he touched. For this reason, it has taken place in modern literature by making almost all known works the subject of research. In addition, there are also structures of Mimar Sinan that have remained in the background, have been referred to by various names and have not been able to be classified. The exact date is unknown, but 15. the end of the century or 16. Uzuncaova Mosque, which he built in Bulgaria at the beginning of the century, is also one of the main examples of these structures, but it was built within the framework of a complex known to have building masses such as a mosque and a caravanserai. From this complex to the present day, only the mosque mentioned, and the entrance door of the caravanserai have continued. The building is used in the context of a museum and a common religious temple, and with this feature, it is reached that it is the only Mimar Sinan Mosque in its field. Uzuncaova Mosque is important from an architectural, sociocultural, historical and functional point of view. Within the scope of the study, Uzuncaova Mosque, which is known to have lost its original function since 1906, was examined in the context of the layout plan, floor plan, facade features, building elements and decorative features, and its architectural features, material and construction technique were evaluated. The types of building elements and decorations of Uzuncaova Mosque are tabulated. The aim of the study is to gain a place in the literature in accordance with the works of Mimar Sinan, the touchstone of Turkish architecture, to increase the recognition of Uzuncaova Mosque and to assist in subsequent studies.

Keywords: Classical Ottoman Architecture, Mimar Sinan Mosques, Uzuncaova Church

1. GİRİŞ

İstanbul' un fethi; Osmanlı Devleti' nin kültürel ve sosyal gelişiminin beraberinde Klasik Osmanlı mimarisi olarak adlandırılan ve mimaride birçok kamusal yapının form ve tasarımlarının temellerinin atıldığı bir dönemi getirmiştir. Bu kamu yapılarının başlıcası dini ve sosyal ihtiyaçlar doğrultusunda tasarlanan cami yapılarıdır (Aslanapa, 1986). Bu dönemde camileri önemli kılan etken diğer kamu yapılarının aksine Erken Osmanlı Dönemi'nden farklılıklar göstermesidir (Uluçam, 1999). Türk kültüründe önemli bir yer edinmiş mimari deha Mimar Sinan da Klasik Osmanlı dönemi baş mimarı olup dönemin mimari mirasının gelişiminde önemli rol oynamıştır (Ögel, 1963). Mimar Sinan bu dönemde, kendisini mimarlığa adanmış ve daha önce yapmış olduğu eserlerin mimari özellikleriyle yeni tasarım fikirlerini harmanlayarak onları aşmayı amaçlamıştır (Aslanapa, 1986). Bu kapsamda pek çok

yapı inşa etmiştir. Osmanlı Beyliği yerleşik hayata geçtikten sonra Osmanlı şehirleri oluşmaya başlanmış ve devletin pek çok yerinde yapılar başlanmıştır. Bu yapıların birçoğu da payitaht dışında bulunmaktadır. Bu sebeple Mimar Sinan kimi yapıları bizzat yapmışken kimi yapılarda da keşif raporları üzerinden çalışarak yapının inşasını koordine etmiştir. Mimar Sinan'ın eserlerinin olduğu Balkanlar da bu konuda önem arz etmektedir. (Kuran, 1986). Bu kapsamda Bulgaristan da yer alan pek çok Mimar Sinan yapısı bulunmakta ve bu yapılardan birisi de Uzuncaova Camii olarak bilinmektedir. Yapı hakkında sınırlı sayıda kaynak bulunmasıyla beraber Sinan Paşa'nın 1595 tarihli vakfiyesinin temel alındığı Güray (2009)'un tez çalışması yol gösterici olmuştur. Bunun yanı sıra Evliya Çelebi, A. Antovov, Ayverdi ve İ. Bognadov da çalışmalarında yapı hakkında bilgiler vermiştir. İ. Dobrev de yaptığı çalışmada Uzuncaova'da yapılan panayırdan bahsederken caminin adını geçirmiştir. Bunun yanı sıra Bayram (1995)'in, "Yemen Fatih Gazi Sinan Paşa'nın Vakfiyeleri, Tezyinatı ve Türk Süsleme Sanatındaki Yeri", adlı çalışmasında; Antonov (1999) "XVI. Yüzyılda Bulgaristan Topraklarında Orta Kol Üzerindeki Menzil Külliyesi" adlı Osmanlı ansiklopedisinde; Yazıcı (2011) "Osmanlı Mimarlığında XVI. Yüzyılın Önemli Bir Banisi: Yemen Fatih Gazi Sinan Paşa ve Camileri" adlı çalışmasında Uzuncaova Camii'ni ele almıştır. Uzuncaova bu çalışmalarda çoklukla Sinan Paşa Camii adıyla anılmakta ve bu isme Bulgaristan ya da Balkanlardaki Mimar Sinan yapıları bağlamında araştırma yapıldığında ulaşılabilmektedir.

Uzuncaova Camii, Bulgaristan Haskovo beldesi, Uzundhovo köyünde bulunan bir külliye merkezinde inşa edilmiştir. Daha sonraları yıkılan bu külliye den geriye kalan tek yapıdır (Güray, 2009). Literatürde birden fazla isimle ele alınması sebebiyle araştırılması zor olup yapı bütünlüğünün büyük oranda korunmuş olması ve camilerin kiliseye dönüştürülmesi konusundaki sınırlı örneklerden olması dolayısıyla önemlidir. Konu bağlamında sınırlı sayıda çalışma yapılmış olup Klasik Osmanlı mimarisi bağlamında değerlendirilmesi gerekli bulunmuştur. Çalışma sonucunda yapının mimari tasarım ve formunun Klasik Osmanlı mimarisini çokça yansıttığına ulaşılmaktadır. Alan çalışmasının yerinde yapılamaması çalışmanın kısıtlarından olup daha sonraki çalışmalarda yapının farklı yönlerden analiz edilerek özgün formu ve kilise olmadan önceki üst örtüsünün değerlendirilmesi önerilmektedir.

2. YÖNTEM

Çalışma kapsamında öncelikle Klasik Osmanlı mimarisi, Mimar Sinan ve Uzuncaova Kilisesi Türkçe ve Bulgarca dillerinde araştırılmıştır. Literatürde ulaşılan belgelerin kaynakları irdelenmiş ve bu kapsamda çalışılan yapının birden fazla adı olduğuna ulaşılmıştır. Bulunan isimler Uzuncaova Camii, Gavur Camii ve Sinan Paşa Camii olup bu isimler doğrultusunda

tekrar literatür taraması yapılmış ve veri toplanmıştır. Bunun yanı sıra alan Google Earth uygulaması üzerinden detaylıca gezilerek gözlem yapılmıştır. Daha sonra Klasik Osmanlı mimarisi bağlamında edinilen mimari bilgiler, gözlemlenen Uzuncaova Camii üzerinde analiz edilerek değerlendirilmiştir.

3. KLASİK OSMANLI MİMARİSİ

Osmanlı Devleti'nin ekonomik, askeri ve sosyokültürel açıdan gelişmesiyle eş yönlü ilerleyen döneme Klasik Dönem adı verilmektedir. Klasik Osmanlı Dönemi'nin başlangıcını İstanbul'un fethi ve II. Bayezid döneminin başı olarak belirten farklı görüşler bulunmaktadır. Bu dönemde Fatih Sultan Mehmet, Yavuz Sultan Selim, Kanuni Sultan Süleyman, I. Ahmet, IV. Murat ve pek çok güçlü alim ve sadrazamın yaşadığı bilinmektedir. Bu kapsamda İstanbul fethinin Klasik Osmanlı mimarisinin başlangıcı olduğunu söylemek mümkündür (Aslanapa,1986).

XIII. yüzyılın sonuna doğru yerleşik düzene geçmeyi başaran Osmanlı Beyliği; idari, ekonomik ve sosyal gelişiminin yanı sıra pek çok sanat eseri ve mimari yapılar ortaya koymuştur. Beyliğin İznik ve Bursa'yı fethetmesiyle beraber imar faaliyetleri hızlandırılmış ve bu kapsamda ilk olarak kamu yapıları inşa edilmeye başlanmıştır. Kamu yapıları içinde en çok cami merkezli külliyeler yer almıştır. Cami yapıları bu dönemde sadece ibadet alanı değil sosyal ihtiyaçlara da karşılık veren yapılar olup ters T planlı, tabhaneli, yan kanatlı veya zaviyeli tip olarak sınıflandırılmışlardır. Bu dönemde camiler genellikle tek kubbeli ve kare baldakenlidir. Klasik Osmanlı mimarisinin temellerinin II. Murat Dönemi'nde atıldığı bilinmektedir. Osmanlı bu dönemde mimaride bir arayış içerisinde olup Tire İmaret Camii'nde (1441) merkezi kubbeyi destekleyen yarım kubbeli sistem bu arayışa örnek niteliğindedir. II. Murat Dönemi'nde Edirne'de yapılan "Üç Şerefeli Camii" (1437-1447) Klasik Osmanlı mimarisinin habercisi niteliğinde bilinmektedir. Bu camiyle ana kubbe yanlarında yer alan küçük kubbelerde desteklenerek genişletilmiş ve merkezi plan şeması oluşturulmaya çalışılmıştır. XV. yüzyılın ortalarında gelişim gösteren Klasik Dönem XVI. Yüzyılda en yüksek noktayı görmüştür (Aslanapa,1986). (Aslanapa,1986).

Osmanlı Devleti'nin yapmış oldukları mimari ve sanatsal eserler arttıkça "Osmanlı şehirleri" oluşmaya başlamıştır. Bu şehir yerleşimlerinde kentsel planlamalar külliye ve diğer kamusal anıtlar doğrultusunda geliştirilmiştir. Klasik dönem külliye yapılarının temelinde camiler yer almaktadır. Caminin çevresinde medrese, darüşşifa, imaret, tabhane, arasta, sıbyan mektebi, çarşı sebil, çeşme ve meşruta gibi yapılar bulunmaktadır. Mimar Sinaneddin Yusuf'un Klasik Osmanlı mimarisi olan Fatih Külliyesi (1463-1470) Osmanlı ve Türk mimarisinin en kapsamlı

ve büyük ilk yapı topluluğudur. Çevresinde Fatih ile eşi Gülbahar Hatun'un türbeleri; sekizer hastane, imaret, hamam, kütüphane, sıbyan mektebi ve medrese simetrik olarak yer almaktadır. Bu dönemde mimaride oransal farklılıklar görülmesine karşın sosyal yapılarda Erken Osmanlı Dönemi şemaları temel alınmıştır. Ancak cami yapılarında bu durumun aksine plan farklılıkları görülmektedir (Uluçam, 1999).

Erken Osmanlı Dönemi camilerinde; Anadolu Selçuklu mezar anıtlarında kullanıldığı bilinen kubbeli-kare küp biçimi temel alınmıştır. Bu biçim, yapının boyutuna göre dört, altı veya sekiz ayak ile kemerlere oturtulmuş ve diğer alanlar yarım, çeyrek ve daha küçük boyutlarda kubbelerle örtülmüştür. Bu durum Erken Osmanlı camilerinin yapımında piramidal bir düzen olmasına sebep olmuştur. Klasik Osmanlı camilerinde ise bunun aksine üst örtü piramidal şekilde, alt kısımlar düzdür. Bu dönemde iç mekân ile dışarı arasında algıda bütünlük bulunmaktadır. Rönesans ve Bizans mimarisinde yer alan "mekânın parçalanması", Osmanlı Klasik dönem camilerinde görülmemektedir (Kuran, 1986).

Klasik Osmanlı mimarisinde her cephe işlevi doğrultusunda düzenlenmiştir. Kubbelerin fil ayaklarına taşılması cami cephelerinde çokça pencere açıklığını mümkün kılmıştır. Bu kapsamda camilerde alt duvarlarda düz, üst sıralarda ise sivri kemerli ve vitraylı camlar yapılmıştır. Yapıların taç kapıları gerek form gerekse de malzemeleriyle cephede en gösterişli eleman olarak yer edinmektedir. Klasik Osmanlı mimarisinde de süslemeye özen gösterilmiş ancak süslemenin mimarinin önüne geçmesine ılımlı bakılmamıştır. Yapılarda taç kapı, mihrap, minare, şerefe ve mihrabiye kavsaralarında tromp veya pandandif geçişlerinde mukarnaslar yapılmış bunun yanı sıra sütunlarda geometrik motifli başlıklar ve kürsülerde de bitkisel motifler kullanılmıştır. Cami iç duvarlarında pencere ve mihrap alınlıkları ve bazı duvarlarda sıraltı tekniğinde İznik'te yapılan çinilerle süsleme yapılmıştır. XVI. Yüzyılda bu çinilerde parlak mercan kırmızısı renginin kullanıldığına ulaşılmıştır. Bunun yanı sıra camilerde genellikle son cemaat yeri revaklı düzenlenmiştir. (Kuran, 1986). Şehir planlamaları ve külliye yapılarının Hassa Mimarlar Ocağı tarafından tasarlanıp, uygulamaların ise merkezden gönderilen mimarlar sorumluluğunda yapıldığı düşünülmektedir. Mimar Sinan, Acem Ali' nin vefatından sonra hassa baş mimarlığına getirilmiş ve klasik dönemde yeni arayışların ve oluşumların temelinde önemli bir yeri bulunmaktadır (Ögel, 1963). Bu kapsamda Klasik Osmanlı mimarisi bağlamında Mimar Sinan'ın değerlendirilmesi önem arz etmektedir.

Mimar Sinan

Osmanlı Devleti'nde her türlü mimari yapım ve onarım işi Hassa Mimarlar Ocağı tarafından karşılanmıştır. Bu ocağın yetiştirdiği en önemli mimarların başında Mimar Sinan gelmektedir. Mimar Sinan'ın hayatı; Acemi Oğlan Dönemi (1512-1520), Yeniçeri Ocağı ve Haseki Dönemi (1521-1538) ve Baş Mimarlık Dönemi (1538- 1558) olmak üzere üç aşamada incelenebilir (Aslanapa,1986). Çalışma kapsamında seçilen örnek alan Uzuncaova Camii, Mimar Sinan'ın mimarbaşı olduğu döneme denk geldiği için bu dönemin irdelenmesi gerekliliği doğmuştur.

1538 yılında başmimarlık görevine getirilen Mimar Sinan bu tarihten itibaren kendisini tamamen mesleğine adanmıştır. Mimarbaşı olduktan kısa bir süre sonra Şehzade Camii'ni planlamış ve geleneksel mimari ile tasarım gücünü harmanlayarak Klasik Osmanlı mimarisinin önemli eserlerini ortaya koymuştur (Kuban, 2007). Mimar Sinan, mimar başı olmadan önce yapmış olduğu eserlerden daha büyük ve daha üstün yapılar yapmayı hedef edinmiş bu kapsamda aşması gereken en önemli eserin Ayasofya (532-537) diğer eserlerin ise Bayezid Camii (1501-1505), Üç Şerefeli Cami (1437-1447), Küçük Ayasofya (527-536) ve Fatih Camii (1462-1470) olduğu düşünülmektedir. Nitekim bu eserlerin mimari üslup ve biçimlerini sentezleyerek çıraklık eseri Şehzade Camii, kalfalık eseri Süleymaniye Camii ve ustalık eseri Edirne Selimiye Camii'ni yapmıştır (Aslanapa,1986).

Mimar Sinan'ın mimar başı olduktan sonraki süreçte merkez ve taşrada birçok yapı yaptığı bilinmektedir. Bu yapılardan payitahtın dışında olup birebir ilgilenemediği yerlerde bile alanın keşif raporlarını dikkatlice inceleyerek yapım faaliyetlerinin başarılı sonuçlanmasını sağlamıştır (Kuran,1986). Mimar Sinan'ın yapılarındaki bu başarının temel etkenlerinin şüphesiz işine hâkim olması ve iyi bir organizasyon olduğunu söylemek mümkündür. Mimar Sinan bunun yanı sıra yapı yerleşimlerinde kullandığı çeşitli ek unsurlarla stratejik planlamalar yapmış ve yapıların topoğrafyayla uyumlarını sağlayarak arazilerin dezavantajlılığını ortadan kaldırmıştır (Eraslan,2011). Mimar Sinan'ın bu başarılarının yanı sıra kubbe- mekân ilişkisinde kullandığı ideal yöntemlerle kubbeyi; 4,6 veya 8 destek üzerine oturarak yapıda duvarın taşıyıcılık görevini bu desteklere yüklemiş ve duvarlarda diğer dönemlere nazaran daha fazla pencere açıklığıyla mekânın ferah ve aydınlık olmasını sağlamış; iç mekânı genişletmiş ve yapının strüktürel sağlamlığını arttırmaya çalışmıştır. Bu onun en önemli buluşu olma niteliğindedir. Bunun yanı sıra mimariye eklediği diğer elemanlar da revak ve kemerlerdir (Mülayim, 2007). Mimar Sinan'ın bu süreçte merkez ve taşrada pek çok yapıtı bulunmakta olup bu yapıtlar; Adsız Risale, Risâletü'l-Mi'mâriye, Tuhfetü'l-Mi'mârîn, Tezkiretü'l-Ebniye ve

Tezkiretü'l-Bünyân olarak bilinmekte ve Topkapı Sarayı'nda yer almaktadır. ¹ Bu yazıtlardan; saptanamayan, harabe olan, yok olan, yenilenmiş olan ve bütünlüğünü koruyanlar olmak üzere toplam 107 cami yapısı olduğuna ulaşılmıştır (Tablo 1) (Şeşen, 1988).

Tablo 1. Mimar Sinan'ın Ulaşılabilen Cami Sayısı

Yapı Türü	Saptanamayan	Yok Olan	Yenilenmiş	Harabe	Özgün Formu Bozulmamış	Toplam
Cami	4	16	21	2	64	107

Mimar Sinan Osmanlı Devleti'nin yetiştirdiği en önemli isim olup eserleri günümüzde dahi örnek niteliğindedir. Bu doğrultuda Mimar Sinan'ın eserleri ve hayatı daha detaylı incelenmelidir. Osmanlı Devleti'nin siyasi ve kültürel etkileri mimari sayesinde Osmanlı şehirlerinin oluşmasını sağlamıştır. Bu kapsamda Anadolu dışında Şam, Sofya ve Hersek gibi birçok şehirde mimarının gelişimini olumlu yönde etkilemiştir (Güneş, 2014). Mimar Sinan'ın, bahsedilen bu yerlerde bilinen bazı eserleri dışında tüm yapılarının incelenmesi zorluk teşkil etmekte ve birçok yapısı gerektiğince çalışılmamıştır. Bu yapılardan birisi de Bulgaristan' da yer alan ve kilise olarak işlevlendirilmiş Klasik Osmanlı mimarisi olduğu bilinen Uzuncaova Camii'dir. Bu kapsamda caminin incelenmesi ve Klasik Osmanlı mimarisi kapsamında değerlendirilmesi gerekliliği doğmuştur.

4. UZUNCAOVA CAMİİ

Uzuncaova Camii; Uspenie Bogorodichno adı ile bilinen, Bulgaristan'ın Haskovo belediyesine bağlı Uzundzhovo (Uzuncaova) köyünde bulunmaktadır. Kültür envanterinden edinilen bilgiye göre 16. yüzyılda Mimar Sinan tarafından yaptırıldığı bilinen caminin inşa tarihi için M.1593–1595 tarihlerine ulaşılmakta ancak bu bilgi kesin olmamakla beraber Mimar Sinan'ın bu tarihten önce vefat ettiği bilinmektedir. Uzuncaova Camii, Haskovo şehir merkezine yaklaşık 10 km uzaklıkta bulunan Uzundzhovo'da; bir medrese, iki han ve bir hamamdan oluşan külliye yapısının merkezi olarak yapılmıştır (Şekil 1). Cami genellikle Uzuncaova Camii olarak bilinmesinin yanı sıra Gavur Camii ve Sinan Paşa Camii olarak da anılmaktadır (Georgiev, 1970). Günümüz kullanımı müze ve Ortodoks kilisesi olup Bulgaristan'ın en büyük köy kilisesi olarak bilinmektedir (Kültür Envanteri, 2020).

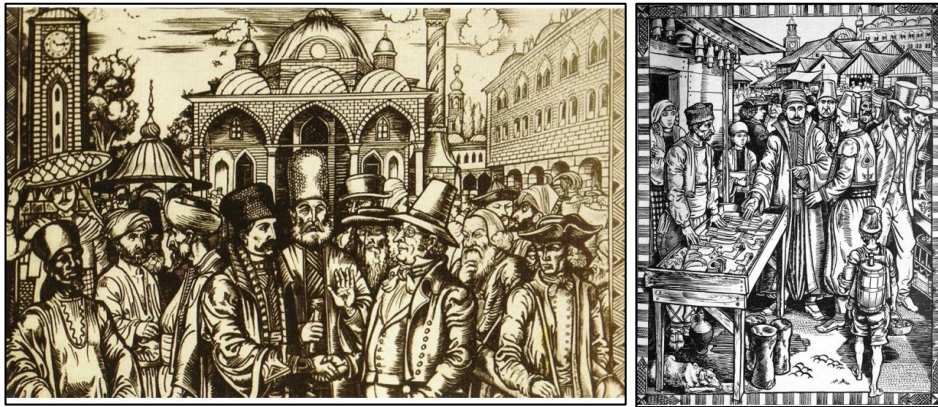
Uzundzhovo, Osmanlı İmparatorluğu döneminin en ünlü köylerinden olup Asya ve Avrupa'dan pek çok taciri bir araya getiren ünlü Uzundzhovsky fuarı burada düzenlenmiştir. Osmanlı işgali sırasında o zamanki Uzundzhovo köyü ve "Meryem Ana'nın Göğe Kabulü" kilisesi yıkılarak

yerine Sultan Bayezid'in emriyle bir han inşa edilmiş ve han çevresinde zamanla Uzundzha ova adı altında küçük bir Türk yerleşim yeri ortaya çıkmıştır.²



Şekil 1. Uzuncaova Panayırı ve Sinan Paşa Hanı (Güray (2009), H.M. Arşivinden)

Ünlü Osmanlı seyyahı Evliya Çelebi, 17. yüzyılın sonlarında Uzuncavo'yu ziyaret etmiştir. Evliya Çelebi, "Sonra Harmanlı kasabasını geçtik ve 5 saat sonra Chirmensky sancağı topraklarında geniş bir arazinin ortasındaki Uzundzha ova kasabasına ulaştık. Maktul İbrahim Paşa tarafından yaptırılan Tatar Pazarcık'ta benzeri ancak sarayda olabilecek büyük, kale gibi bir han vardır. Dayanıklılık açısından, bu dikkate değer bina belki de Pazarcık'takinden daha güçlüdür. İçeride ve dışarıda rahat, büyük bir ambarı olan 80 ocağı vardır- bu heybetli bir handır. Kasabada bir cami, birkaç küçük han, işlek bir çarşı, kale kapılarını andıran, tamamı mavimsi kurşunla kaplı iki demir kapısı vardır. Yaklaşık yüz gecekondü daha var ama su yok."³ Bahsedilen bu han yıkılmış ve günümüzde sadece giriş açıklıklarından biri bulunmaktadır.



Şekil 2. Uzuncaova Camii ve Saat Kulesini gösteren gravürler

1878'de Bulgaristan'ın kurtuluşuyla Müslüman nüfusun bölgeden ayrılması sonucunda cami terk edilmiştir. 1906 yılında Osmanlı Devleti'nin, Bulgaristan'a devretmesi üzerine

² https://tr.wikipedia.org/wiki/Uzuncaova_Kilisesi

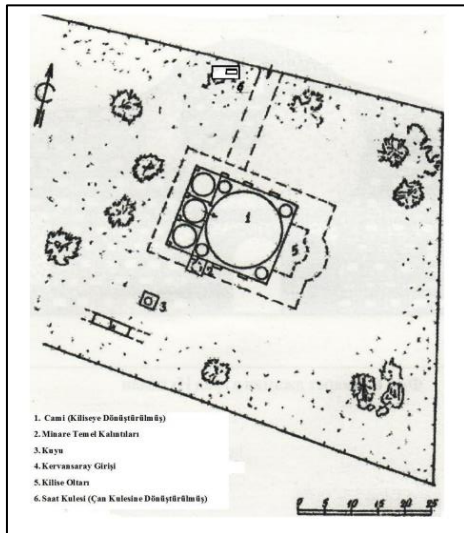
³ https://tr.wikipedia.org/wiki/Uzuncaova_Kilisesi

Usundzhovo halkı camiye yıkıp malzemelerini bir kilise yapımı için kullanmak istemelerine karşı yapının kilise olarak yeniden işlevlendirilmesine karar verilmiştir. 2007 yılında restore edilen kilise Plovdiv Metropoliti Nikolai tarafından yeniden kutsanmıştır. ⁴



Şekil 3. Uzuncaova Camii Doğusunda yer alan yazıt (Çeviri: Burada eski Bulgar kilisesi yerine yaklaşık 1593 yılında bir Türk Camisi inşa edildi)

Uzuncaova Camii, Uzundzhova ile Haskovo arasındaki yol kenarında yer alan geniş bir arazide bulunmaktadır. Yapının kuzey batısında saat kulesi, güney batısında bir kuyu ve kervansarayaya ait olduğu düşünülen duvar kalıntıları, batısında dikdörtgen planlı yeni bir dinlenme alanı ve tuvalet, kuzeyinde ise bir çeşme yapısı yer almaktadır (Şekil 4, Şekil 5) (Güray, 2009).

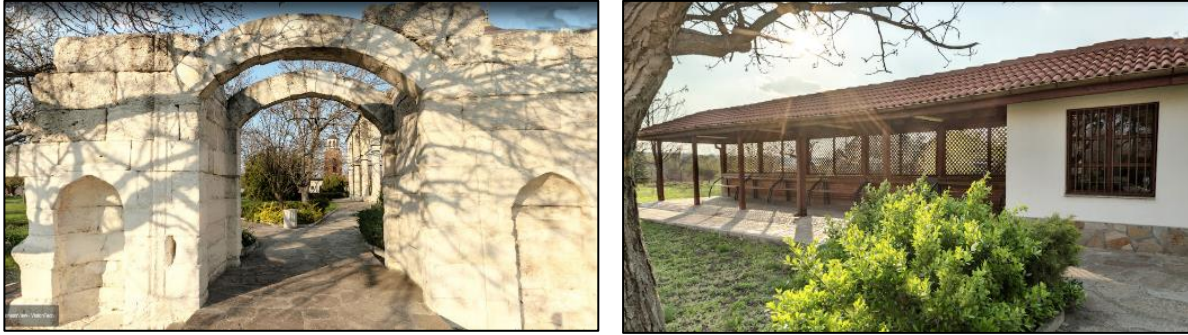


Şekil 4. Uzuncaova Camii Vaziyet Planı (soldaki) (Güray, 2009) ve Google Earth görünümü (sağdaki) (Google Earth, 2023)

Caminin Kuzeybatı tarafında yer alan saat kulesinin Uzuncaova Camii'nden daha sonra 18. yüzyıl sonu ile 19. yüzyıl başı arasında yapıldığı bilinmektedir. Vakfiyesinde yazılan tarihe

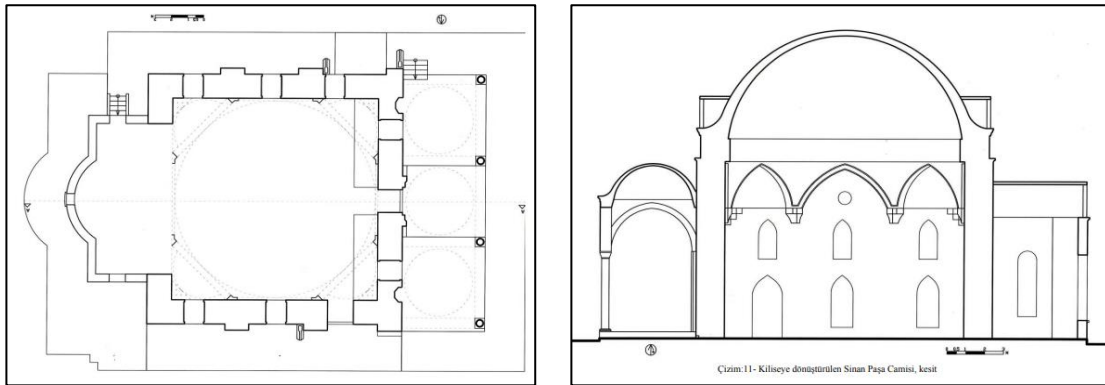
⁴ http://dariknews.bg/view_article.php?article_id=177758

göre H.1230/M.1814–15 tarihlerinde yapılmıştır. Günümüzde çan kulesi olarak işleyiş göstermektedir (Şekil 7) (Güray, 2007).



Şekil 5. Uzuncaova Camii Kervansaray Kapı Kalıntısı, Dinlenme Alanı ve WC (soldan sağa) (Google Earth, 2023)

Uzuncaova Camii kible yönü tespitinin yanlış yapılmış olmasından dolayı yapı girişi; üst örtüsü üç kubbeli, revaklı batı cephesinden verilmiştir (Güray, 2009). Batı yönünden verilmiş ve cami plan aksı bu sebeple doğu batı yönlü uzanmaktadır (Şekil 6). Bu durumu caminin daha önce var olan bir kilise kalıntısı üzerine inşa edilmesinin sonucu olarak göstermek mümkündür (Şekil 3).



Şekil 6. Uzuncaova Camii Plan ve Kesiti (soldan sağa) (Güray, 2009)

Cami dış cephesinde beyaz-gri küfeki kesme taş kullanılmıştır. Cami üst örtüsü kiliseye dönüştürüldükten sonra kurşun levha ile kaplanmıştır. Kubbenin ortasında yer alan lale formu alem kaldırılarak yerine haç yerleştirildiği bilinmektedir (Güray, 2009). Caminin güney cephesinde üç sıra pencere düzenlemesine gidilmiş olup en üstte yuvarlak bir göz pencere, ortada ve altta üçer tane olmak üzere toplam yedi pencere bulunmaktadır. Cephedeki bu hareketin sebebi kiblenin sembolik olarak bu cephede olduğunun gösterilmesi amaçlı olduğu düşünülmüştür. En üstteki yuvarlak planlı göz pencere, cephenin ortasında yer alırken, ikinci ve birinci sıradakiler alt alta gelecek şekilde yerleştirilmiştir. Yapının alt sıra pencereleri; düz lentolu, mermer söveli, demir parmaklıklı ve sivri kemerlidir (Şekil 7).

Yapının kuzey cephesinde iki sıra sivri kemerli pencere düzeni bulunmakta üstte üç, altta iki pencere olmak üzere beş pencere ile bir taç kapı yer almaktadır. Caminin taç kapısı; zikzak şekilli tepelik bölümü, sivri kemerli kavsarası, giriş açıklığının üzerindeki Osmanlıca yazıların olduğu üç adet kabartma taş ve süslemesiz dikdörtgen silmeleriyle çok sade bir yapıdadır. Cami harimi merkezi bir kubbe ile örtülmüş ve kubbe dört köşesinden mukarnaslı payandalarla desteklenmiştir. Caminin Kuzey cephesinden de bir kapısı olup bu kapının cami cephelerinden anlaşıldığı üzere kuzey cephesi alt sıradaki pencerelerden birinin genişletilmesiyle oluşturulduğuna ulaşılmıştır (Şekil 7).

Kiliseye dönüştürülmeden önceki özgün planını bilemediğimiz yapının doğu cephesine, dikdörtgen planlı bema yarım dairesel planlı bir apsis yerleştirilmiştir. Bu bölümün yıkılan minare ve doğu cephesi taşlarından yapıldığı düşünülmektedir. Yapının doğu cephesi arkaya doğru piramidal şekilde beş parçadan oluşmakta ve ortadaki parça oval formludur. Ortadaki parçanın üzerinde yuvarlak kemerli uzun tek kanatlı ahşap bir pencere yer alırken üst örtüsünün üzerinde yonca şeklinde haçvari bir pencere bulunmaktadır. Yapı cephelerindeki bütün alt sıra pencereler demir korkulukludur (Şekil 7).

Caminin batı cephesi yapılan hatalı kible tespiti sonucu giriş cephesi olarak tasarlanmıştır. Üç sivri kemerli revaklı düzende son cemaat yerinin bulunduğu bu cephede alt sırada iki pencere bir mukarnaslı ahşap kapı ile üst sırada yer alan iki sivri kemerli pencereden oluşmaktadır. Bu pencerelerin yanı sıra batı cephesinde sağ ve solda iki adet mihrabiye yer almaktadır (Şekil 7) (Tablo 2).



Şekil 7. Uzuncaova Camii Görünüşleri (Google Earth üzerinden alınmıştır)

Uzuncaova Camii'nin, mihrap, minber ve minaresi günümüze ulaşamamıştır. Cami günümüzdeki haliyle tek kubbeli-kare baldakenli, sade cephe düzenine sahip, iç ve dış formu benzerdir. Cami girişinde üç kubbe ile örtülmüş revaklı bir son cemaat yeri bulunmaktadır. Yapının içine girildiğinde doğu cephesi iç duvarında pek çok ikonanın yerleştirildiği ahşap bir paravan, güney cephesi iç duvar önünde taht yapısı yer almaktadır (Şekil 8). Yapının üst örtüsü dışarıdan sekizgen bir kasnağa oturan kubbe olup yaklaşık 10-15 cm genişliğinde saçak bulunmaktadır. Cami kiliseye dönüştürüldükten sonra üst örtüde kısmi değişiklikler yapılmış ve haçvari bir sistemde beşik tonozlar eklenmiştir (Güray, 2009).



Şekil 8. Uzuncaova Camii Kuzey, Doğu ve Güney İç Mekân Görünüşleri (Soldan sağa)

Yapının özgün iç mekân görünümü yitirilmiştir. Harimin üzerindeki kubbeye Hz. İsa ile etrafında melekler tasvir edilmiştir. Kubbedeki palmetlere⁵ bakıldığında kırmızı bir kontür görülmekte ve bunun süslemelerin altında olduğu düşünülmektedir.

5. DEĞERLENDİRME VE SONUÇ

Uzuncaova Camii Klasik Osmanlı mimarisinde önemli bir yere sahip olan Mimar Sinan imzalı bir eser olup günümüzde kilise-müze olarak kullanılmaktadır. Yapı uzun yıllar cami işlevindeyken bölge halkının yapıyı yıkıp yerine kilise inşa etmesini istemesi üzerine yetkililerce yapının yeniden işlevlendirilmesine karar verilmiştir. Cami, Bulgaristan'ın Haskovo beldesinde yer alan Uzuncaova köyünde bulunmaktadır.

Uzuncaova Camii yapılan çalışmalarda Gavur Camii, Sinan Paşa Camii, Uzuncaova Camii gibi farklı pek çok isimle anılmış ve bu durum literatürde anlaşmazlık- bilgi karmaşasına yol açmıştır. Uzuncaova Camii, Klasik Osmanlı mimarisinin pek çok yönünü yansıtmaya değerli bir eserdir.

Caminin üst örtüsü cami kiliseye çevrildikten sonra değiştirilerek haçvari bir analogi çalışması yapılmıştır. Özgün planına ulaşamayan yapı günümüzdeki haliyle tek kubbeli, kare baldakenli harimi, üç kubbeli son cemaat yeri, sade cephe düzeni, iç ve dış bütünlüğünün bulunması gibi

⁵ Bitkisel Motif (Bkz TDK)

özellikleriyle Erken dönem ve Klasik Osmanlı mimarisinin ortak bir örneği niteliğindedir. Caminin merkezi kubbe ve destekler yardımıyla geniş mekân kurgusuna sahip olması ve dış duvarlarına açılmış çok sayıda alt üst sıralı pencere, Klasik Osmanlı mimarisini yansıtmaktadır. Kubbeyi taşıyan mukarnaslı payandalar da yine Klasik Osmanlı mimarisinin etkisini göstermektedir (Tablo 2). Klasik Osmanlı mimari üslubunu gösteren diğer özellikler de caminin ana girişinde yer alan revak, taç kapı ve pencerelerdeki sivri kemer yapı elemanlarıdır.

Yapının pencerelerinde Klasik Osmanlı mimarisinde sıklıkla karşılaşılan vitray süslemeler günümüzde görülmemekle birlikte yapının orijinal camlarında vitrayların bulunduğu dair de herhangi bir bilgiye ulaşılamamaktadır. Yapı üzerinde yer alan sonradan kaplanmış palmetlerin altlarındaki kırmızı renkli izlerin Klasik Dönemde baş gösteren kırmızı renkli mercan çinilerinden kaynaklı olabileceği düşünülmektedir (Tablo 2, Tablo 3).

Tablo 2. Uzuncaova Camii Kapı- Pencere Tipleri (fotoğraflar Google Earth üzerinden alınmıştır)

Kapı Tipleri



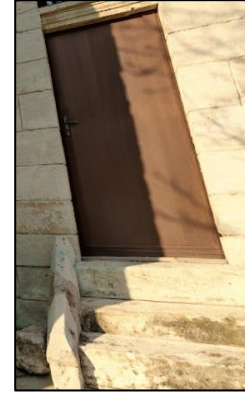
Taç Kapı Girişi



Taç Kapı İç Görünüşü



Sonradan Eklenen Kuzey Kapısı

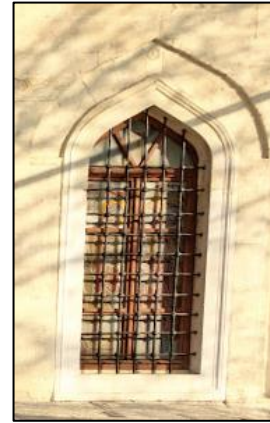


Sonradan Eklenen Apsis Giriş Kapısı

Pencere Tipleri



Sivri Kemerli Kuzey Üst Sıra Penceresi



Sivri Kemerli Kuzey Alt Sıra Penceresi (Parmaklıklı)



Sivri Kemerli Güney Alt Sıra İç Mekân Penceresi



Yuvarlak Kemerli Apsis Penceresi



Sonradan Eklenen Haçvari Apsis Penceresi



Yuvarlak Kemerli Apsis Kuzey Penceresi



Yuvarlak Form (oval) Güney Çatı Penceresi

Tablo 3. Uzuncaova Camii Mihrabiye Tipleri ve Süslemeler (fotoğraflar Google Earth üzerinden alınmıştır)

Mihrabiye Tipleri



Taç Kapı Sol Mihrabiye



Taç Kapı Sağ Mihrabiye



Kervansaray
Kalıntısı
Mihrabiyesi



Giriş
Sol
Kervansaray
Kalıntısı
Mihrabiyesi
Giriş
Sağ

Süslemeler



Kilise Kubbe Freski



Mukarnas ve üzerindeki
fresk



Batı Cephesi Sütun Alt
İşlemeleri



Batı Cephesi Sütun
Başlığı

Uzuncaova Camii'nin inşa tarihi bakımından net bir bilgi bilinmemekte olup bilim adamları tarafından çoğunlukla Mimar Sinan olmak üzere başka mimarlarla da anılmıştır. Ancak Mimar Sinan ile Koca Sinan Paşa'nın ismen karıştırılması üzerine yapının, "Koca" mahlasına da sahip olduğu bilinen Mimar Sinan' a atfedildiği düşünülmektedir. Bu kapsamda detaylı bir tarih araştırması ve zaman çizelgeleri ile yapı detaylı olarak ele alınmalıdır. Caminin Mimar Sinan yapısı olduğunun kanıtlanması durumunda Mimar Sinan'ın diğer yapılarıyla karşılaştırmalı çalışmalar yaparak caminin yapım süreci ve özgün durumu ile ilgili veri toplanmalıdır.

Çalışmada yapının orijinal çizimlerine ulaşamamış olup özgün durumu bilinmemektedir. Dolayısıyla Klasik Osmanlı mimarisine dair taşıdığı izlerin çoğunlukla silindiği düşünülmektedir. Bu kapsamda ileride yapılacak araştırmalarda Bulgaristan yerel kaynakları ve bölge halkından edinilen fotoğraflar ele alınarak yapının kilise olmadan önceki halinin incelenmesi elzemdir.

KAYNAKÇA

- ASLANAPA, Oktay, Osmanlı Devri Mimarisi, İstanbul, 1986.
- ANTONOV, A., “XVI. Yüzyılda Bulgaristan Topraklarında Orta Kol Üzerindeki Menzil Külliyesi”, Osmanlı Ansiklopedisi (Ankara: Yeni Türkiye Yayınları, 1999), 10: 510-513.
- AYVERDİ, E.H., (1982): Avrupa’da Osmanlı Mimari Eserleri, Bulgaristan, Yunanistan, Arnavutluk, C. IV, Kitab: 4–6, İstanbul Fetih Cemiyeti, İstanbul.
- BAYRAM, S., “Yemen Fatihı Gazi Sinan Paşa’nın Vakfiyeleri, Tezyinatı ve Türk Süsleme Sanatındaki Yeri”, Milletlerarası X. Türk Sanatları, 17-23 Eylül 1995 (Cenevre, 1999), 163.
- BOGDANOV, İ., (1965): Uzundjovo, Baştino Ognışte, İzdatelstvo na Natsionalniya Sivet na Oteçestveniya Front, Sofya.
- DOBREV, İ. (1989): Uzundjovskiyat Panair, Sofya: BZNS.
- ERASLAN, A. “Mimar Sinan’ın Şehirciliği Üzerine Panoramik Bir Analiz”, Toplumsal Tarih, S:213(Eylül 2011), s.86-92.
- GEORGIËVA, J.,ALACOV, D.,BAEVA, Z. ve KOLEVA, M. (1970): Pametnitsi na Kulturata v Haskovski Okrıg, İstoriçeski Muzey-Haskovo, Sofya: Reklamator.
- GÜNEŞ, G. A. (2014). Hassa Mimarlar Ocağı ve Mimar Sinan, Tarih Okulu Dergisi, 2014 (XVII) - . DOI: 10.14225/Joh423.
- GÜRAY, B. (2009). Bulgaristan-Haskovo (Hasköy) ve Çevresindeki Osmanlı Yapıları, Sosyal Bilimler Enstitüsü, S.55-62.
- KUBAN, D., “Sinan”, Osmanlı, X, s.191
- KURAN, A. (1986). Mimar Sinan, İstanbul.
- MÜLAYİM, S., “Osmanlı Mimarisinden Bir Kesit”, Osmanlı, X, s.90- 117.
- ÖGEL, Semra,“Osmanlı Devrinde Türk Külliyesi” Türk Kültürü, S. 11, İstanbul, 1963, s. 37-41.
- ŞEŞEN, R., “Mimar Sinan ile İlgili Yazmalar”, Mimar Sinan Dönemi Türk Mimarlığı ve Sanatı (Haz. Zeki Sönmez), Türkiye İş Bankası Kültür Yayınları, İstanbul 1988, s. 269-270. Yazmalar hakkında derlenen bilgiler Şeşen’in eserinden alınmıştır.
- ULUÇAM, Abdüsselam, “Klasik Dönem Osmanlı Mimarisi”, Osmanlı, 10, Ankara, 1999, s.163-184
- YAZICI, N., “Osmanlı Mimarlığında XVI. Yüzyılın Önemli Bir Banisi: Yemen Fatihı Gazi Sinan Paşa ve Camileri”, Uluslararası Sosyal Araştırmalar Dergisi 4/17 (2011): 439.
- “Uzuncaova Kilisesi, Camii”, Kültür Envanteri, <https://kulturenvanteri.com/yer/?p=46963>. (Erişim Tarihi: 6 Temmuz 2023).

GÖRÜNTÜ SINIFLANDIRMADA ÖZELLİK ÇIKARICI OLARAK EVRİŞİMSEL SİNİR AĞI KULLANIMI

Memduh KÖSE

Kırşehir Ahi Evran University, Faculty of Engineering and Architecture, Department of Electrical and Electronics Engineering, Bağbaşı Campus

ORCID ID: 0000-0002-4935-4542

ÖZET

Bu makalede, bir görüntü sınıflandırıcısını eğitmek için önceden eğitilmiş bir Evrişimli Sinir Ağı (ESA) özellik çıkarıcı olarak kullanılmıştır. ESA çeşitli görüntülerden oluşan büyük ölçekli veri setleri kullanılarak eğitilir ve veri setlerinden görüntüler için zengin özellik çıkarımını doğrudan veri setinden öğrenebilir. Bu özellikler genellikle HOG (Yönlendirilmiş Gradyanların Histogramları), LBP (Yerel İkili Model) veya SURF (Hızlandırılmış Sağlam Özellikler) gibi tanımlayıcı kullanılarak çıkarılan özelliklerden daha iyi performans göstermektedir. Bu makalede, 10 farklı kişiden web kamerasından alınan görüntüler ile ESA Matlab ortamında eğitilmiş ve bu veriler Resnet50 önceden eğitilmiş ağ modeli kullanılarak sınıflandırılmıştır. Kullanılan ağ modeli %94 oranında yüksek doğrulukta sınıflandırma başarısına ulaşmaktadır.

Anahtar Kelimeler: Evrişimsel Sinir Ağı, Resnet50, Öznitelik Çıkarma, Veri Seti

USE OF CONVOLUTIONARY NEURAL NETWORK AS FEATURE EXTRACTOR IN IMAGE CLASSIFICATION

ABSTRACT

In this article, a pre-trained Convolutional Neural Network (CNN) is used as feature extractor to train an image classifier. CNN is trained using large-scale datasets consisting of various images and can learn rich feature extraction for images directly from the dataset. These features generally outperform features extracted using descriptors such as HOG (Histograms of Oriented Gradients), LBP (Local Binary Model) or SURF (Accelerated Robust Features). In this article, CNNs were trained in the Matlab environment with webcam images from 10 different people, and these data were classified using the Resnet50 pre-trained network model. The used network model achieves a high accuracy classification success of 94%.

Keywords: Convolutional Neural Network, Resnet50, Feature Extraction, Data Set

EĞİTİLMİŞ BİR EVRİŞİMSEL SİNİR AĞININ TAVUK ETİ SINIFLANDIRILMASINDA KULLANILMASI

Mustafa Ali Hussein HUSSEIN

Kırşehir Ahi Evran University, Faculty of Engineering and Architecture, Department of Electrical and Electronics Engineering, Bağbaşı Campus

ORCID ID: 0009-0006-5472-2852

Memduh KÖSE

Kırşehir Ahi Evran University, Faculty of Engineering and Architecture, Department of Electrical and Electronics Engineering, Bağbaşı Campus

ORCID ID: 0000-0002-4935-4542

Emre YAVUZER

Niğde Ömer Halis Demir University, Faculty of Engineering, Department of Food Engineering,

ORCID ID: 0000-0002-9192-713X

İbrahim ŞANLIALP

Kırşehir Ahi Evran University, Faculty of Engineering and Architecture, Department of Computer Engineering, Bağbaşı Campus

ORCID ID: 0000-0002-6324-231X

ÖZET

Bu çalışmada, tavuk eti önceden eğitilmiş bir Evrişimli Sinir Ağı (ESA) kullanılarak sınıflandırılmaktadır. ESA, bir cep telefonu kamerası kullanılarak elde edilen beş farklı tavuk eti (göğüs, kanat, bagnet, bacak, but) görüntülerinden oluşan geniş ölçekli bir veri seti ile eğitilir. Özellikler görüntü veri setinden öğrenilir ve daha sonra bu görüntüler CNN kullanılarak sınıflandırılır. Bu büyük ölçekli görüntü veri seti kullanılarak doğrudan elde edilen özellikler, tanımlayıcılar kullanılarak elde edilen özelliklerden daha iyi performans göstermektedir. Kullanılan ağ %98,6 oranında yüksek doğrulukta sınıflandırma başarısına ulaşmaktadır.

Anahtar Kelimeler: Tavuk Eti, Evrişimsel Sinir Ağı, Öznitelik Çıkarma

USING A PRE-TRAINED CONVOLUTIONAL NEURAL NETWORK IN CHICKEN MEAT CLASSIFICATION

ABSTRACT

In this study, chicken meat is classified using a pre-trained Convolutional Neural Network (CNN). CNN is trained with a large-scale dataset consisting of five different chicken meat (i.e., breast, wing, drumstick, leg, thigh) images obtained using a mobile phone camera. Features are learned from the image dataset and then these images classified by using CNN. The features extracted directly obtained using this large-scale image dataset perform better than the features obtained using descriptors. The used network achieves a high accuracy classification success of 98.6%.

Keywords: Chicken Meat, Convolutional Neural Network, Feature Extraction

EPOKSİ/KİL NANOKOMPOZİTLERİN MEKANİK VE TERMAL PERFORMANSI: Na-AKTİF BENTONİT KİL İÇERİĞİNİN ETKİSİ

Emine Feyza ŞÜKÜR

Samsun University, Faculty of Engineering, Department of Mechanical Engineering, Ballica Campus
ORCID ID: 0000-0003-2644-880X

ÖZET

Killer, yüksek en-boy oranları, mekanik özellikleri, geri dönüştürülebilirlikleri, şeffaflıkları, aleve dayanıklılıkları ve düşük maliyetleri nedeniyle polimerler için mükemmel nano takviyeler olarak kabul edilmektedir. Çok sayıda çalışma epoksi-kil nanokompozitlerinin farklı özelliklerini araştırmış olsa da, farklı kil bazlı nanokompozitlerde katkı oranı, yapı ve özellikler arasındaki korelasyonu anlamak için önemli araştırmalar yapılması gerekmektedir. Bu çalışmanın temel amacı, farklı katkı oranlarına sahip Na ile aktive edilmiş bentonit kilinin (EBNT SA) termogravimetrik analiz (TGA), çekme ve eğilme testleri yoluyla epoksi-kil nanokompozitlerinin termal ve mekanik performansı üzerindeki etkisini değerlendirmektir. Çekme hasarlı numunelerin yüzeylerini incelemek için taramalı elektron mikroskobu (SEM) kullanılmıştır. Nanokil içeren çok ölçekli kompozitler, ağırlıkça %1, 2 ve 3 EBNT SA ilavesiyle döküm yöntemi kullanılarak üretilmiştir. Sonuçlar, EBNT SA-epoksi nanokompozitlerin çekme ve eğilme mukavemetinin tüm katkı oranları için arttığını ve en iyi performansın ağırlıkça %2 EBNT SA'da elde edildiğini göstermiştir. Mekanik performansa ek olarak, EBNT SA takviyeli epoksi nanokompozitler, saf epoksiye kıyasla gelişmiş termal stabilite göstermiştir. EBNT SA-epoksi nanokompozitlerin gelişmiş mekanik performansı epoksi ve EBNT SA nanopartikülleri arasındaki güçlü yapışma ile elde edilirken, gelişmiş termal stabilite bentonit kilinin yüksek sıcaklığa dayanıklı alüminosilikat yapısının bir sonucudur.

Anahtar Kelimeler: Epoksi, kil, Na ile aktive edilmiş bentonit, nanokompozit

MECHANICAL and THERMAL PERFORMANCE of EPOXY/CLAY NANOCOMPOSITES: EFFECT of Na-ACTIVATED BENTONITE CLAY CONTENT

ABSTRACT

Clays are highly regarded as excellent nano-reinforcements for polymers due to their high aspect ratio, mechanical properties, recyclability, transparency, flame resistance, and low cost. While numerous studies have investigated the different properties of epoxy-clay nanocomposites, considerable research needs to be conducted to understand the correlation between additive ratio, structure, and properties in different clay-based nanocomposites. The main objective of this study was to assess the effect of Na-activated bentonite clay (EBNT SA) with different additive ratios on the thermal and mechanical performance of epoxy/clay

nanocomposites through thermogravimetric analysis (TGA), tensile, and flexural tests. Scanning electron microscopy (SEM) was used to examine the surfaces of the tensile-damaged samples. Nanoclay-containing multiscale composites were produced by using casting method with the addition of 1, 2, and 3 wt% EBNT SA. The results indicated that the tensile and flexural strength of the EBNT SA-epoxy nanocomposites were enhanced for all additive ratios, with the best performance achieved at 2 wt% EBNT SA. In addition to the mechanical performance, the EBNT SA-reinforced epoxy nanocomposites showed improved thermal stability compared to neat epoxy. The enhanced mechanical performance of the EBNT SA-epoxy nanocomposites was attained by the strong adhesion between the epoxy and the EBNT SA nanoparticles, while the improved thermal stability was a result of the high temperature-resistant aluminosilicate structure of the bentonite clay.

Keywords: Epoxy, clay, Na-activated bentonite, nanocomposite

1. INTRODUCTION

In the last few years, there has been a significant increase in the use of polymer composites in automotive, aerospace, and marine applications. Polymer composite materials possess superior thermal and mechanical properties due to their components, making them the most remarkable structural materials (Jassim et al., 2017). They exhibit specific strength, hardness, high-temperature resistance, and other unique properties unmatched by any other known materials. Epoxy resin is the most commonly used polymer among thermoset resins due to its good chemical and water resistance, high stiffness, high adhesive strength, and excellent heat and electrical resistance properties (Sand Chee and Jawaid, 2019). Despite the advanced functionality, varying service conditions in different application areas may require structural modifications to enhance performance of epoxy. The incorporation of nanometer-sized organic or inorganic fillers with varying surface morphology and properties can alter the thermal, mechanical, barrier, electrical and optical properties of the epoxy (Dzuhri et al., 2015). Fillers in nanocomposites can consist of nanoscale particles, sheets or fibres, including layered minerals such as clay; two-dimensional materials such as carbon nanotubes, nanowires, nanofibres and cellulose whiskers; and three-dimensional materials such as bundles of nanowires and nanotubes and multi-nanolayers (Beryl and Xavier, 2023). Among these fillers, the ease of processing, environmental availability, well-developed chemistry and low cost of nanoclays have made them superior to many nanoparticles (Kini et al., 2023). Bentonite is a naturally occurring clay extracted from volcanic deposits. They hold a distinctive place among clay-based resources owing to the exceptional qualities of their main mineral component, smectites (García-Romero et al., 2019; Perez et al., 2022). Smectite type clays are composed of

layers which consist of tetrahedrally coordinated Si atoms fused into an edge-shared octahedral plane comprising of $\text{Al}(\text{OH})_3$ or $\text{Mg}(\text{OH})_2$ (Gao, 2004). The impacts of bentonite clay on the modification of polymer matrices have been reported in several studies. The review of literature indicates that bentonite enhances the tensile strength and modulus, imparts heat resistance, reduces gas permeability and flammability, and improves biodegradability of biodegradable polymers. These improved properties are attributed to the strong interfacial interaction between nanofillers and the polymer (Mapossa et al., 2023). Raju et al., investigated the effect of different concentrations of bentonite clay nano particles (2.5-10 wt%) by shear mixing followed by ultra-sonication process on mechanical performance of epoxy composites. The study indicated that the inclusion of clay nanoparticles significantly enhanced the compressive and tensile strength of pure epoxy. As the concentration of clay increased in the epoxy matrix, the moduli values also increased (Mahadeva Raju et al., 2018). Ollier et al., examined the effect of chemical modifications of bentonite on the water absorption, thermal degradation, mechanical and dynamic-mechanical properties of unsaturated polyester/bentonite nanocomposites. They reported that modifying clay with quaternary ammonium and phosphonium salts appears to be a suitable method for enhancing the thermal, mechanical, and dynamic-mechanical characteristics of the UP matrix, while also maintaining its barrier properties, as measured by water absorption (Ollier et al., 2013). Further research is required regarding the influence of distinct variations and quantities of bentonite clays on the efficacy of polymer composites due to the scarcity of literature in this area.

The primary aim of the study was to examine the influence of Na-activated bentonite clay content on the ultimate performance of epoxy/bentonite nanocomposites. The investigation focused on the mechanical performance and thermal degradation of the nanocomposites at various levels of bentonite clay content.

2. MATERIAL and METHOD

2.1. Material

The epoxy (MGS-L160) resin used as matrix material and its hardener (MGS-M160) were purchased from Dost Kimya Industrial Raw Materials Co., İstanbul, Türkiye. Dry-ground sodium (Na) activated bentonite (EBNT SA) was commercially supplied from Esan Eczacıbaşı Industrial Raw Materials Co., İstanbul, Türkiye (Figure 2.1).



Figure 2.1. Different form of Bentonite clay, a) rock, b) powder, c) nano particle (Esan)

2.2. Preparation of EBNT SA Reinforced Epoxy Nanocomposites

The mould casting method was used for the preparation of the epoxy nanocomposites doped with EBNT SA and the procedure used in our previous studies was followed (Sukur et al., 2020). Firstly, the quantity of epoxy resin required was determined, and an amount of EBNT SA corresponding to 1, 2, and 3 wt% of the epoxy was weighed. In order to have a uniform dispersion of the EBNT SA particles evenly in the epoxy resin, a tipped sonicator was used. EBNT SA nanoparticles were homogeneously dispersed in acetone by tip sonication at a sonic frequency of 20 kHz for 15 min. The acetone/EBNT SA mixture was subsequently introduced into the EPhR and sonicated for 20 minutes. The removal of acetone from the EBNT SA-epoxy mixture was achieved by degassing the mixture in a vacuum oven at 70°C for 24 hours. Finally, the mixture was poured into the moulds designed for the tensile and the flexural tests. Following the molding process, the composite samples underwent curing at 70 °C for 24 hours, followed by post-curing at 80 °C for 15 hours.

2.3. Test and Analysis

The produced bentonite/epoxy polymer nanocomposites were exposed to tensile and flexural testing, according to ASTM standards. The optimum nanoparticle ratio was then determined. The tests were conducted at ambient temperature with an Instron 5982 model testing machine, having a loading capacity of 100 kN, and assessed the tensile properties with respect to ASTM D638 width and using a crosshead speed of 2 mm/min. The procedures in line with ASTM-D790 were followed during the three-point flexural tests. A 36:1 span to thickness ratio was used for specimen specification and specimen thickness was kept constant at 4mm, with tests conducted at a crosshead speed of 5 mm/min. The fractured surface morphology through tensile testing of both pure epoxy and bentonite/epoxy nanocomposites was examined using a scanning electron microscope (JSM-7001 F analytical field-emission SEM, Japan). Thermogravimetric

analysis (TGA) was conducted utilizing a thermogravimetry-differential thermal analyzer (Mettler Toledo) inside a nitrogen atmosphere devoid of moisture. The heating rate was set to 10 °C/minute within the temperature range of 25 to 800 °C.

3. RESULTS and DISCUSSION

3.1. Mechanical Characterization

Tensile stress-strain curves, tensile strength, and strain values for both pure epoxy and epoxy nanocomposites doped with 1, 2, and 3 wt% EBNT SA are given in Figure 3.1. The graphs show that the tensile stress and strain values of the epoxy nanocomposites that have been modified with EBNT SA have increased at all the additive ratios. Whilst the tensile strength of pure epoxy was 64 MPa, the tensile strength values of nanocomposites doped with 1, 2, and 3 wt% EBNT SA were found to be 75 MPa, 84 MPa, and 70 MPa respectively. An increase of 17%, 31%, and 9% was observed in the tensile strength of EBNT SA/epoxy nanocomposites in comparison to epoxy. Similarly, strain values increased at all additive levels, with 1.5, 1.7 and 1.25-fold increases at filler ratios of 1, 2 and 3 wt%, respectively. The rise in strain values indicates that the EBNT SA nanoparticles lessens the brittleness of epoxy and provides the matrix with a more ductile composition. The progression of fracture surfaces from brittle to ductile-brittle and ductile lends support to this conclusion (Figure 3.3). Upon examination of the flexural test results depicted in Figure 3.2, it becomes clear that the EBNT additive enhances the flexural properties of pure epoxy. It is noted that the maximum load (259 N) and flexural stress (158 MPa) values are attained at a 2% additive ratio. The enhanced mechanical proficiency of EBNT SA-epoxy nanocomposites was attributed to the robust bonding between the epoxy and EBNT SA nanoparticles. However, the reduction in doping rate from 2% to 3% was linked to the propensity of nanoparticles to aggregate (Wang et al., 2021).

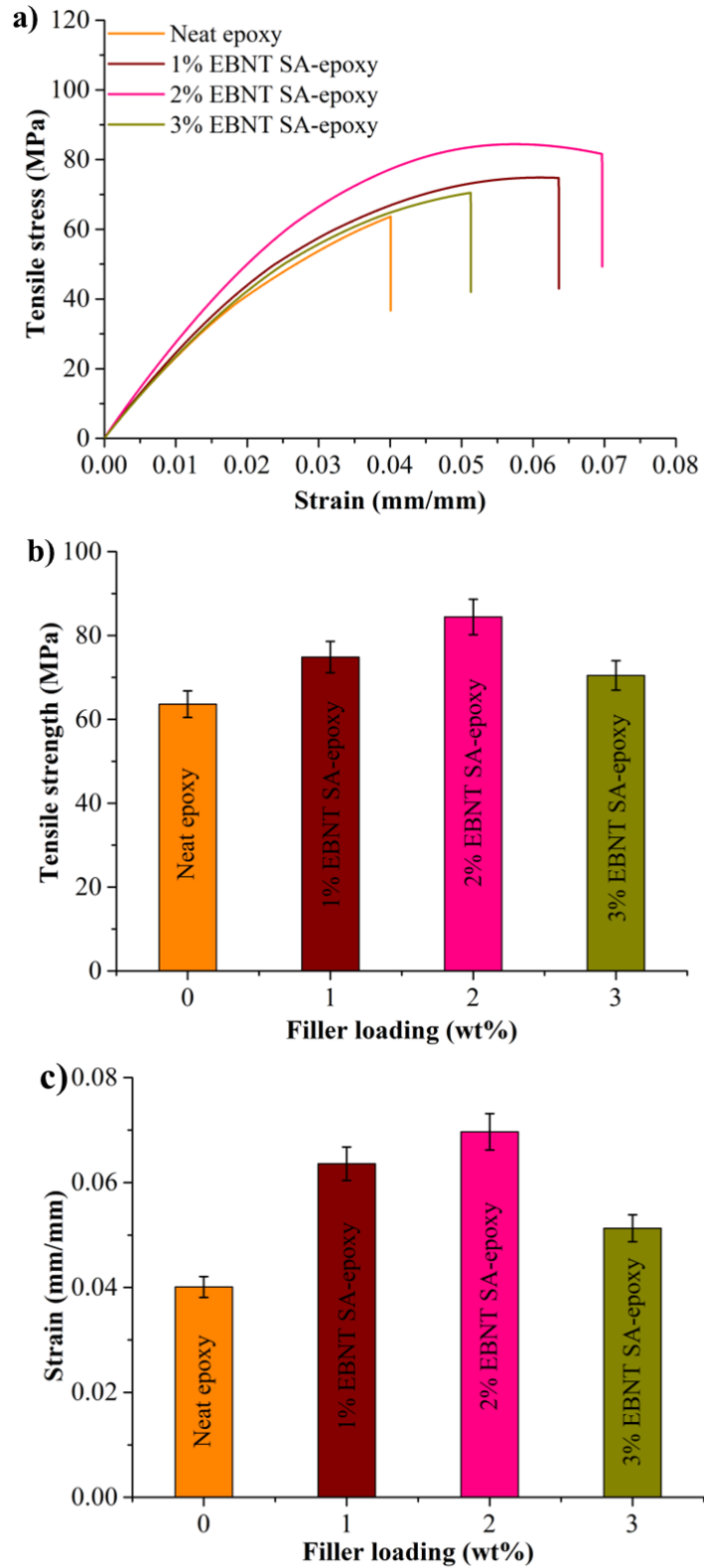


Figure 3.1. a) Tensile stress-strain curves, b) tensile strength, and c) strain values of neat epoxy and EBNT SA-epoxy nanocomposites

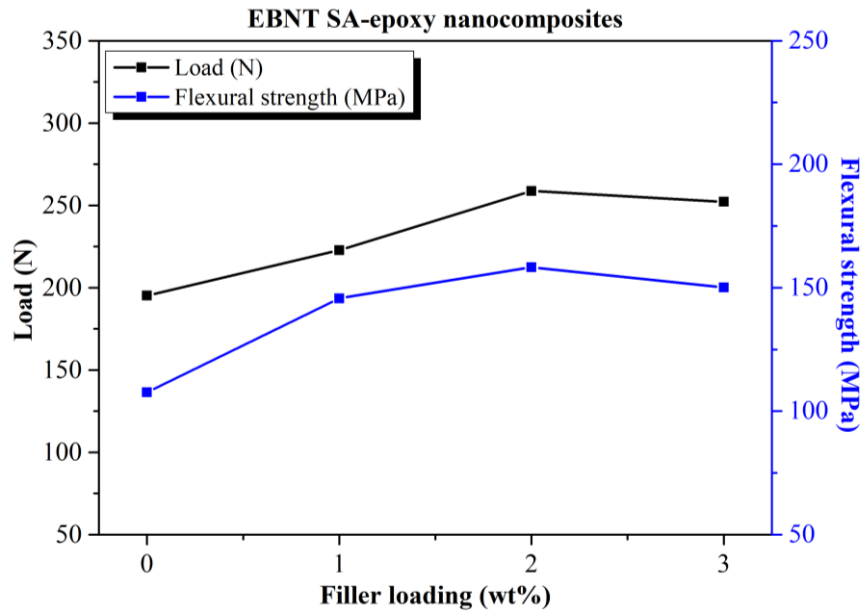


Figure 3.2. Flexural test results of neat epoxy and EBNT SA-epoxy nanocomposites

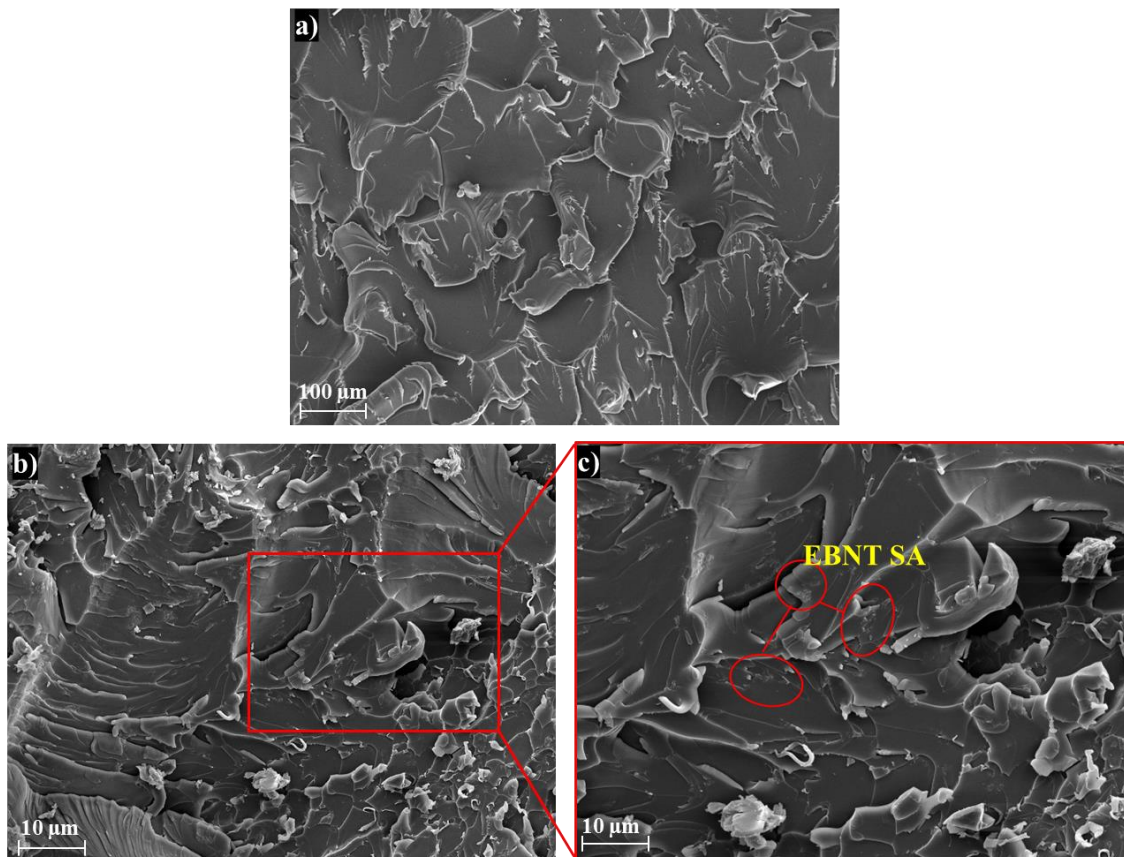


Figure 3.3. SEM images of tensile fractured surfaces of neat epoxy and EBNT SA-epoxy nanocomposites

3.2. Thermal Characterization

The TGA curves for both neat epoxy and 2 wt% EBNT SA-epoxy nanocomposite can be seen in Figure 3.4. The temperatures T_5 and T_{50} , at which a 5% and 50% degradation of the material occurs, along with the residual weight percentage of charred residue at 800°C, are given in Table 1. The residual weight percentage of the neat epoxy and 2 wt% EBNT SA-epoxy nanocomposite at 800 °C was 3.37%, and 3.53%, respectively. Upon analyzing the TGA results, it was observed that the composite containing 2% bentonite clay nanoparticles demonstrated an increase in T_5 and T_{50} temperatures, with the T_5 temperature of EBNT SA-epoxy nanocomposite exhibiting a 22% increase compared to neat epoxy. The improved thermal stability achieved with EBNT SA nanoclay can be attributed to the aluminosilicate structure of bentonite clay, which is highly resistant to high temperatures (Wang et al., 2021). However, bentonite clay surfaces can neutralize free radicals generated during epoxy heating (Khandelwal et al., 2023). This mechanism is considerably enhances the thermal stability of composite.

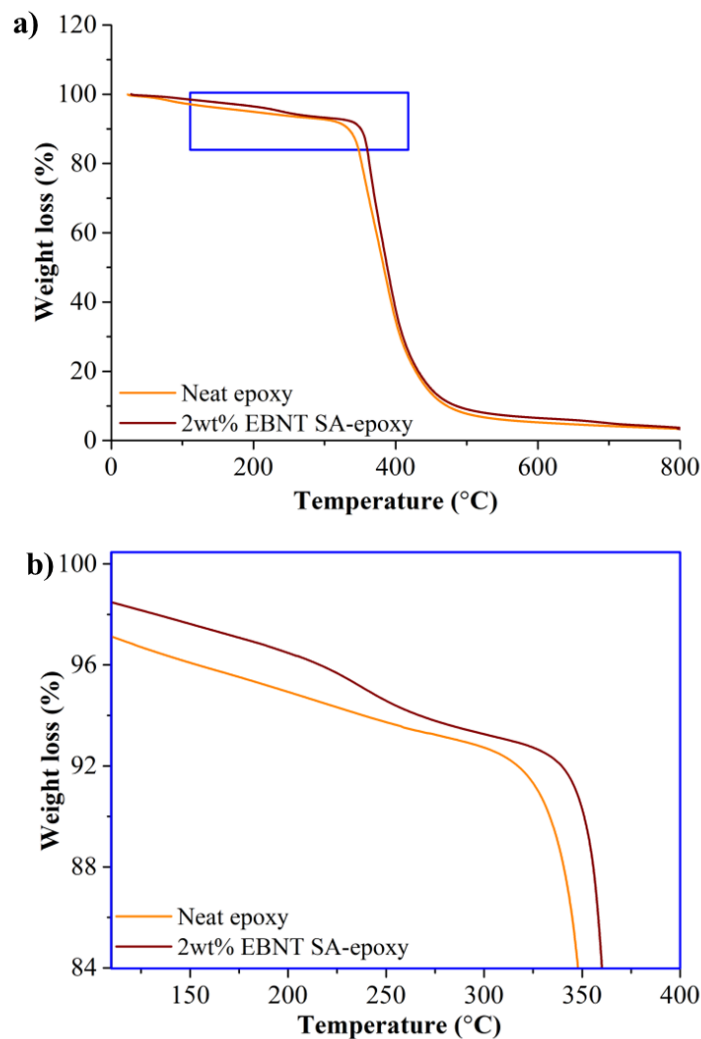


Figure 3.4. TGA curves of neat epoxy and 2wt% EBNT SA-epoxy nanocomposite

Table 3.1. Thermal stability data of neat epoxy and 2wt% EBNT SA-epoxy nanocomposite

Samples	T ₅ (°C)	T ₅₀ (°C)	Residue, % (at 800 °C)
Neat epoxy	197.1	382.4	3.37
2 wt% EBNT SA-epoxy nanocomposite	240.3	387.3	3.53

4. CONCLUSION

In this study the effect of Na-activated bentonite clay (EBNT SA) with different additive ratios on the thermal and mechanical performance of epoxy/clay nanocomposites was investigated through thermogravimetric analysis (TGA), tensile, and flexural tests. The significant results acquired from the test and analyses are listed as items below.

- Modifying the epoxy matrix with Na-activated bentonite clay nanoparticles yielded enhanced tensile and flexural performance at all ratios of the additive.
- Nanocomposites reinforced with 2 wt% EBNT SA demonstrated superior performance with a respective 31% and 32% increase in tensile and flexural strengths.
- The addition of EBNT SA has had a positive impact on the thermal stability of pure epoxy.

5. REFERENCES

- Beryl JR and Xavier JR (2023) Halloysite for clay–polymer nanocomposites: effects of nanofillers on the anti-corrosion, mechanical, microstructure, and flame-retardant properties—a review. *Journal of Materials Science* 58(27): 10943–10974. DOI: 10.1007/s10853-023-08710-1.
- Dzuhri S, Yuhana NY and Khairulazfar M (2015) Thermal Stability and Decomposition Study of Epoxy/Clay Nanocomposites. *Sains Malaysiana* 44(3): 441–448. DOI: 10.17576/jsm-2015-4403-16.
- Gao F (2004) Clay/polymer composites: the story. *Materials Today* 7(11): 50–55. DOI: 10.1016/S1369-7021(04)00509-7.
- García-Romero E, María Manchado E, Suárez M, et al. (2019) Spanish Bentonites: A Review and New Data on Their Geology, Mineralogy, and Crystal Chemistry. *Minerals* 9(11): 696. DOI: 10.3390/min9110696.
- Jassim KA, Thejeel MA-N, Salman EM-T, et al. (2017) Study characteristics of (epoxy–bentonite doped) composite materials. *Energy Procedia* 119: 670–679. DOI: 10.1016/j.egypro.2017.07.094.
- Khandelwal S, Han GH, Kim S, et al. (2023) Effect of dehydroxylation/amorphization degree of bentonite on the microstructure, thermal stability, and mechanical strength of basalt epoxy composites. *Journal of Materials Research and Technology* 23: 3249–3256. DOI: 10.1016/j.jmrt.2023.02.008.
- Kini AU, Shettar M, Gowrishankar MC, et al. (2023) A technical review on epoxy-nanoclay nanocomposites: Mechanical, hygrothermal and wear properties. *Cogent Engineering* 10(2). DOI: 10.1080/23311916.2023.2257949.
- Mahadeva Raju GK, Dakshayini BS, Madhu GM, et al. (2018) Characterizing and Modeling of Mechanical Properties of Epoxy Polymer Composites Reinforced with Bentonite Clay. *Materials Today: Proceedings* 5(14): 28098–28107. DOI: 10.1016/j.matpr.2018.10.051.
- Mapossa AB, da Silva Júnior AH, de Oliveira CRS, et al. (2023) Thermal, Morphological and Mechanical Properties of Multifunctional Composites Based on Biodegradable Polymers/Bentonite Clay: A Review. *Polymers* 15(16): 3443. DOI: 10.3390/polym15163443.

- Ollier R, Rodriguez E and Alvarez V (2013) Unsaturated polyester/bentonite nanocomposites: Influence of clay modification on final performance. *Composites Part A: Applied Science and Manufacturing* 48: 137–143. DOI: 10.1016/j.compositesa.2013.01.005.
- Perez FM, Santori GF, Pompeo F, et al. (2022) Silica-Resin-Bentonite Nanocomposite and Its Application in Catalysis. *Minerals* 12(12): 1486. DOI: 10.3390/min12121486.
- Sand Chee S and Jawaid M (2019) The Effect of Bi-Functionalized MMT on Morphology, Thermal Stability, Dynamic Mechanical, and Tensile Properties of Epoxy/Organoclay Nanocomposites. *Polymers* 11(12): 2012. DOI: 10.3390/polym11122012.
- Sukur EF, Kocaman S and Önal G (2020) Mechanical, tribological and thermal properties of epoxy based phenolic nanocomposites reinforced with graphene nanoplatelet. *Computational Research Progress in Applied Science & Engineering CRPASE: Transactions of Mechanical Engineering* (Special Issue). Available at: <https://www.researchgate.net/publication/344041047> (accessed 11 October 2021).
- Wang J, Deng Z, Huang Z, et al. (2021) Study on preparation and properties of bentonite-modified epoxy sheet molding compound. *e-Polymers* 21(1): 309–315. DOI: 10.1515/epoly-2021-0025.

MACHINE LEARNING APPROACHES FOR SUSTAINABLE PLANNING: A CASE STUDY OF TÜRKİYE

Merve KAYACI ÇODUR

Erzurum Technical University, Faculty of Engineering and Architecture, Department of Industrial Engineering, ERZURUM

ORCID ID: 0000-0003-1459-9678

ABSTRACT

The efficient allocation of energy resources is crucial for optimizing the operations of any transportation network, and the railway sector in Türkiye is no exception. This study explores the application of the Machine Learning (ML) algorithms to address the complex task of forecasting energy demand in Türkiye's railway system. The first component of this study involves a comprehensive review of Türkiye's railway energy planning, highlighting the importance of sustainable and efficient energy utilization in a rapidly expanding transportation network. With Türkiye's ambitious railway expansion plans, it is imperative to develop accurate energy demand forecasting models that can adapt to the dynamic nature of the rail system. The second component of our research delves into the concept of ML algorithms. ML algorithms are commonly used for forecasting in a wide range of domains, including finance, energy, weather, and more.

This study presents an innovative approach by applying ML techniques to the domain of railway energy demand forecasting in Türkiye. Through comprehensive experimentation and evaluation, it is demonstrated that the superiority of the best three ML methods in accurately predicting energy demand in the complex railway network of Türkiye.

In conclusion, this research addresses the critical challenge of energy demand forecasting in Türkiye's rapidly evolving railway sector. The study combines insights from Türkiye's railway energy planning with ML techniques, showcasing the potential of the best three algorithm to improve forecasting accuracy. By enhancing our understanding of energy consumption patterns in the Turkish railway system, this research contributes to more efficient resource allocation and sustainable transportation planning.

Keywords: Energy Demand, Machine Learning, Railway Planning

SÜRDÜRÜLEBİLİR PLANLAMA İÇİN MAKİNE ÖĞRENİMİ YAKLAŞIMLARI: TÜRKİYE'DE BİR ÖRNEK ÇALIŞMASI

ÖZET

Enerji kaynaklarının verimli bir şekilde tahsis edilmesi, herhangi bir ulaşım ağının operasyonlarını optimize etmek için çok önemlidir ve Türkiye'deki demiryolu sektörü de bir istisna değildir. Bu çalışma, Türkiye'nin demiryolu sistemindeki enerji talebini tahmin etme gibi karmaşık bir görevi ele almak için Makine Öğrenimi (ML) algoritmalarının uygulanmasını araştırmaktadır. Bu çalışmanın ilk bileşeni, Türkiye'nin demiryolu enerji planlamasının kapsamlı bir incelemesini içermekte ve hızla genişleyen bir ulaşım ağında sürdürülebilir ve verimli enerji kullanımının önemini vurgulamaktadır. Türkiye'nin iddialı demiryolu genişleme planlarıyla birlikte, demiryolu sisteminin dinamik doğasına uyum sağlayabilecek doğru enerji talebi tahmin modellerinin geliştirilmesi zorunludur. Araştırmamızın ikinci bileşeni ML algoritmaları kavramını incelemektedir. ML algoritmaları, finans, enerji, hava durumu ve daha fazlası dahil olmak üzere çok çeşitli alanlarda tahmin için yaygın olarak kullanılmaktadır.

Bu çalışma, Türkiye'deki demiryolu enerji talebi tahmini alanına ML tekniklerini uygulayarak yenilikçi bir yaklaşım sunmaktadır. Kapsamlı deney ve değerlendirmeler sonucu elde edilen en iyi üç ML algoritmasının, Türkiye'nin karmaşık demiryolu ağındaki enerji talebini doğru bir şekilde tahmin etmedeki üstünlüğü gösterilmiştir.

Sonuç olarak, bu araştırma Türkiye'nin hızla gelişen demiryolu sektöründe enerji talebi tahmini konusundaki kritik zorluğu ele almaktadır. Çalışma, Türkiye'nin demiryolu enerji planlamasından elde edilen bilgileri makine öğrenimi teknikleriyle birleştirerek, tahmin doğruluğunu artırmak için en iyi üç algoritmanın potansiyelini ortaya koymaktadır. Bu araştırma, Türk demiryolu sistemindeki enerji tüketim modellerine ilişkin anlayışımızı geliştirerek, daha verimli kaynak tahsisine ve sürdürülebilir ulaşım planlamasına katkıda bulunmaktadır.

Anahtar Kelimeler: Enerji Tahmini, Makine Öğrenmesi, Demiryolu Planlama

A STUDY ON DETERMINING RECREATIONAL AREA USAGE OPPORTUNITIES IN THE COASTAL STRIP OF FATSA DISTRICT, ORDU PROVINCE, TÜRKİYE

Sultan Sevinç KURT KONAKOĞLU

Amasya University, Faculty of Architecture, Department of Urban Design and Landscape
Architecture, Yeşilirmak Campus

ORCID ID: 0000-0001-5383-0954

Tuğba ÜSTÜN TOPAL

Tekirdağ Namık Kemal University, Faculty of Fine Arts, Design and Architecture, Department of
Landscape Architecture, Central Campus

ORCID ID: 0000-0002-9687-927X

Kadir Tolga ÇELİK

Amasya University, Faculty of Architecture, Department of Urban Design and Landscape
Architecture, Yeşilirmak Campus

ORCID ID: 0000-0002-3036-4206

ABSTRACT

As a result of the rapidly increasing global population and the associated urbanization activities, there is a growing pressure on green spaces today. Especially due to fast and unplanned urbanization, the intense urbanization with concrete has become one of the most significant urban issues of our time. This situation can lead to city dwellers not being able to connect with natural resources such as water and green areas, and not being able to meet their needs for recreational activities. In this context, coastal areas, especially in seaside cities, can be transformed into good recreational areas for urban residents to meet these needs. This way, these areas can provide opportunities for recreational activities for city dwellers. The aim of this study is to determine the recreational area usage opportunities in coastal areas. In this regard, the coastal strip of Fatsa district of Ordu province in Türkiye was identified as the study area. On-site observations were conducted in Fatsa district as part of the study. As a result of the study, recreational activities such as sitting, dining, walking, chatting, taking photographs, enjoying the scenery/sea, fishing, socializing, playing games, cycling, rollerblading/skateboarding, walking pets, shopping, having fun at the amusement park and playing in the playground are being carried out on the coastal strip. Based on the findings obtained in the study, existing and proposed recreational area usage maps have been created for the study area.

Keywords: Coastal Area Change, Coastal Landfill Area, Fatsa Coastal Strip, Ordu

ORDU İLİ FATSA İLÇESİ ÖRNEĞİNDE KIYI BANDI REKREASYONEL ALAN KULLANIM OLANAKLARININ BELİRLENMESİNE YÖNELİK BİR ÇALIŞMA

ÖZET

Dünyada hızla artan nüfus ve buna bağlı olarak ortaya çıkan kentleşme faaliyetleri sonucunda bugün yeşil alanlar üzerindeki baskı giderek artmaktadır. Özellikle hızlı ve plansız kentleşme faaliyetleri sonucunda kentlerdeki yoğun betonlaşma günümüzdeki en önemli kent sorunlarından biridir. Bu durum kentlinin su ve yeşil alanlar gibi doğal kaynaklar ile temas edememelerine ve rekreasyon faaliyetlerini gerçekleştirme gibi ihtiyaçlarını karşılayamamalarına neden olabilmektedir. Bu doğrultuda, özellikle sahil kentlerinde yer alan kıyı bantları kent insanının bu ihtiyaçlarını karşılayabilmeleri adına iyi bir rekreasyon alanı haline getirilebilmektedir. Böylelikle, bu alanlar kent insanının rekreatif etkinlik amaçlı kullanımına olanak sağlayabilmektedir. Bu çalışmanın amacı, kıyı bantlarındaki rekreasyonel alan kullanım olanaklarını belirlemektir. Bu doğrultuda, çalışma alanı olarak Ordu ili Fatsa ilçesi kıyı bandı belirlenmiştir. Çalışma kapsamında Fatsa ilçesinde yerinde gözlem çalışmaları yapılmıştır. Çalışmanın sonucunda, kıyı şeridinde oturma, yeme-içme, yürüme, sohbet etme, fotoğraf çekme, manzara/denizi seyretme, sosyalleşme, oyun oynama, bisiklete binme, paten/kaykay sürme, evcil hayvan gezdirme, alışveriş yapma, lunaparkta eğlenme ve oyun alanında oynama gibi rekreatif etkinlikler gerçekleştirilmektedir. Çalışma kapsamında elde edilen bulgular dâhilinde, çalışma alanı için mevcut ve öneri rekreasyonel alan kullanım haritaları oluşturulmuştur.

Anahtar Kelimeler: Kıyı Alanı Değişimi, Kıyı Dolgu Alanı, Fatsa Kıyı Şeridi, Ordu

1. INTRODUCTION

Following the Industrial Revolution, rapid and unplanned urbanization movements resulted in an increase in residential areas in cities, a decrease in green spaces, and a reduction in coastal areas. This situation can prevent urban residents from having contact with natural resources such as water and green spaces and hinder them from engaging in recreational activities. However, urban dwellers also require open green spaces where they can spend their leisure time, participate in recreational activities, and find solace from a social and psychological perspective.

The coastal areas, which are regions where trade and industry are prominent, transportation takes place, and various tourist activities occur, experience high levels of population growth, urbanization, and development due to the intensive use of natural resources and human

activities (Cengiz, 2009; Ruth & Baklanov, 2012; Garipağaoğlu, Özcan & Uzun, 2014). While this increase in coastal areas contributes to coastal urbanization in terms of urban development, it also leads to a rise in recreational needs in urban spaces due to the intense human pressure (Dorwart, 2004; Özdemir Işık & Demirel, 2016). Hence, coastal cities are creating coastal fill areas through sea reclamation to address the urban population's requirements for water-related activities, transportation, and recreation (Kurt Konakoğlu & Çelik, 2021).

Conceptually, coastal areas are defined as the point where land meets water, the land portion extending along bodies of natural water such as the sea, lakes, and rivers, serving as a spatial threshold where marine and terrestrial ecosystems converge and interact, representing critically important natural habitat areas that must be preserved (Sesli, Aydınoglu & Akyol, 2003; Doğan, 2008; Alpay, 2011). Legally, coastal areas are defined as the area between the shoreline and the coastal edge line. Therefore, while the coastline on the seaside is subject to continuous changes, there is a defined area limited by a fixed coastal edge line on the land side (Ferudun, 2009).

Filling operations in coastal areas are typically carried out by placing large volumes of sand and similar materials towards the sea along the coastline. Since the 1930s, coastal filling has become increasingly common worldwide. In our country, instead of sand, which offers an environmentally friendly and natural appearance, rock fill, concrete walls, or groynes are used (Demir, Savran & Otay, 2000; Cengiz, 2009; Balık, 2017). In coastal fill areas, recreational activities for urban residents generally involve activities carried out to have fun, rest, and relax. People find relief and rejuvenation by distancing themselves from the dense and monotonous urban environment through recreational activities in open spaces (Eminağaoğlu, Surat, Yavuz Özalp & Yaman, 2016; Kurt Konakoğlu & Çelik, 2021).

The aim of the study is to determine the recreational area usage opportunities along the coastal strip of Fatsa district of Ordu province in Türkiye. Through on-site observations and fieldwork, the current usage status of the area has been assessed within the scope of this study.

2. RESEARCH AND FINDINGS

2.1. Study Area and Methodology

The Black Sea Coastal Highway, with a length of 648 kilometers, extends from Sinop to the Sarp Border Gate. The Black Sea Coastal Highway passes through 7 provinces, namely Sinop, Samsun, Ordu, Giresun, Trabzon, Rize, and Artvin. Its construction began in 1987, and it was opened for use in 2007.

As the study area, a 3 km long coastal strip located north of the Black Sea Coastal Highway between Elekçi Creek and Bolaman Creek within the boundaries of Fatsa district in Ordu province has been selected (Figure 2.1, Figure 2.2).



Figure 2.1. Study Area Boundaries

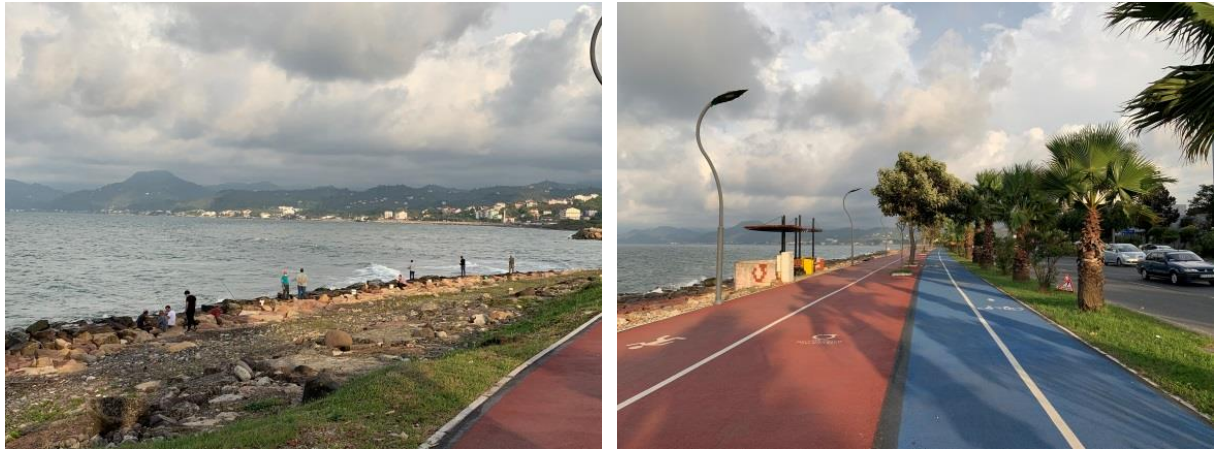


Figure 2.2. Images from the Study Area

Access to Fatsa is primarily provided through the Black Sea Coastal Highway. Due to its strategic location, Fatsa is situated on a route that connects all the cities of the Eastern Black Sea region, Samsun Çarşamba Airport, Trabzon Airport, and the Central Anatolia region. The coastal strip in Fatsa typically features a high coast type, characterized by blocky, steep, and rugged headlands. The coastal area is situated at an elevation of approximately 10 meters above sea level on alluvial plains. The district experiences a Black Sea climate, with mild winters and moderately warm summers (Başak Şahin, 2020). According to the population data for the year 2022, the population of the city of Ordu is 763,190, and for the same year, the population of Fatsa district is 126,775. This population consists of 63,025 males and 63,750 females (URL-1, 2023).

Within the scope of the study, a literature review was conducted, problems in the area were identified during fieldwork, and an observational study, one of the qualitative research techniques, was carried out. Existing recreational activities in the study area were determined, and both existing and proposed recreational area usage maps were created for the study area. A 2023 Google Earth satellite image was used as the base layer for the maps.

2.2. Findings from Observations and Fieldwork

The section of the study area located between Bolaman Creek and Fatsa Fishermen's Harbor consists of rocky and sandy terrain. This portion extends towards the sea, approximately 10-20 meters from the end of the pedestrian and bicycle path that runs parallel to the Black Sea Coastal Highway. There has been no specific arrangement for recreational use in this area. The residents of Fatsa predominantly use this part of the area for fishing (Figure 3). The section of the study area between Fatsa Fishermen's Harbor and Elekçi Creek extends approximately 40-90 meters towards the sea from the end of the pedestrian and bicycle path. In this part of the area, there are recreational facilities such as a playground, dining area, accommodation area, educational space, entertainment area, and a parking lot.



Figure 3. Images from the Fishing Activity

In the study area, there are 2 educational institutions, 1 guesthouse (Fatsa Teachers' Center and ASO), 3 restaurants, 2 buffets, 1 amusement park area, 1 children's playground, 1 swimming pool, 1 gas station, 2 groynes, fishermen's harbors, retail units, commercial areas, parking spaces around the buildings, and a 3.5-meter-wide pedestrian path and a 2.7-meter-wide bicycle path that run continuously parallel to the coast. Access to the area can be achieved via the Black Sea Coastal Highway, using motorized vehicles (private cars, minibuses, buses) or non-motorized vehicles (bicycles, motorcycles). The area is predominantly used by the residents of Fatsa. In recent years, with the opening of the Sarp Border Gate, the cities located along the Black Sea Coastal Highway have started to gain significance in terms of tourism. With this development, the dining places, commercial areas, and amusement park area located on the fill area within the boundaries of the area are used not only by the residents of Fatsa but also by tourists visiting the city for day trips, offering opportunities for dining, sightseeing, shopping, and entertainment. For this reason and due to good lighting in the area, the space is used at

different times of the day and night throughout all seasons. The residents of Fatsa and tourists visiting the area engage in various activities such as sitting, walking, chatting, taking photographs, enjoying the scenery/sea, fishing, socializing, playing games, cycling, rollerblading/skateboarding, walking pets, shopping, having fun at the amusement park, and playing in the playground on the fill area's coastal strip after having a meal.

During the land and on-site observation studies, issues such as the absence of parking lots, seating units, noise pollution, coastal pollution, urban amenities for disabled individuals, and ramps were identified within the boundaries of the study area.

With the construction of the 648-kilometer-long Black Sea Coastal Highway in 1987, changes began in the coastal areas of the cities along this route. This situation led to natural beaches and coastlines being filled with debris over time, resulting in the loss of any connection between urban residents and the coast, as well as harm to coastal ecology. To protect the beaches and bays in the coastal areas that were disrupted during road construction, groynes were constructed. In the 1984 zoning plan of Fatsa district, it can be observed that the fill area located north of the Black Sea Coastal Highway was planned together with the residential area. In 2002, the construction of the fill area between Elekçi Creek and the fishermen's harbor was completed, opening it up for recreational use (offering dining options, commercial areas, sports facilities, recreational areas, playgrounds, entertainment areas, and open green spaces). In 2019, a pedestrian and bicycle path located parallel to the Black Sea Coastal Highway was also opened for use, ensuring uninterrupted access to the coastal area between Elekçi Creek and Bolaman Creek.

3. CONCLUSION

Based on the land and on-site observation studies conducted in the area, the results obtained within the scope of the study are as follows:

- The study area's 1984 zoning plan indicated that the fill area located north of the Black Sea Coastal Highway was planned alongside the residential area. The fill area was opened for recreational use in 2002, and in 2019, a pedestrian and bicycle path running parallel to the Black Sea Coastal Highway was also made accessible.
- Within the boundaries of the study area, there are issues such as the absence of parking facilities, seating units, noise pollution, coastal pollution, and urban amenities for disabled individuals, including ramps.
- In the fill area section of the study area, there are currently various recreational activities taking place, including sitting, dining, walking, conversing, photography, enjoying the

scenery/sea, fishing, socializing, playing games, cycling, rollerblading/skateboarding, walking pets, shopping, having fun at the amusement park and playing in the playground.

- Within the boundaries of the study area in the fill area section, there are various recreational activities currently taking place, including sitting, dining, walking, conversing, photography, enjoying the scenery/sea, fishing, socializing, playing games, cycling, rollerblading/skateboarding, walking pets, shopping, having fun at the amusement park and playing in the playground.
- For the study area, it is considered to design informative signs and directional signage for tourists, designated areas where urban residents can swim and take photographs, a multi-purpose activity area that allows urban residents to socialize (exhibition area, concert area etc.), a skateboarding track accessible to all age groups, and sports facilities.
- Along with the proposed activity spaces, it is recommended to engage in recreational activities within the study area, including sitting, dining, walking, conversing, photography, enjoying the scenery/sea, fishing, socializing, playing games, cycling, rollerblading/skateboarding, walking pets, having fun at the amusement park, playing in the playground, attending concerts/artistic events, visiting an outdoor museum, participating in sports activities, and taking boat trips on the sea.

The existing recreational activities conducted in the study area, as well as the recommended recreational activities for the area, are illustrated in Figure 4.



Figure 4. The existing recreational activities conducted within the study area and the recommended recreational activities to be conducted.

It is believed that both the existing and proposed recreational area usage for the Fatsa coastline will have economic, social, and cultural contributions to both the district, Ordu province, and the local community.

REFERENCES

- Alpay, B. (2011). City Center of Alaplı (Zonguldak) and Coastal Filling Area Arrangement Process – Urban Design Projects. *İnönü University Journal of Art and Design*, 1(3), 297-306.
- Balık, İ. (2017). Usage of Coastal Zone in Ordu and Effects on the Marine Ecosystem. *Urban Academy*, 10(29), 31-47.
- Başak Şahin, Z. (2020). Description Report for the 1/1000 Scale Additional Implementation Zoning Plan for the Boat Manufacturing and Slipway Area in Fatsa District, Ordu Province. Available from: <https://webdosya.csb.gov.tr/db/ordu/duyurular/1000-uip-aciklama-raporu-fatsa-cekek-yer-20200805095513.pdf> Access date: 14.10.2023
- Cengiz, C. (2009). *Ecological Planning in Coastal Areas: Yalova-Armutlu Case Study* (Doctoral Thesis). Ankara University, Institute of Natural Sciences, Ankara.
- Demir, H., Savran, S. & Otay, E.N. (2000). *Bandırma Alternatif Kıyı Dolgu Projesi Fizibilite Çalışması*. 3rd National Coastal Engineering Symposium, October 5th-7th, Proceedings Book, Çanakkale, Türkiye, 403-418.
- Doğan, İ. (2008). *Uzaktan Algılama Verileri ile Kıyı Çizgisi Değişiminin Zamansal Olarak Belirlenmesi: Alaçatı Örneği* (Doctoral Thesis). Yıldız Technical University, Institute of Natural Sciences, İstanbul.
- Dorwart, C. E., Leung, Y. & Moore, R. (2004). *Managing Visitors' Perceptions*. National Recreation and Park Association. Available from: <http://www.findarticles.com> Access date: 14.10.2023
- Eminağaoğlu, Z., Surat, H., Yavuz Özalp, A. & Yaman, Y. K. (2016). *Determination of the Borcka Dam Reservoir Recreational Area Usage*. Kastamonu University Journal of Forestry Faculty, 16(2),348-361.
- Ferudun, A. (2009). Legal Status of Coastal Regions. *Journal of Naval Science and Engineering*, 5(1), 76-93.
- Garipağaoğlu, N., Özcan, S. & Uzun, M. (2014). The Changes of Coastal Area Investigation in the Between ModaCaddebostan (Kadıköy). *International Journal of Geography and Geography Education*, 29,60-80. <https://doi.org/10.14781/mcd.28746>
- Kurt Konakoğlu, S. S. & Çelik, K. T. (2021). *A Study on Determination of Akçaabat Coastline Recreational Area Usage*. USVES (International Symposium on Social Sciences and Educational Sciences), April 10th -11th, Online, Proceeding Book. 1159-1176.
- Özdemir Işık, B. & Demirel, Ö. (2016). Determination of Coastal Areas of Recreational Activities in the City of Trabzon. *Journal of the Faculty of Forestry Istanbul University*, 66(2), 483-496. <https://doi.org/10.17099/jffiu.54846>
- Ruth, M. & Baklanov, A. (2012). Urban Climate Science, Planning, Policy and Investment Challenges. *Urban Climate*, 1, 1-3. <https://doi.org/10.1016/j.uclim.2012.10.001>
- Sesli, F.A., Aydınoglu, A.Ç., & Akyol, N. (2003). Kıyı Alanlarının Yönetimi. *Union of Chambers of Turkish Engineers and Architects - Chamber of Survey and Cadastre Engineers*, 9, 757-768.
- URL-1. (2023). Population statistics of Ordu province in the year 2022. Available from: <https://www.nvi.gov.tr/ordu/ordu-2022-yil-sonu-nufus-istatistikleri> Access date: 14.10.2023

ADENOKARSİNOM VE SKUAMÖZ HÜCRELİ KARSİNOM TANILI AKCİĞER KANSERİ HASTALARINDA BAZI PLURİPOTENSİ BELİRTEÇLERİNİN EKSPRESYON DÜZEYLERİNİN ARAŞTIRILMASI

İrem YELESER

Mersin University, Institute of Health Sciences, Department of Medical Biology, Ciftlikkoy Campus

ORCID ID: 0000-0002-0800-3893

Mehmet Emin ERDAL

Mersin University, Institute of Health Sciences, Department of Medical Biology, Ciftlikkoy Campus

ORCID ID: 0000-0002-6191-2930

ÖZET

Kanserin en yaygın ve tehlikeli türlerinden biri olan akciğer kanseri küçük hücreli akciğer kanseri ve küçük hücreli dışı akciğer kanseri olmak üzere iki ana gruba ayrılır.

Küçük hücreli dışı akciğer kanseri tanılı bireylerde *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerini belirlemeyi amaçladığımız çalışmamızın araştırma grubuna, 2008-2019 yılları arasında Mersin Üniversitesi Tıp Fakültesi Dâhili Tıp Bilimleri Bölümü Göğüs Hastalıkları Anabilim Dalına başvuru yapmış bireyler dâhil edildi. Bu bireylere ait doku örnekleri ise Cerrahi Tıp Bilimleri Bölümü Patoloji Anabilim Dalı arşivinden alındı. Çalışma grubu 15'i adenokarsinom, 16'sı skuamöz hücreli karsinom tanılı olmak üzere 31 hastadan oluşturuldu. Aynı hastaların tümörlü dokularının yakınlarında yer alan sağlıklı akciğer doku örnekleri de (31 örnek) kontrol grubu içerisinde değerlendirildi. Doku örneklerinden sırasıyla total RNA izolasyonu ve cDNA sentezi gerçekleştirildi. Seçilen genlerin ekspresyon düzeylerini saptamak amacıyla TaqMan problemlerinin kullanıldığı Real-Time PCR gerçekleştirildi ve karşılaştırmalı CT ($\Delta\Delta CT$) yöntemi aracılığıyla ilgili genlerin ekspresyon analizi yapıldı. Araştırma sonucunda elde edilen ekspresyon seviyeleri adenokarsinom-adenokarsinom kontrol, skuamöz hücreli karsinom- skuamöz hücreli karsinom kontrol ve adenokarsinom- skuamöz hücreli karsinom gruplarında istatistiksel olarak analiz edildi. Bu analizler Paired t testi, Wilcoxon testi, Student's t testi ile Mann-Whitney U testi kullanılarak yapıldı.

SOX2, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeyleri, adenokarsinom-adenokarsinom kontrol, skuamöz hücreli karsinom- skuamöz hücreli karsinom kontrol ve adenokarsinom- skuamöz hücreli karsinom gruplarında istatistiksel olarak anlamlı bir fark olmadığı gözlemlendi ($p>0.05$).

Sonuç olarak elde ettiğimiz verilerin akciğer kanseri ve pluripotensi belirteçleri arasındaki ilişkiyi araştıran ve özellikle küçük hücreli dışı akciğer kanseri türlerini biyobelirteçler (pluripotensi faktörleri gibi) aracılığıyla ayırt etmeye yönelik çalışmalar yapacak diğer araştırmacılara ışık olabileceğini düşünüyoruz.

Anahtar Kelimeler: Akciğer kanseri, Gen ekspresyonu, Kanser kök hücreleri, Pluripotensi belirteçleri, Real-Time PCR

INVESTIGATION OF THE EXPRESSION LEVELS OF SOME PLURIPOTENCY MARKERS IN LUNG CANCER PATIENTS DIAGNOSED WITH ADENOCARCINOMA AND SQUAMOUS CELL CARCINOMA

ABSTRACT

Lung cancer, one of the most common and dangerous types of cancer, is divided into two main groups: Small cell lung cancer and non-small cell lung cancer. We aimed to determine the expression levels of *SOX2*, *OCT3 / 4*, *NANOG*, *KLF4* and *c-Myc* genes in patients diagnosed with non-small cell lung cancer who applied to the Mersin University, Medicine Faculty, Internal Medical Sciences, Department of Chest Diseases in 2008-2019. Tissue samples of these individuals were taken from the archive of the Department of Surgical Medical Sciences, Department of Pathology. The study group consists of 31 patients, 15 of whom were diagnosed with adenocarcinoma and 16 were diagnosed with squamous cell carcinoma. A control group was formed with healthy lung tissue samples (31 samples) located near the tumorous tissues of the same patients. Total RNA isolation and cDNA synthesis were performed from tissue samples, respectively. In order to determine the expression levels of the genes selected, Real-Time PCR was performed where TaqMan probes were used and expression analysis of the relevant genes was performed using the comparative CT ($\Delta\Delta CT$) method. The expression levels obtained as a result of the study were statistically analyzed in adenocarcinoma-adenocarcinoma control, squamous cell carcinoma-squamous cell carcinoma control and adenocarcinoma-squamous cell carcinoma groups. These analyzes were performed using Paired t test, Wilcoxon test, Student's t test and Mann-Whitney U test.

Expression levels of *SOX2*, *OCT3/4*, *NANOG*, *KLF4* and *c-Myc* genes did not show a statistically significant difference in adenocarcinoma-adenocarcinoma control, squamous cell carcinoma-squamous cell carcinoma control and adenocarcinoma-squamous cell carcinoma groups ($p > 0.05$).

As a result, we think that the data we have obtained will illuminate to other researchers who will investigate the relationship between lung cancer and pluripotency markers and especially to differentiate non-small cell lung cancer types through biomarkers (such as pluripotency factors).

Keywords: Cancer stem cells, Gene expression, Lung cancer, Pluripotency markers, Real-Time PCR

Teşekkür: Bu çalışma, Mersin Üniversitesi Bilimsel Araştırma Projeleri Birimi tarafından 2019-3-TP2-3792 proje numarası ile desteklenmiştir.

1. GİRİŞ

Akciğer kanseri; oluşumuna genetik, epigenetik ve çevresel faktörlerin birlikte etki ettiği kompleks bir hastalıktır. Akciğer dokusuna ait hücreler; normal fonksiyonlarını yerine getiremez, büyüme ve çoğalmaları kontrol edilemez hale gelirse bu süreç ilgili bölgede kanser oluşumu ile sonlanır. Akciğer kanserinin en genel sınıflandırılması “Küçük Hücreli Akciğer Kanseri (KHAK)” ve “Küçük Hücreli Dışı Akciğer Kanseri (KHDAK)” olarak yapılan akciğer kanseri, her iki cinsiyette de görülme sıklığı ilk sıralarda bulunan, kanserin ne yazık ki ölümle en çok sonuçlanan tipidir.

Yamanaka Faktörleri (OCT3/4, SOX2, KLF4 ve C-MYC-OSKM) Yamanaka ve ark. tarafından tanımlanan indüklenmiş pluripotent kök hücrelerin (iPSC) oluşturulması sürecinde önemli olan faktörlerdir. Aynı zamanda birer transkripsiyon faktörü de olan bu dördünün özellikle fibroblastlara aktarılmasıyla oluşturulan pluripotent hücreler çok sayıda hastalığın tanımlanması ve tedavisi için bir umut olmuştur.

Çalışmamız kapsamında KHDAK'nin en yaygın iki türü olan adenokarsinom ve skuamöz hücreli karsinom hastalarında *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeyleri araştırıldı. Analizler sonucunda elde edilen gen ekspresyon düzeylerinin hasta gruplarının kendi kontrolleriyle (adenokarsinom- adenokarsinom kontrol ve skuamöz hücreli karsinom- skuamöz hücreli karsinom kontrol) ve aynı zamanda her iki hasta grubunun (adenokarsinom- skuamöz hücreli karsinom) da birbiriyle karşılaştırılması sonucu, seçilen genlerin hangi türde ne düzeyde eksprese olduğu belirlenmeye çalışıldı. KHDAK türlerini birbirinden ayırt etmek için moleküler düzeyde kullanılabilecek bir belirteç olup olmadığı tespit edilmeye çalışıldı. Akciğer kanseri günümüzde bu kadar tehlikeli bir durum sergiliyorken hastalığın mekanizması daha detaylı aydınlatılmalı, erken teşhis edilmeli ve tedavisine yönelik stratejiler geliştirilmelidir. Elde edilen sonuçların tedavi geliştirme ya da hastanın sağ kalım süresini uzatmak amacıyla ilaç endüstrisi tarafından kullanılması hem hastalar için birer umut ışığı olacak hem de ilaç çalışmaları adına yeni bir kapı da aralanmış olacaktır.

2. ARAŞTIRMA VE BULGULAR

2.1. Çalışma Materyali

Mersin Üniversitesi Tıp Fakültesi Cerrahi Tıp Bilimleri Bölümü Patoloji Anabilim Dalının arşivinden 2010-2019 tarihleri arasında dâhil edilme ve dışlanma kriterlerine uyan 62 örnek (31 hasta ve 31 kontrol olmak üzere) alındı. Alınmış olan örnekler daha önceden Dahili Tıp Bilimleri Bölümü Göğüs Hastalıkları Anabilim Dalına başvurmuş olan hastalara ait olup aynı hastaların tümörlü dokularının yakınlarında yer alan sağlıklı doku örnekleri ile de kontrol grubu oluşturuldu.

Patoloji Anabilim Dalı arşivinde bulunan parafine gömülü doku örneklerinden 10'ar mikronluk 5'er kesit alınıp ependorf tüplere aktarıldı. Parafine gömülü doku örnekleri total RNA izolasyonu yapılacak güne kadar -20°C'de muhafaza edildi.

Araştırma kapsamında çalışmaya dâhil edilen bireylere ait klinik veriler kullanılmadı.

2.2. Parafin Dokudan Total RNA İzolasyonu

Total RNA izolasyonu öncesinde parafine gömülmüş doku örneklerinin ilk olarak ksilen aracılığıyla deparafinizasyonu gerçekleştirildi; ardından TRIzol ile izolasyon basamaklarına devam edildi.

2.3. cDNA Sentezi

cDNA (complementary DNA, Komplementer DNA) sentezi için gerekli reaksiyon bileşenleri ve izole edilen RNA örnekleri deneyden kısa bir süre önce -20°C 'den çıkarılarak çözdürüldü. Bileşenlerin kısa bir santrifüjünden sonra cDNA reaksiyon karışımı (mix) hazırlandı. Bu karışım için gerekli bileşenler ve miktarları Tablo 2.1'de verilmiştir. Hazırlanan karışım hem 62 çalışma örneği hem de bir sonraki deney basamağında (gen ekspresyon analizi) kullanılacak referans örnekler göz önünde bulundurularak toplamda 5000 µl olacak şekilde hazırlandı. Hazırlanan karışımdan her bir reaksiyon tüpüne 50 µl konuldu ve ardından her bir örneğe ait 5 µl RNA numaralandırılmış bu reaksiyon tüplerine eklendi.

Bu çalışmada referans olarak kullanılan "0" örneği hazırlanırken tüm kontrol örneklerinin (31 adet) 2'şer µl RNA'sı (toplam 62 µl) alındı ve sadece kontrol grubun olduğu bir RNA havuzu elde edildi. Bu havuzdan da 30 µl RNA alınarak 300 µl'lik cDNA reaksiyon karışımına eklenerek 3 ayrı reaksiyon tüpüne bölüştürüldü.

Tüm tüpler kısa bir santrifüjün ardından ABI Prism 7500 Real-Time PCR System (Applied Biosystems) adlı cihaza yerleştirildi ve 37°C'de 60 dk, 95°C'de 5 dk olacak şekilde hazırlanmış PCR koşullarının ardından RT-PCR (Reverse Transcriptase-Polymerase Chain Reaction:

Revers-Transkriptaz Polimeraz Zincir Reaksiyonu) aracılığıyla cDNA elde etme süreci tamamlanmış oldu.

Tablo 2.1. cDNA sentezi için gerekli reaksiyon bileşenleri ve miktarları

Bileşen	Miktar (100 µl için)	Miktar (5000 µl için)
dH ₂ O	80 µl	4000 µl
dNTP (10 mM)	8 µl	400 µl
Revers Transkriptaz (RT) enzimi (200u)	0,4 µl	20 µl
5X RT Buffer	16 µl	800 µl
Oligo(dT) 18 (200 U/µl)	10 µl	500 µl
RNase İnhibitör (40 U/µl)	1 µl	50 µl
Toplam	115,4 µl	5770 µl

2.4. Real-Time PCR ile Ekspresyon Analizi

Çalışma içerisinde araştırılan *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genleri ile endojen kontrol olarak kullanılan ACTB genine (referans gen) özgü Reverse (R) ve Forward (F) primerler ile proplar Tıbbi Biyoloji Ana Bilim Dalı Başkanı Prof. Dr. Mehmet Emin Erdal tarafından Primer Express 3.0 (Applied Biosystems) programı aracılığıyla dizayn edildi (Tablo 2.2).

Tablo 2.2. Çalışmada ekspresyon analizi yapılan genlerin primer-prob dizileri

Genin Sembolü	Gen No*	mRNA Nükleotid Dizi No**	Primer/Pro b	Primer/Prob Dizisi
SOX2	6657	NM_003106.4	Prob	5'-FAM- CAAGGAGAGGCTTCTTGCTG-BHQ1-3'
			R Primer	5'- TTTCACGTTTGCAACTGTCC-3'
			F Primer	5'- AGTCTCCAAGCGACGAAAAA-3'
OCT-3/4	5460	NM_001173531.3	Prob	5'-FAM-GGGAGGAGCTAGGGAAAGAA-BHQ1-3'
			R Primer	5'-CAAAAACCCTGGCACAACACT-3'
			F Primer	5'-GTACTCCTCGGTCCCTTTCC-3'
NANOG	79923	NM_001297698.2	Prob	5'-FAM- GTCCCGGTCAAGAAACAGAA-BHQ1-3'
			R Primer	5'-TCTGCTGGAGGCTGAGGTAT-3'
			F Primer	5'-CAAAGCAAACAACCCACTT-3'
KLF4	9314	NM_001314052.2	Prob	5'-FAM-ACTACCGTAAACACACGGGG-BHQ1-3'
			R Primer	5'-ATGTGTAAGGCGAGGTGGTC-3'
			F Primer	5'-CCCACACAGGTGAGAAACCT-3'
MYC	4609	NM_001354870.1	Prob	5'-FAM-AGGAGAATGTCAAGAGCGGA-BHQ1-3'
			R Primer	5'-GGCCTTTTCATTGTTTTTCCA-3'
			F Primer	5'-CAGATCAGCAACAACCGAAA-3'
ACTB (β-Actin)	60	NM_001101.5	Prob	5'-VIC-TCCCCCAAAGTTCACAATGT-TAMRA-3'
			R Primer	5'-AGAGAAGTGGGGTGGCTTTT-3'
			F Primer	5'-AAACTGGAACGGTGAAGGTG-3'

*www.ncbi.nlm.nih.gov/gene, **www.ncbi.nlm.nih.gov/nucore

Tüm kantitasyon işlemleri ABI Prism 7500 Real-Time PCR System (Applied Biosystems) cihazı kullanılarak yapıldı. Seçilen genlerin hasta ve kontrol örneklerindeki ekspresyon düzeyi değişimleri her bir örnek için Tablo 2.3'te gösterilen miktarlarca hazırlanarak SDS 2.0.6 yazılımı ile $\Delta\Delta CT$ değerleri kullanılarak belirlendi. Veri normalizasyonu $2^{-\Delta\Delta CT}$ değerinin hesaplanmasıyla sağlandı.

Tablo 2.3. Real-Time PCR reaksiyon bileşenleri ve miktarları

Reaksiyon Bileşeni	Miktarı
dH ₂ O	5 µl
qPCR Probe Master Mix (2x)	12,5 µl
<i>SOX2</i>	2,5 µl primer çifti (F ve R) (900nM)
<i>OCT3/4</i>	
<i>NANOG</i>	
<i>KLF4</i>	
<i>c-Myc</i>	
<i>ACTB</i>	0,7 µL prob (200 nM)
	1µl primer çifti (F ve R) (900nM)
	1 µL prob (200 nM)
TOPLAM	26,2 µl

2.5. İstatistiksel Analiz

Çalışmamızda elde edilen verilerin istatistiksel analizi Mersin Üniversitesi Tıp Fakültesi Biyoistatistik ve Bilişim Anabilim Dalı'ndan danışmanlık alınarak yapıldı.

SOX2, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* değişkenlerine ait verilerin normal dağılıma uygunluğu Shapiro-Wilk test istatistiği ile değerlendirildi. Tanımlayıcı istatistikler minimum, maksimum, $ORT \pm SS$ (ortalama \pm standart sapma), Q1-Q3 olarak verildi. Grup karşılaştırmalarında, verilerin normal dağılıma uygun olup olmaması durumuna göre parametrik ve non-parametrik istatistiksel yöntemler kullanılmış olup, bağımlı iki gruba ait karşılaştırmalar için Paired t testi ile Wilcoxon testi kullanılırken, bağımsız iki grup karşılaştırmaları için Student t testi ile Mann-Whitney U testi kullanıldı. Tüm sonuçlar $p < 0.05$ olduğunda istatistiksel olarak anlamlı kabul edildi.

2.6. Deneysel Sonuçlar

Çalışmamızda *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeyleri;

- Adenokarsinom- kontrol,
- Skuamöz hücreli karsinom – kontrol,
- Adenokarsinom- skuamöz hücreli karsinom grupları arasında istatistiksel olarak değerlendirildi.

2.6.1. Çalışma Grubunun Yaş ve Cinsiyet Bakımından Değerlendirilmesi

Çalışmamıza 26'sı erkek ve 5'i kadın olmak üzere toplamda 31 birey dâhil edildi. Erkek bireyler tüm çalışma grubunun %83,9'unu, kadınlar ise %16,1'ini oluşturmaktadır. Yaş ortalaması yalnızca erkeklerde 67,19, yalnızca kadınlarda 61,8 olarak hesaplandı. Yaş ortalamaları bakımından erkek ve kadın bireyler arasında istatistiksel olarak anlamlı bir fark gözlenmedi ($p=0.243$) (Tablo 2.4).

Tablo 2.4. Çalışma grubuna dâhil edilen kadın ve erkeklerin yaş ortalaması

Çalışma Grubu (n=31)	Cinsiyet	Kişi Sayısı	%	Yaş Ortalaması (Ort±SS)	p
	Erkek	26	83,9	67,19±8,83	0.243
	Kadın	5	16,1	61,8±11,63	

2.6.2. Adenokarsinom ve Skuamöz Hücreli Karsinom Hasta Gruplarının Yaş ve Cinsiyet Bakımından Değerlendirilmesi

Çalışmamızda adenokarsinom tanılı 15 ve skuamöz hücreli karsinom tanılı 16 kişi yer almaktadır. Gruplarda yer alan bireylerin cinsiyet dağılımı ve yaş ortalaması Tablo 2.5'te verilmiştir. Yaş ortalaması bakımından iki tür arasında istatistiksel olarak anlamlı bir fark bulunmadı ($p=0.501$).

Tablo 2.5. Adenokarsinom ve skuamöz hücreli karsinom gruplarında cinsiyet dağılımı

			Grup		Toplam
			Adeno-karsinom	Skuamöz hücreli karsinom	
Cinsiyet	Kadın	Kişi sayısı	2	3	5
		%	% 13,3	% 18,8	% 16,1
	Erkek	Kişi sayısı	13	13	26
		%	% 86,7	% 81,3	% 83,9
Toplam		Kişi sayısı	15	16	31
		%	% 100,0	% 100,0	% 100,0

2.6.3. Adenokarsinom Hasta Grubu ve Kontrol Grubu Arasında Gen Ekspresyon Düzeylerinin Değerlendirilmesi

Çalışmamızda araştırılan *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerine adenokarsinom hasta grubunda ve kontrol grupta bakılarak p değerleri hesaplandı. Bu genlerin her biri için hesaplanan p değerleri sırasıyla 0.149, 0.612, 0.385, 0.642, 0.259'dur.

İlgili genlerin ekspresyon düzeyleri hasta ve kontrol grupta incelendiğinde istatistiksel olarak anlamlı bir fark bulunmadı ($p>0.05$) (Tablo 2.6).

Tablo 2.6. Adenokarsinom ve kontrol grubunda *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerine dair bilgiler ve p değerleri (Q1=%25, Q3=%75)

Gen Adı	Adenokarsinom kontrol (n=15)			Adenokarsinom (n=15)			p
	Ort ±SS	Min-Max	[Q1-Q3]	Ort ±SS	Min-Max	[Q1-Q3]	
<i>KLF4</i>	0,68±0,61	0,06-2,26	[0,22-1,10]	0,79±0,51	0,11-1,59	[0,32-1,22]	0.642
<i>c-Myc</i>	1,01±0,68	0,17-2,41	[0,44-1,50]	1,24±0,66	0,04-2,24	[0,77-1,66]	0.259
<i>NANOG</i>	0,46±0,23	0,15-0,98	[0,32-0,62]	0,52±0,27	0,15-0,87	[0,34-0,86]	0.385
<i>OCT3/4</i>	0,98±0,40	0,01-1,65	[0,76-1,24]	1,08±0,64	0,46-2,61	[0,65-1,10]	0.612
<i>SOX2</i>	0,82±0,65	0,06-2,52	[0,38-1,17]	1,43±1,36	0,12-5,19	[0,35-2,20]	0.149

2.6.4. Skuamöz Hücreli Karsinom Hasta Grubu ve Kontrol Grubu Arasında Gen Ekspresyon Düzeylerinin Değerlendirilmesi

SOX2, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerine skuamöz hücreli karsinom hasta grubunda ve kontrol grupta bakılarak p değerleri hesaplandı. 5 gene ait p değerleri sırasıyla 0.219, 0.128, 0.719, 0.250 ve 0.311 olarak belirlendi. Ekspresyon düzeyleri hasta ve kontrol grupta kıyaslandığında istatistiksel olarak anlamlı bir fark bulunmadı ($p>0.05$) (Tablo 2.7).

Tablo 2.7. Skuamöz hücreli karsinom ve kontrol grubunda *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerine dair bilgiler ve p değerleri (Q1=%25, Q3=%75)

Gen Adı	Skuamöz hücreli karsinom kontrol (n=16)			Skuamöz hücreli karsinom (n=16)			p
	Ort ±SS	Min-Max	[Q1-Q3]	Ort ±SS	Min-Max	[Q1-Q3]	
<i>KLF4</i>	1,00±1,16	0,16-4,67	[0,26-1,37]	0,66±0,52	0,05-1,61	[0,16-1,05]	0.250
<i>c-Myc</i>	1,35±1,32	0,17-5,52	[0,36-1,94]	1,06±0,94	0,01-3,38	[0,35-1,55]	0.311
<i>NANOG</i>	0,55±0,40	0,17-1,48	[0,25-0,65]	0,52±0,31	0,09-1,17	[0,26-0,75]	0.719
<i>OCT3/4</i>	1,28±1,00	0-2,94	[0,52-2,13]	0,86±0,50	0,10-1,71	[0,54-1,25]	0.128
<i>SOX2</i>	1,38±1,07	0,10-4,13	[0,55-1,83]	1,84±1,79	0,18-5,79	[0,38-2,71]	0.219

2.6.5. Adenokarsinom ve Skuamöz Hücreli Karsinom Hasta Grupları Arasında Gen Ekspresyon Düzeylerinin Değerlendirilmesi

Çalışmamız kapsamında araştırılan 5 genin ekspresyon düzeyleri KHDAK türlerinden adenokarsinom ve skuamöz hücreli karsinom hasta gruplarında araştırıldı ve p değerleri

belirlendi. İlgili genlerin ekspresyon seviyeleri incelendiğinde iki hasta grubu arasında istatistiksel olarak anlamlı bir fark olmadığı gözlemlendi ($p>0.05$) (Tablo 2.8).

Tablo 2.8. Adenokarsinom ve skuamöz hücreli karsinom hasta gruplarında *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeylerine dair bilgiler ve p değerleri (Q1=%25, Q3=%75)

Gen Adı	Adenokarsinom (n=15)			Skuamöz hücreli karsinom (n=16)			p
	Ort ±SS	Min-Max	[Q1-Q3]	Ort ±SS	Min-Max	[Q1-Q3]	
<i>KLF4</i>	0,79±0,51	0,11-1,59	[0,32-1,22]	0,66±0,52	0,05-1,61	[0,16-1,05]	0.506
<i>c-Myc</i>	1,24±0,66	0,04-2,24	[0,77-1,66]	1,06±0,94	0,04-3,38	[0,35-1,55]	0.548
<i>NANOG</i>	0,52±0,27	0,15-0,87	[0,34-0,86]	0,52±0,31	0,09-1,17	[0,26-0,75]	0.946
<i>OCT3/4</i>	1,08±0,64	0,46-2,61	[0,65-1,10]	0,86±0,5	0,10-1,71	[0,54-1,25]	0.295
<i>SOX2</i>	1,43±1,36	0,12-5,19	[0,35-2,20]	1,84±1,79	0,18-5,79	[0,38-2,71]	0.477

3. SONUÇ

- Çalışma kapsamında KHDAK türlerinden adenokarsinom ve skuamöz hücreli karsinom tanısı konulmuş bireylere ait doku örnekleri üzerinden *SOX2*, *OCT3/4*, *NANOG*, *KLF4* ve *c-Myc* genlerinin ekspresyon düzeyleri araştırıldı. 5 gen için de adenokarsinom ile skuamöz hücreli karsinom hasta ve kontrol örneklerinde görülen ekspresyon düzeyleri arasındaki farkın istatistiksel olarak anlamlı olmadığı sonucuna ulaşıldı ($p>0.05$).
- Çalışma sonucunda elde edilen veriler ışığında farklı iki türü birbirinden ayırt etmede biyobelirteç olarak kullanılabilecek bir pluripotensi faktörü olup olmadığı test edildi. Ancak KHDAK türlerini birbirinden ve sağlıklı örneği hastadan ayırt etmede kullanılabilecek, istatistiksel olarak anlamlı olduğu sonucuna varılan bir pluripotensi belirteci tespit edilemedi.
- Biz çalışmamızı 31 hasta örneği kullanarak gerçekleştirdik. Elde ettiğimiz ekspresyon düzeylerinin istatistiksel olarak anlamlı olmama sebeplerden biri çalışılan örneklem sayısının yeterli gelmemesi olabilir. İki KHDAK türü için daha fazla sayıda hasta ve kontrolün dâhil edildiği araştırmalar ile daha farklı sonuçlar elde edilebilir.
- Araştırdığımız hastalarımızın yaş ortalaması 66,32 iken en genç hastamız 48 ve en yaşlı hastamız 79 yaşında idi. Hastalık 65 yaş üzeri bireylerde daha sık görülüyor olmakla birlikte Türk popülasyonunda 25-49 genç ve 50-69 orta yaşlı olarak değerlendirilen yaş aralıklarında, erkeklerde en sık görülen kanser tipi akciğer kanseri olarak belirlenmiştir. Bu yüzden hasta seçimi yapılırken daha genç yaşta bireylerin de araştırmaya dâhil edilmesi ile daha farklı sonuçlara ulaşılabilir.

- Çalışmamızda yer alan bireylere ait klinik veriler araştırma süresince kullanılmamıştır. Örneğin hastanın akciğer kanserinin kaçınıcı evresinde olduğu, şu an herhangi bir tedavi görüp görmediği, tedavi görüyorsa eğer bu tedaviye vermiş olduğu yanıt, geçirmiş olduğu cerrahi müdahale, örnek için alınan dokunun yeri ve büyüklüğü vs. gibi bilgiler ilgili klinikten alınmamış ve çalışmaya dâhil edilmemiştir. Bireyin içinde bulunduğu kanser evresi ile genlerin ekspresyonları arasında bağlantılı bir durum söz konusu olabilir. 1. veya 2. evrede olması ile 3. veya 4. evrede olması yaşam sürecini ve kalitesini etkileyebildiği gibi hedef genlerdeki ekspresyon düzeyleri üzerinde de etki yaratabilir. Şu an biz 31 hastamızın hastalığın hangi evresinde olduğunu bilmiyoruz. Bu durum sonuçlarımızın çeşitlilik göstermesine ve istatistiksel olarak anlamlı veriler elde etmememize sebep olmuş olabilir. Literatürde yer alan bilgilerden farklı olarak *OCT3/4*, *NANOG* ve *c-Myc* için ölçülen ekspresyon düzeylerinin kontrol gruplarında hasta gruplarından daha yüksek seviyede bulmamızın nedenlerini de hastanın tedavi öyküsüne bağlayabiliriz. Kullanmış olduğu ilaçlar, aldığı kemoterapi ya da radyoterapi ile bazı genlerin ekspresyon düzeylerinde azalış görünme ihtimali olabilir.
- Akciğer kanserinde en kritik risk faktörünün sigara tüketimi olduğu bilinen bir gerçektir. Yine hastaların sigara tüketip tüketmediği, eğer tüketiyorsa ne kadar zamandır kullandığı, bir gün içerisinde içmiş olduğu sigara sayısı gibi bilgilerin de sağlanmasıyla birlikte daha detaylı analizler gerçekleştirilebilir.
- Ayrıca bu genlerin ekspresyonlarındaki olası değişimlerin, kanserin erken tanı ve tedavisine katkı sağlayacağı düşünülmektedir. Kanser kök hücreleri üzerine yapılacak olan çalışmalar kanserin tedavisi adına birer ışık olabileceği için gün geçtikçe kök hücrelerde eksprese olan pluripotensi faktörlerinin de önemi ve tanınırlığı artacaktır.
- Bizim çalışmamız gibi akciğer kanseri ile pluripotensi belirteçleri arasındaki ilişki hakkında fikir sahibi olmayı amaçlayan benzeri araştırmalar sonucunda elde edilen bulgular ile akciğer kanseri etiyojisi, patogenezi, genetik alt yapısı, farklı akciğer kanseri türleri arasındaki moleküler ayrımların neler olabileceği, organizmada akciğer kanseri oluşurken hangi türde hangi pluripotensi belirtecinin ne seviyede kullanıldığı sorularına cevap vermeye yönelik yeni fikirler edinilebilir. Bu cevapların da ileride aynı konu üzerinde çalışmak isteyen araştırmacılara birer fikir olabileceğine inanmaktayız.

KAYNAKÇA

Li, X., Ma, C., Luo, H., Zhang, J., Wang, J., & Guo, H. (2020). Identification of the differential expression of genes and upstream microRNAs in small cell lung cancer compared with normal lung based on bioinformatics analysis. *Medicine*, 99(11), e19086.

Makena, M. R., Ranjan, A., Thirumala, V., & Reddy, A. P. (2020). Cancer stem cells: Road to therapeutic resistance and strategies to overcome resistance. *Biochimica et Biophysica Acta (BBA)-Molecular Basis of Disease*, 1866(4), 165339.

Marcos-Abdala, H. G., Youker, K. A., Torre-Amione, G., & Bhimaraj, A. (2019). Yamanaka Factors as Drivers of Recovery in a Mouse Model of Heart Failure. *Journal of Cardiac Failure*, 25(8), S112.

Türkyılmaz M. (2019).Türkiye Kanseri İstatistikleri (Cancer Statistics in Turkey). 15 Şubat 2020 tarihinde https://hsgm.saglik.gov.tr/depo/birimler/kanser-db/istatistik/Trkiye_Kanser_statistikleri_2016.pdf adresinden erişildi.

Yang, D., Liu, Y., Bai, C., Wang, X., & Powell, C. A. (2020). Epidemiology of lung cancer and lung cancer screening programs in China and the United States. *Cancer Letters*, 468, 82-87.

SEREBRAL PALSİLİ BİREYLERDE FİZİKSEL AKTİVİTE: DERLEME**Dr. Öğr. Üyesi Demet GÖZAÇAN KARABULUT**

Gaziantep Islam Science and Technology University, Faculty of Health Sciences,

Department of Physiotherapy and Rehabilitation, Gaziantep, Turkey

ORCID ID: 0000-0001-9235-1059**ÖZET**

Serebral Palsi (SP), hareket kısıtlılıkları ve motor işlev bozukluklarına neden olan, çocuklarda görülen fiziksel engelliliğin en yaygın nedenlerindedir. Prenatal, natal veya postnatal dönemlerde ortaya çıkabilen ve yaşam boyu süren bir motor bozukluktur. SP'li bireylerin motor gelişimleri tipik gelişim gösteren akranlarına oranla daha yavaş ilerlemektedir. SP'li bireylerde spastisite, seçici motor kontrol kayıpları, kas zayıflıkları, koordinasyon bozukluğu gibi motor fonksiyon etkilenimleri bu bireylerin fiziksel aktivite düzeylerini olumsuz etkilemektedir. Diğer sağlıklı gelişen akranlarında olduğu gibi, fiziksel aktivite SP'li bireylerde mobilite ve motor gelişimin desteklenmesi, biyopsikososyal fonksiyonların iyileşmesi, yaşam kalitesinin geliştirilmesi ve günlük yaşam içerisinde sportif aktivitelere katılımın artırılması açısından büyük öneme sahiptir. Fiziksel aktivitenin, kilo kontrolü sağlamanın yanında, kemik gelişimini artırması, kan basıncını düşürmesi, aktif yaşam biçimini desteklemesi ve sosyal katılımı artırması gibi birçok olumlu etkisi bulunmaktadır. Bu olumlu etkilerinin yanı sıra SP'li birey ve ailelerinde olumlu fiziksel ve psikolojik etkiler oluşturmada ve günlük yaşam aktivitelerinde motor fonksiyonların gerçekleştirilmesine önemli katkıları bulunmaktadır. SP'li bireylerde fiziksel aktivitenin yetersiz düzeyde olması hem çocuğun hem de çocuğa bakım veren bireylerin yaşam kalitelerini olumsuz yönde etkiler. Güncel araştırmalarda SP'li bireylerde fiziksel aktivitenin değerlendirilmesi ve programlara dahil edilmesinin gerekliliği vurgulanmaktadır.

Tüm verilen bu bilgilere dayanarak bu bildiri kapsamında sunulacak olan derlemede SP'li bireylerde fiziksel aktivitenin gelişimi ile ilişkili olası risk faktörlerinin açıklanması, fiziksel aktivite düzeyindeki iyileştirmelerin SP'li birey üzerindeki etkilerinin tartışılması amaçlanmıştır. Ek olarak fiziksel aktivitenin SP'li bireylerdeki önemine vurgu yapılarak bu konuda farkındalığın artırılması amaçlanmıştır.

Anahtar Kelimeler: Çocuk, Fiziksel Aktivite, Serebral Palsi

PHYSICAL ACTIVITY IN INDIVIDUALS WITH CEREBRAL PALSY: A REVIEW

ABSTRACT

Cerebral Palsy (CP) is one of the most common causes of physical disability in children, leading to movement limitations and motor function impairments. It is a lifelong motor disorder that can manifest during the prenatal, natal, or postnatal periods. The motor development of individuals with CP progresses slower than their typically developing peers. Motor function impairments such as spasticity, selective motor control deficits, muscle weakness, and coordination disorders in individuals with CP negatively impact their levels of physical activity. As in other healthy developing peers, physical activity holds significant importance for individuals with CP in supporting mobility and motor development, improving biopsychosocial functions, improving quality of life and increasing participation in sports activities in daily life. In addition to facilitating weight management, physical activity has numerous positive effects, including promoting bone development, reducing blood pressure, supporting an active lifestyle, and increasing social participation. Alongside these beneficial effects, physical activity has a profound impact on both the physical and psychological well-being of individuals with CP and their families. It contributes significantly to the execution of motor functions in daily life activities. Inadequate levels of physical activity in individuals with CP can have detrimental effects on the quality of life for both the child and the caregivers. Current research highlights the necessity to evaluate physical activity in individuals with CP and include it in programs. Based on all this information provided, the aim of this review is to explain potential risk factors associated with the development of physical activity in individuals with CP and to discuss the effects of improvements in physical activity levels on individuals with CP. Additionally, it aims to emphasize the importance of physical activity in individuals with CP and raise awareness on this issue.

Keywords: Children, Physical Activity, Cerebral Palsy

1. INTRODUCTION

Cerebral Palsy (CP) is one of the most common causes of physical disability in children. It causes movement limitations, various motor, sensory dysfunctions and other related problems (Rosenbaum et al., 2006). Spasticity, selective motor control losses, muscle weaknesses, and coordination disorders lead to decreased physical activity and a sedentary lifestyle in individuals with CP. However, there is a decrease in the variety of physical activities they participate in social life (Zwaier, 2010).

Spasticity, inadequate selective and isolated muscle contraction, ambulation issues, and proprioception loss are some of the reasons for the insufficient physical activity levels in individuals with CP. Particularly, individuals with CP who have lower levels of motor function and gross motor function are at a higher risk (Maher, Williams, Olds & Lane, 2007). Current research emphasizes the need to assess physical activity and incorporate informative programs for individuals with CP.

This review aims to explain potential risk factors associated with the development of physical activity in individuals with CP and discuss the effects of improvements in physical activity levels on individuals with CP. Additionally, the importance of physical activity in individuals with CP is highlighted in this review to increase awareness on this matter.

2. PHYSICAL ACTIVITY IN INDIVIDUALS WITH CEREBRAL PALSY

Physical activity is defined as movements that require energy expenditure above the basal level, generated by the contraction of skeletal muscles (Murphy & Carbone, 2008). It encompasses exercise, play, mobility, work, and participation in recreational activities. Muscle strength, flexibility, joint structure, and function are effective factors in maintaining these aspects for individuals (Murphy & Carbone, 2008).

Recent research indicates that individuals with CP have lower rates of participation in physical activity compared to their typically developing peers. Additionally, they are reported to spend twice as much time in sedentary activities (Carlson, Taylor, Dodd & Shield, 2013). Motor impairments seen in individuals with CP negatively affect the quality and speed of walking. This leads to high energy consumption, easy fatigue during activities involving walking, and consequently, a gradual decrease in the level of physical activity (Bjornson et al., 2007). Cardiorespiratory fitness and muscle endurance are lower in disabled children, and the obesity rate is higher. Rapid physical changes with advancing age, increased body weight, and height further contribute to increased inactivity (Mulligan et al., 2004).

In individuals with CP, identifying the factors that hinder or support participation in physical activity forms the basis for increasing their engagement in physical activities (Verschuren, Wiaart & Ketelaar, 2013). Key factors hindering participation in physical activity in individuals with CP include sedentary behavior habits, dislike of the activity, lack of motivation, and environmental barriers (Li & Chen, 2012). Insufficient levels of physical activity in individuals with CP adversely affect both the child's and the caregivers' quality of life. Additionally, it predisposes them to sleep problems (Enzin et al., 2022).

It is emphasized that increasing the level of physical activity, which is reduced in CP, and increasing interest in this issue. There are many different recommendations for increasing the level of physical activity (Verschuren et al., 2016). When considering these recommendations for individuals with CP, the individual's motor involvement level should be taken into account. Recommendations specific to each individual should be considered. Current research emphasizes the necessity of assessing physical activity and incorporating it into programs for individuals with CP (Verschuren et al., 2016).

3. CONCLUSIONS

Physical activity levels in individuals with CP are lower than their typically developing peers. They also lag behind in terms of the variety of physical activities they participate in daily life. The physical activity levels of individuals with CP are at risk in proportion to the gross motor function impairment level. Insufficient physical activity level in this population can exacerbate motor dysfunctions and further decrease the quality of life. The importance of physical activity in individuals with CP, the necessity for its dissemination, and supporting screening and intervention to increase physical activity in this pediatric population may be recommended. Additionally, increasing awareness among healthcare professionals working with individuals with CP is another recommendation.

In conclusion, it can be stated that the level of physical activity is a critical issue in individuals with CP and needs to be thoroughly investigated using comprehensive assessment tools. It is important for clinicians and academics to focus on the significance of physical activity in individuals with CP.

REFERENCES

- Bjornson, K.F., Belza, B., Kartin, D., Logsdon, R., McLaughlin, J.F. (2007) . Ambulatory physical activity performance in youth with cerebral palsy and youth who are developing typically. *Phys Ther*, 87,248–257.
- Carlon, S.L., Taylor, N.F., Dodd, K.J., Shields, N. (2013). Differences in habitual physical activity levels of young people with cerebral palsy and their typically developing peers: a systematic review. *Disability & Rehabilitation*, 35(8), 647-655.
- Enzin, F., Güzal, H. Ç., & Felek, S. (2022). Serebral Palsili Olgularında Fiziksel Aktivite Düzeyi ile Uyku Kalitesi Arasındaki İlişkinin Değerlendirilmesi. *Harran Üni Tıp Fak Derg*, 19(2), 354-360.
- Li, C., Chen, S. (2012). Exploring experiences of physical activity in special school students with cerebral palsy:a qualitative perspective. *European Journal of Adapted Physical Activity*, 5(1),7-12.
- Maher, C. A., Williams, M. T., Olds, T., & Lane, A. E. (2007). Physical and sedentary activity in adolescents with cerebral palsy. *Developmental Medicine & Child Neurology*, 49(6), 450-457.

Mulligan, H., Abbott, S., Clayton, P., McKegg, P., Rae, R. (2004). The outcome of a functional exercise programme in an adolescent with cerebral palsy: a single case study. *Journal of Physiotherapy*, 32(1), 30-38.

Murphy, N.A., Carbone, P.C. (2008). Promoting the participation of children with disabilities in sports, recreation and physical activities. *American Academy of Pediatrics*, 5,121.

Rosenbaum, P., Paneth, N., Leviton, A. et al. (2006). A report: the definition and classification of cerebral palsy. *Dev Med Child Neurol*, 29,8–14.

Verschuren, O., Peterson, M. D., Balemans, A. C., & Hurvitz, E. A. (2016). Exercise and physical activity recommendations for people with cerebral palsy. *Developmental Medicine & Child Neurology*, 58(8), 798-808.

Verschuren, O., Ketelaar, M., Gorter, J.W., Helders, P.J., Uiterwall, C.S., Takken, T. (2007). Exercise training program in children and adolescents with cerebral palsy: a randomized controlled trial. *Arch Pediatr Adolesc Med*, 161, 1075-81.

Zwier, J.N., Van Schie, P.E., Becher, J.G., Smits, D.W., Gorter, J.W., Dallmeijer, A.J. (2010). Physical activity in young children with cerebral palsy. *Disabil Rehabil*, 32, 1501–1508.

SEREBRAL PALSİLİ BİREYLERDE TIRNAK MORFOLOJİK DEĞİŞİKLİKLERİNİN İNCELENMESİ

Dr. Öğr. Üyesi Demet GÖZAÇAN KARABULUT

Gaziantep Islam Science and Technology University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Gaziantep, Turkey

ORCID ID: 0000-0001-9235-1059

Prof. Dr. Mehmet İbrahim TURAN

Gaziantep Medical Point Hospital, Department of Pediatric Neurology, Gaziantep, Turkey

ORCID ID: 0000-0001-7639-688X

ÖZET

Uluslararası Serebral Palsi (SP) Tanımlama Yürütme Komitesi SP'yi gelişmekte olan fetal veya yenidoğan beyinde meydana gelen, aktivite kısıtlamalarına neden olan, hareket ve postür gelişiminde kalıcı bozukluklara neden olan bir motor bozukluk olarak tanımlar. SP, doğum öncesi, doğum sırası ve doğum sonrası dönemde gelişimini tamamlamamış Merkezi Sinir Sistemi'nde, bir lezyon sonucu ortaya çıkar ve oluşan bu lezyon kalıcı, fakat ilerleyici değildir. SP'li bireylerde çeşitli nedenlerden kaynaklı tırnak yapılarında bozulmalar meydana gelebileceği belirtilmektedir. Bu hipotezden yola çıkarak bu araştırmada SP'li bireylerin el ve ayak tırnak morfolojik görünümleri değerlendirilmiştir. Bu çalışmanın amacı, SP'li bireylerin tırnak morfolojik değişikliklerini incelemektir.

Çalışmaya 6-16 yaş arası 16 SP'li birey dahil edildi. Bireylerin sosyodemografik özelliklerinin yanında hastalıklarına dair bazı bilgiler sorgulandı. Çalışmaya dahil edilen SP'li bireylerin Kaba Motor Fonksiyon Sınıflama Sistemi ile kaba motor fonksiyon seviyeleri belirlendi. Spastisite değerlendirmeleri ise Modifiye Ashworth Skalası ile yapıldı. SP'li bireylerin hem el hem ayak tırnakları morfolojik durumları incelendi.

Çalışmaya dahil olan SP'li bireylerin yaş verilerinin ortalaması 9.83 ± 3.26 , Kaba Motor Fonksiyon Sınıflama Sistemine göre seviyeleri I-III arasında, spastisite değerlendirmelerine göre ise sonuçları 0-3 arasında değişmekteydi. Tırnak morfolojik durumlarının incelenmesi sonucunda tırnak yapılarında, renk ve görünüm açısından, değişiklikler olduğu saptandı.

SP'li bireylerin tırnak morfolojilerinin değişkenlik gösterdiği gözlemlendi. SP'li bireylerin tırnak morfolojik değişikliklerini inceleyen daha çok çalışmaya ihtiyaç olduğu sonucuna varıldı.

Anahtar Kelimeler: Çocuk, Serebral Palsi, Tırnak

INVESTIGATION OF NAIL MORPHOLOGICAL CHANGES IN INDIVIDUALS WITH CEREBRAL PALSY

ABSTRACT

The International Cerebral Palsy (CP) Definition Implementation Committee defines CP as a motor disorder that occurs in the developing fetal or neonatal brain, causing activity restrictions and permanent disorders in the development of movement and posture. CP occurs as a result of a lesion in the Central Nervous System, which has not completed its development in the prenatal, natal and postnatal period, and this lesion is permanent but not progressive. It is stated that nail structures abnormalities may occur in individuals with CP due to various reasons. Based on this hypothesis, the finger and toe nail morphological appearances of individuals with CP were evaluated in this study. The aim of this study is to investigate the nail morphological changes in individuals with CP.

16 individuals with CP between the ages of 6 and 16 were included in the study. In addition to the individuals' sociodemographic characteristics, some information about their diseases was questioned. Gross motor function levels of individuals with CP included in the study were determined with the Gross Motor Function Classification System. Spasticity evaluations were made with the Modified Ashworth Scale. The morphological conditions of both fingernails and toenails in individuals with CP were examined.

The average age data of individuals with CP included in the study was 9.83 ± 3.26 , their levels ranged between I-III according to the Gross Motor Function Classification System, and their results ranged between 0-3 according to spasticity evaluations. As a result of the examination of the nail morphological conditions, it was determined that there were changes in the nail structures in terms of color and appearance.

It was observed that the nail morphologies in individuals with CP varied. It was concluded that more studies are needed examining the nail morphological changes in individuals with CP.

Keywords: Children, Cerebral Palsy, Nail

1. INTRODUCTION

Cerebral Palsy (CP) is a group of permanent disorders in movement and posture development, characterized by non-progressive disability that occurs in the developing brain, causing activity limitation. Posture and motor function disorders are observed in individuals with CP (Jones et al., 2007; Viehweger et al., 2008). The prevalence of CP in Turkey is 4.4/1,000 live births (Serdaroğlu et al., 2006). Posture and movement disorders that cause motor problems, permanent brain damage, and brain damage occurring before birth or in the first years of life are the three main criteria used in the clinical diagnosis of CP (Alexander & Matthews, 2015).

Although the involvement of the damaged brain area is not progressive, the consequences of disability and disability progress with the growth and development of the child. This leads to changes in clinical findings and developmental problems (Reddihough & Collins, 2003). Spasticity and muscle contractions, which are clinical findings, predispose to various nail disorders. It is known that the medications used by individuals with CP cause disorders in the nail structure (Güler et al., 2017). A systematic approach should be followed when evaluating nail structural disorders. Since the disorder may affect one or more nails, all 20 nails must be evaluated (Mayeaux, 2000). Fingernails and toenails should be evaluated comprehensively. Pitting, color, shape and contour defects in the nails are evaluated from different angles. There are studies on nail structures in conditions such as zinc and copper deficiency, systemic diseases and epilepsy problems (Armutcu et al., 2004). However, when the literature was examined, to the best of our knowledge, no study was found examining the nail structural conditions of individuals with CP.

Based on the hypothesis that structural alterations in nails may occur in individuals with CP due to various reasons, this research evaluated the morphological appearances of nails on the hands and feet of individuals with CP. Thus, it aimed to gain insight into whether there is a change in the nail structures of children with CP. In this context, this study aimed to examine the morphological changes in the nails of individuals with CP.

2. METHODS AND RESULTS

Sixteen children diagnosed with CP between the ages of 6-16 were included in the study. Children whose families agreed to participate were included in the study. Children whose parents could not be reached or were not willing to participate were excluded from the study. The socio-demographic information form created for the study included questions about the children's age, gender, height, weight, duration of physiotherapy and rehabilitation programs, and socio-demographic information of the children's parents. The Gross Motor Function Classification System (GMFCS) was used to classify the gross motor function levels of the children with CP included in the study (Günel et al., 2009). GMFCS was initially developed in 1997 and expanded in 2007, with Turkish validity and reliability established in 2011 (El et al., 2012). This system is a classification system based on movements initiated by the child, emphasizing sitting, changing positions, and mobility. In GMFCS, gross motor functions of children with CP are classified into 5 levels based on age ranges of 0-2 years, 2-4 years, 4-6 years, 6-12 years, and 12-18 years (Wood et al., 2000). GMFCS consists of five levels;

Level I: Walks independently. Level II: Walks with limitations. Level III: Walks using assistive devices that can be manually controlled. Level IV: Mobility is limited, and mobility is achieved using motorized devices. Level V: Mobility is achieved by being transported in a wheelchair.

Additionally, the morphological status of both the hand and foot nails of individuals with CP included in the study was examined. When evaluating nails, it is recommended to systematically examine all 20 nails of the individual (Mayeaux, 2000). Accordingly, all 20 nails were evaluated.

Written informed consent forms were obtained from all individuals participating in the study. The study was approved by the clinical research ethics committee (Protocol Number:2021/48). This study was conducted in accordance with the Principles of the Declaration of Helsinki.

The mean age of individuals with CP included in the study was 9.83 ± 3.26 years. The socio-demographic characteristics of the individuals are provided in Table 1. It was determined that, apart from the 4 children with GMFCS level I, in the children with GMFCS levels other than I, there were deviations from normal nail anatomic images.

Table 1. The physical and sociodemographic characteristics (n=16)

		Mean \pm S.D
Age		9.83 \pm 3.26
Height_(cm)		118.14 \pm 16.42
Weight_(kg)		24.16 \pm 12.23
		n (%)
Gender	Male	9 (56.25)
	Female	7 (43.75)
GMFCS Level	Level I	5 (31.25)
	Level II	6 (37.5)
	Level III	5 (31,25)
Educational Level of the Respondents	Primary School	9 (56.25)
	High School	5 (31.25)
	University	2 (12.50)
Income	Low	3 (18.75)
	Medium	10 (62.5)
	High	3 (18.75)

S.D: Standard Deviation, GMFCS: Gross Motor Function Classification System

3. CONCLUSION

In this study, nail morphological changes in individuals with CP were examined. It was found that the majority of CP-afflicted children included in the study exhibited deviations from the normal anatomic structures of nails. The conclusion drawn was that the nail morphological images of the participants were adversely affected. Upon reviewing the relevant literature, it is noteworthy that the assessment of nail morphologies in epileptic individuals has been examined

(Armutcu et al., 2004). However, the number of studies examining nail morphologies in children with CP is insufficient. It can be emphasized that there is a need for awareness campaigns and more comprehensive studies regarding the evaluation of nail morphologies in children with CP.

REFERENCES

- Alexander MA and Matthews DJ. Pediatric rehabilitation: principles and practice. 5th. Ed., New York: Demos Medical Publishing; 2015.
- Armutcu F, Özerol E, Gürel A, Kanter M, Vural H, Yakıncı C, Akyol Ö. (2004). Effect of Long-Term Therapy with Sodium Valproate on Nail and Serum Trace Element Status in Epileptic Children. *Biological Trace Element Research*, 102.
- El Ö, Baydar M, Berk H, Peker Ö, Koşay C, Demiral Y. (2012). Interobserver reliability of the Turkish version of the expanded and revised gross motor function classification system. *Disability and rehabilitation*, 34(12):1030-3.
- Güler S, Işık İ, İşcan A. (2017). Onychomadesis: A rare adverse effect in early-period valproic acid therapy. *Türk Pediatri Arşivi*, 52:98-100.
- Gunel, M. K., Mutlu, A., Tarsuslu, T., & Livanelioglu, A. (2009). Relationship among the Manual Ability Classification System (MACS), the Gross Motor Function Classification System (GMFCS), and the functional status (WeeFIM) in children with spastic cerebral palsy. *European journal of pediatrics*, 168, 477-485.
- Jones MW, Morgan E, Shelton JE, Thorogood C. (2007). Cerebral palsy: introduction and diagnosis (part I). *Journal of pediatric health care: official publication of National Association of Pediatric Nurse Associates & Practitioners*, 21(3):146-52.
- Mayeaux, E. J. (2000). Nail disorders. *Primary Care: Clinics in Office Practice*, 27(2), 333-351.
- Reddihough DS, Collins KJ. (2003). The epidemiology and causes of cerebral palsy. *Aust J Physiother*, 49(1):7-12.
- Serdaroglu A, Cansu A, Ozkan S, Tezcan S. (2006). Prevalence of cerebral palsy in Turkish children between the ages of 2 and 16 years. *Developmental medicine and child neurology*, 48(6):413-6.
- Viehweger E, Robitail S, Rohon MA, Jacquemier M, Jouve JL, Bollini G, et al. (2008). Measuring quality of life in cerebral palsy children. *Annales de readaptation et de medecine physique : revue scientifique de la Societe francaise de reeducation fonctionnelle de readaptation et de medecine physique*, 51(2):119-37.
- Wood E, Rosenbaum P. (2000). The gross motor function classification system for cerebral palsy: a study of reliability and stability over time. *Developmental medicine and child neurology*, 42(5):292-6.

KLAVÜLANİK ASİT VE AMOKSİSİLİN ETKEN MADDELİ SOĞUK ALGINLIĞI İLAÇLARIN TAYİNİNE YÖNELİK Fe₃O₄@MWCNT NANOKOMPOZİT TEMELLİ ELEKTROKİMYASAL SENSÖR GELİŞTİRİLMESİ

Elif Esra ALTUNER

Program of Medical Laboratory Techniques, Department of Medical services and Techniques, Europe Vocational School, Kocaeli Health and Technology University, Kocaeli,
ORCID ID: 0000-0001-7663-6898

Fatih ŞEN

Sen Research Group, Department of Biochemistry, Science&Art Faculty, Kutahya Dumlupınar University, Kutahya
ORCID ID: 0000-0001-6843-9026

ÖZET

Bu çalışmada öncelikle çok duvarlı karbon nanotüp (MWCNT) destekli demir (III) oksit nanopartikülleri (Fe₃O₄ NP'ler) kimyasal yöntemle sentezlendi ve Fe₃O₄@MWCNT NP'ler elde edildi. Fe₃O₄@MWCNT NP'lerin karakterizasyon analizleri henüz yapılmamış olup, soğuk algınlığı ilacı olarak kullanılan amoksisilin ve klavulanik asit türevlerinin duyarlılığı konusunda elektrokimyasal sensör çalışmalarına başlanmıştır. Bu çalışma hücresel hat üzerinde gerçekleştirildi ve çalışma elektrotu olarak camsı karbon elektrot (GCE), referans elektrot olarak gümüş/gümüş klorür elektrot (Ag/AgCl) ve hesaplama elektrotu (platin plaka) kullanıldı. Döngüsel voltametri (CV) analizinde Fe₃O₄@MWCNT NP'ler ile modifiye edilmiş camsı karbon elektrot (GCE) elektrot üzerinde görünür ve keskin piklerin ortaya çıktığı belirlendi. CV çalışmalarını daha iyi yorumlayabilmek için GCE, MWCNT/GCE ve Fe₃O₄@MWCNT NPs/GCE elektrotlarından ayrı ayrı ölçümler alındı. Elde edilen CV'lerin pik piklerinden elde edilen değerler ile tanı sınırı (LOD) ve belirleme sınırı (LOQ) belirlendi ve değerlerin uygun aralıklarda olduğu görüldü. Bu çalışma, aşırı kullanım sonucu kalp ve damarlarda pıhtı oluşmasına neden olabilecek ilaçların belirli dozlarının belirlenmesi ve daha kontrollü kullanılmasıyla insan sağlığı açısından faydalı bir çalışmadır. Aynı şekilde bu çalışma, farmasötik ilaçların nanoteknolojik alanında geliştirilmesi planlanan sensörlerin geliştirilmesine de ışık tutacaktır. Bu sayede farmasötik ilaçların tanısına yönelik elektrokimyasal çalışmaların nanoteknolojik alanda daha da artacağı ve literatüre daha fazla katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Amoksisilin; Elektrokimyasal sensör; Fe₃O₄@MWCNT NPs; Klavulanik asit.

DEVELOPMENT OF Fe_3O_4 @ MWCNT NANOCOMPOSITE-BASED ELECTROCHEMICAL SENSOR FOR THE DETERMINATION OF COLD DRUGS CONTAINING THE ACTIVE INGREDIENTS OF CLAVULANIC ACID AND AMOXICILLIN

ABSTRACT

In this study, firstly, multi-walled carbon nanotube (MWCNT) supported iron (III) oxide nanoparticles (Fe_3O_4 NPs) were synthesized by chemical method and Fe_3O_4 @MWCNT NPs were obtained. Characterization analyzes of Fe_3O_4 @MWCNT NPs have not been carried out yet, and electrochemical sensor studies have been started on the sensitivity of amoxicillin and clavulanic acid derivatives used as cold medicines. This study was carried out on the cellular line, and glassy carbon electrode (GCE) was used as the working electrode, silver/silver chloride electrode (Ag/AgCl) and calculating electrode (platinum plate) were used as the reference electrode. In the cyclic voltammetry (CV) analysis, it was determined that visible and sharp peaks appeared on the glassy carbon electrode (GCE) electrode modified with Fe_3O_4 @MWCNT NPs. To better interpret CV studies, separate measurements were taken from GCE, MWCNT/GCE and Fe_3O_4 @MWCNT NPs/GCE electrodes. The limit of diagnosis (LOD) and limit of determination (LOQ) were determined with the values obtained from the peak peaks of the CVs obtained and it was observed that the values were within appropriate ranges. This study is a useful study for human health by determining a certain dose of drugs that can cause clots in the heart and vessels as a result of overuse and their more controlled use. Likewise, this study will shed light on the development of sensors planned to be developed in the nanotechnological field of pharmaceutical drugs. In this way, it is thought that electrochemical studies for the diagnosis of pharmaceutical drugs will increase further in the nanotechnological field and contribute even more to the literature.

Keywords: Amoxicillin; Electrochemical sensor; Fe_3O_4 @MWCNT NPs; Clavulanic acid.

1. INTRODUCTION

Epidemic diseases in the world can become a disaster that leads to death if precautions are not taken (Alizadeh *et al.*, 2022). Epidemic diseases are caused by a serious decrease in body metabolism and immunity, and the common cold is one of these factors (Gu *et al.*, 2012). For this reason, pharmaceutical drugs for colds have taken their place in the commercial market and are used in treatment applications for patients. In particular, pills containing clavulanic acid and amoxicillin are among the most consumed cold medications.

The common cold is a viral infection that occurs in the nasal and throat passages (upper respiratory tract) (Diouf *et al.*, 2021). The common cold is caused by viruses, and there are over 200 viruses that cause the common cold (Mäkelä *et al.*, 1998). The most common cold viruses are rhinoviruses, coronaviruses, adenoviruses and RSV. There is no cure for the common cold. Treatment is aimed at relieving symptoms (Heikkinen and Järvinen, 2003). Medicines used for colds are: Painkillers and antipyretics, clavulanic acid and amoxicillin drugs used against bacterial infections (John *et al.*, 2014). Pills containing clavulanic acid and amoxicillin are antibiotics used in the treatment of bacterial infections. These pills contain a substance called clavulanic acid, which increases the killing effect of amoxicillin by breaking down the bacterial cell wall (Tekpetek and Tufan, 2014). These pills are usually taken by mouth. However, in some cases, especially in severe infections, it can also be given intravenously. Overdose of such drugs can cause serious damage, including heart clots. For this reason, researchers have given great importance to the development of sensitive, inexpensive and sensitive sensors for the diagnosis of pharmaceutical drugs.

Sensors are systematic devices that are sensitive to a specific analyte and provide a permanent signal (Altuner, Ozalp, M. Deniz Yilmaz, *et al.*, 2022). One of the most important features of sensors is that the signals always respond. The permanently obtained data is recorded in the detector via a transducer and converted into data (Orooji *et al.*, 2020). Electrochemical sensors are among the most preferred sensors group (Chokkareddy, Kumar Bhajanthri and Redhi, 2017). In sensors, these signals are received through electron exchange based on electron electrochemical redox reaction. For this, there is a catalyst that starts the catalytic reaction. Generally, nano metals are preferred for this purpose.

Nanotechnology is a branch of science that covers studies between 1-100 nm (Altuner, Gur and Şen, 2021). Nanotechnology catalytic reactions, sensors have a wide range of applications that are highly preferred in the field of health and medicine (Altuner *et al.*, 2021). For example, multi-wall carbon nanotube supported (MWCNT) iron (III) oxide nanoparticles (Fe_3O_4 @MWCNT NPs) were synthesized and a sensor against the tuberculosis drug rifampicin was developed (Alizadeh *et al.*, 2022). Or, a sensor sensitive to 3,3',5,5' tetra methyl benzidine (TMB) was developed by synthesizing chitosan-supported cobalt nanoparticles (Altuner, Ozalp, M Deniz Yilmaz, *et al.*, 2022).

In this study, just as the example of the rifampicin sensor was given above, MWCNT-supported Fe_3O_4 NPs were first synthesized and a sensor was developed for amoxicillin and clavulanic-

containing drugs. The obtained cyclic voltammetric analyzes (CVs) reflect the precision and sensitivity in very important currents.

2. MATERIAL&METHOD

2.1. Materials

All materials were supplied by Sigma&Aldrich. The synthesized $\text{Fe}_3\text{O}_4@\text{MWCNT}$ NPs were obtained from the materials used for the rifampicin sensor in the previous reported studies (Alizadeh *et al.*, 2022).

2.2. Instruments

Methrohm Dropsens $\mu\text{stat-i}$ 400s brand potentiostat was used for electrochemical analyses.

2.3. Synthesis of $\text{Fe}_3\text{O}_4@\text{MWCNT}$ NPs

The synthesis of nanoparticles was prepared according to $\text{Fe}_3\text{O}_4@\text{MWCNT}$ NPs prepared for the drug rifampicin (Alizadeh *et al.*, 2022). Subsequently, these nanoparticles showed catalytic effects in sensor studies for clavulanic acid and the drug amoxicillin.

3. RESULTS & DISCUSSION

In this study, $\text{Fe}_3\text{O}_4@\text{MWCNT}$ NPs are synthesized and used as a catalyst that initiates electron flow in electrochemical sensor studies. In this study, a triple cell system line was used, glassy carbon electrode (GCE) was used as the working electrode, silver/silver chloride (Ag/AgCl) electrode was used as the reference electrode, and platinum plate electrode was used as the calculating electrode. In our study, a comparison was made using GCE, MWCNT/GCE and $\text{Fe}_3\text{O}_4@\text{MWCNT}$ NPs/GCE electrodes. In addition, comparisons at different scanning speeds for each electrode also gave positive results. Figure 1 shows cyclic voltammetry (CVs) analyzes at different scanning speeds for all three types of electrodes.

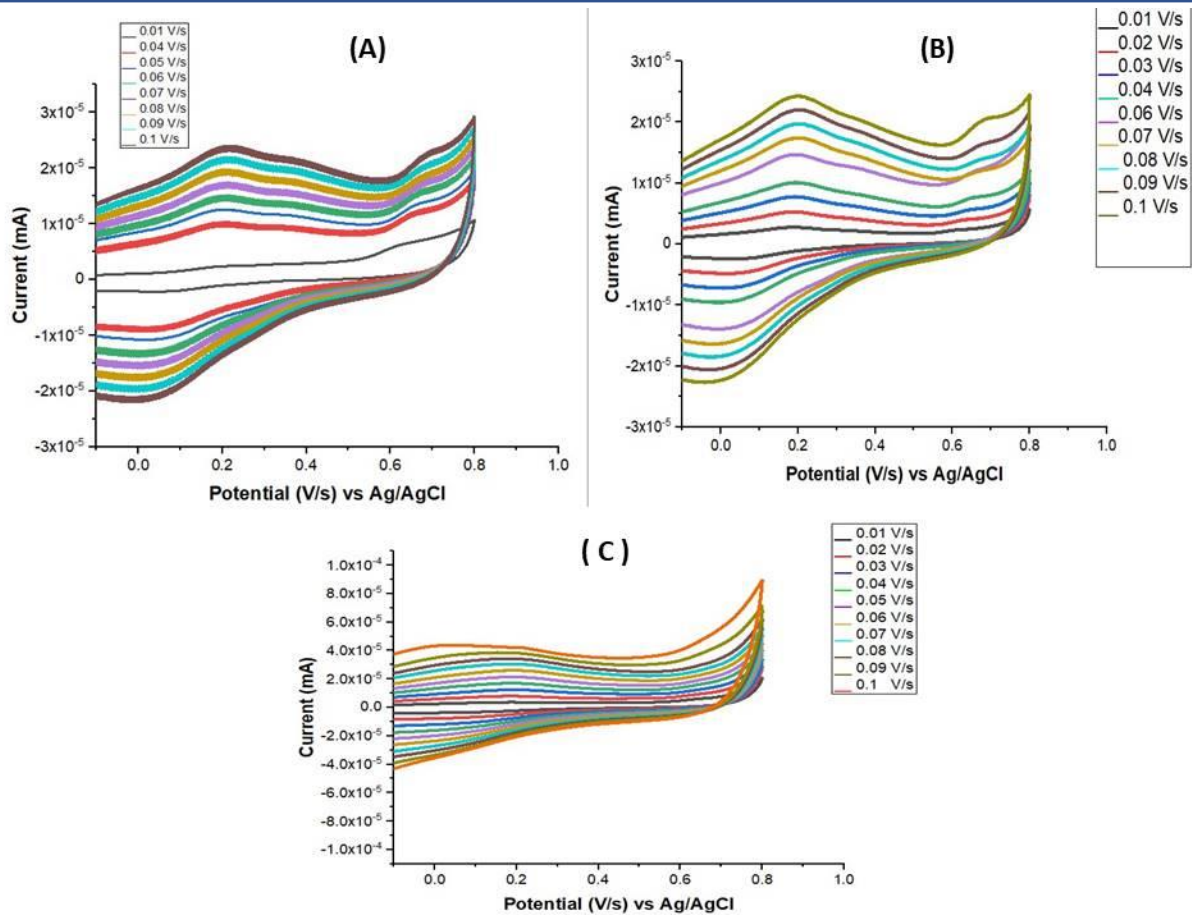


Figure 1. Three different electrodes results against to clavulanic acid and the drug amoxicillin at different scan rates (0.01-0.1 V/s) (A) MWCNT/GCE (B) Fe₃O₄@MWCNT NPs/GCE (C) GCE.

According to Figure 1, while the GCE electrode gave the lowest current against the drug at 0.01- 0.1 V/s, MWCNT/GCE gave a peak at slightly higher levels.

It was observed that when the electrode was supported with metal nanoparticles, the current response increased and reached its peak. This means that when metal nanoparticles came into play, the catalytic reaction reached its highest response and highest speed. In Figure 2, all three types the responses of the electrode to the drug at the same scan rate are observed.

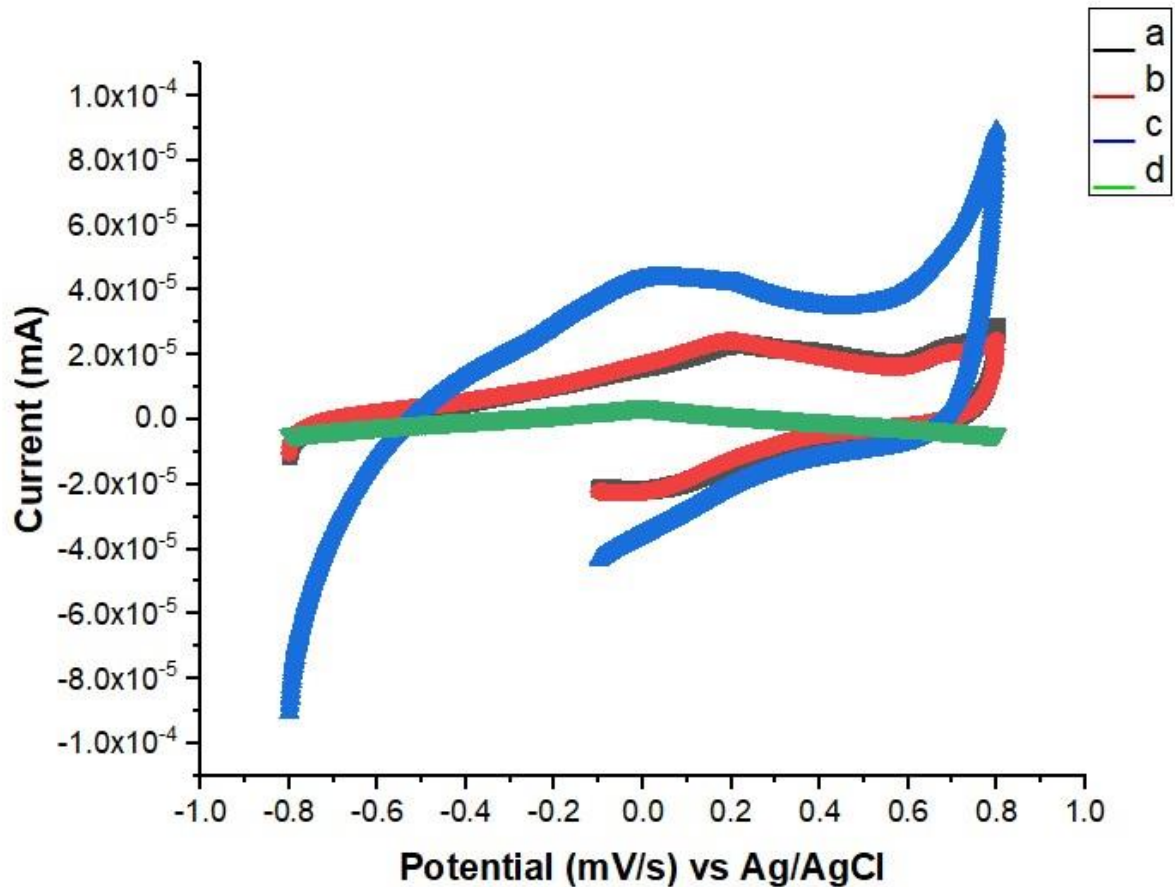


Figure 2. The different electrodes results against to same drug concentration at 0.1 V/s scan rate (a-b) MWCNT/ GCE (c) Fe_3O_4 @MWCNT/GCE (d) GCE.

According to Figure 2, at the same concentration and at the same scanning speed (0.01 V/s), GCE gave the lowest current against the pharmaceutical clavulanic + amoxicillin drug, while the (Fe_3O_4 @MWCNT/GCE) electrode modified with metallic nanoparticles gave the highest current and showed the highest sensory sensitivity.

4. CONCLUSION

In this study, Fe_3O_4 @MWCNT NPs were synthesized by chemical method and an electrochemical sensor was developed against clavulanic acid and amoxicillin pills used against colds. In this study, three different electrodes were used (GCE, MWCNT/GCE and Fe_3O_4 @MWCNT/GCE). First of all, CVs measurements were taken for all three types of electrodes at different scan rates (0.01-0.1 V/s) at the same concentration. In the measurements taken, it was observed that as the modification increased, the sensory catalytic activity against the drug increased. In the next step, the sensor response of all three electrodes was overlapped at the same concentration of drug and the same scan rate (0.1 V/s). It was observed that the CVs

analysis here supported the previous CVs analysis and that the Fe₃O₄@MWCNT/GCE electrode gave the highest sensor response.

REFERENCES

- Alizadeh, M. *et al.* (2022) ‘An ultra-sensitive rifampicin electrochemical sensor based on Fe₃O₄ nanoparticles anchored Multiwalled Carbon nanotube modified glassy carbon electrode’, *Chemosphere*, p. 136566. doi: 10.1016/J.CHEMOSPHERE.2022.136566.
- Altuner, E. E. *et al.* (2021) ‘Dendrimer-based nanocomposites for alcohol fuel cells’, *Nanomaterials for Direct Alcohol Fuel Cells*, pp. 337–352. doi: 10.1016/B978-0-12-821713-9.00007-X.
- Altuner, E. E., Ozalp, V. C., Yilmaz, M. Deniz, *et al.* (2022) ‘Development of electrochemical aptasensors detecting phosphate ions on TMB substrate with epoxy-based mesoporous silica nanoparticles’, *Chemosphere*, p. 134077. doi: 10.1016/J.CHEMOSPHERE.2022.134077.
- Altuner, E. E., Ozalp, V. C., Yilmaz, M Deniz, *et al.* (2022) ‘High-efficiency application of CTS-Co NPs mimicking peroxidase enzyme on TMB(ox)’, *Chemosphere*, 292, p. 133429. doi: 10.1016/J.CHEMOSPHERE.2021.133429.
- Altuner, E. E., Gur, T. and Şen, F. (2021) ‘Ternary/quaternary nanomaterials for direct alcohol fuel cells’, *Nanomaterials for Direct Alcohol Fuel Cells*, pp. 157–172. doi: 10.1016/B978-0-12-821713-9.00001-9.
- Chokkareddy, R., Kumar Bhajanthri, N. and Redhi, G. G. (2017) ‘A Novel Electrode Architecture for Monitoring Rifampicin in Various Pharmaceuticals’, *Int. J. Electrochem. Sci*, 12, pp. 9190–9203. doi: 10.20964/2017.10.13.
- Diouf, A. *et al.* (2021) ‘Tramadol sensing in non-invasive biological fluids using a voltammetric electronic tongue and an electrochemical sensor based on biomimetic recognition’, *International Journal of Pharmaceutics*, 593, p. 120114. doi: 10.1016/J.IJPHARM.2020.120114.
- Gu, Y. *et al.* (2012) ‘Inkjet printed antibiotic- and calcium-eluting bioresorbable nanocomposite micropatterns for orthopedic implants’, *Acta Biomaterialia*, 8(1), pp. 424–431. doi: 10.1016/j.actbio.2011.08.006.
- Heikkinen, T. and Järvinen, A. (2003) ‘The common cold’, *The Lancet*, 361(9351), pp. 51–59. doi: 10.1016/S0140-6736(03)12162-9.
- John, L. J. *et al.* (2014) ‘Patterns of Antimicrobial therapy in acute tonsillitis: A cross-sectional Hospital-based study from UAE’, *Anais da Academia Brasileira de Ciências*, 86(1), pp. 451–457. doi: 10.1590/0001-3765201420120036.
- Mäkelä, M. J. *et al.* (1998) ‘Viruses and bacteria in the etiology of the common cold’, *Journal of Clinical Microbiology*, 36(2), pp. 539–542. doi: 10.1128/JCM.36.2.539-542.1998/ASSET/3EC33F9C-D532-4F2E-8770-CBBFF6D79604/ASSETS/GRAPHIC/JM0280892001.JPEG.
- Orooji, Y. *et al.* (2020) ‘Cerium doped magnetite nanoparticles for highly sensitive detection of metronidazole via chemiluminescence assay’, *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 234, p. 118272. doi: 10.1016/J.SAA.2020.118272.
- Tekpetek, T. and Tufan (2014) *Amoksisilin molekülünün moleküler modellemesi*. Namık Kemal Üniversitesi. Available at: <http://acikerisim.nku.edu.tr:8080/xmlui/handle/20.500.11776/507> (Accessed: 5 September 2021).
- Akçaloğlu, N. 2019. Bor nitrür nano yapı takviyeli polimer kompozitlerin üretimi ve özelliklerinin araştırılması. Mersin Üniversitesi Fen Bilimleri Enstitüsü, Nanoteknoloji ve İleri Malzemeler Ana Bilim Dalı, Yüksek Lisans Tezi.
- Camerucci, M. A., Urretavizcaya, G., & Cavalieri, A. L. (2003). Sintering of cordierite-based materials. *Ceramics International*, 29(2), 159-168. [https://doi.org/10.1016/S0272-8842\(02\)00100-1](https://doi.org/10.1016/S0272-8842(02)00100-1)
- Çelik, O.C. 2008. Kordiyerit + Müllit, Kordiyerit + Anortit, Kordiyerit + Anortit + Müllit kompozit refrakterlerinin mikroyapısal incelenmesi. Gebze Yüksek Teknoloji Enstitüsü, Mühendislik ve Fen Bilimleri Enstitüsü, Malzeme Bilimi ve Mühendisliği Ana Bilim Dalı, Yüksek Lisans Tezi.
- Guczi, L., & Kiricsi, I. (1999). Zeolite supported mono-and bimetallic systems: structure and performance as CO hydrogenation catalysts. *Applied Catalysis A: General*, 186(1-2), 375-394. [https://doi.org/10.1016/S0926-860X\(99\)00156-8](https://doi.org/10.1016/S0926-860X(99)00156-8)

- Hamzawy, E. M., El-Kheshen, A. A., & Zawrah, M. F. (2005). Densification and properties of glass/cordierite composites. *Ceramics international*, 31(3), 383-389.
<https://doi.org/10.1016/j.ceramint.2004.06.003>
- Lao, X., Xu, X., Jiang, W., Liang, J., & Liu, J. (2019). Effect of excess MgO on microstructure and thermal properties of cordierite ceramics for high-temperature thermal storage. *Ceramics International*, 45(17), 22264-22272.
<https://doi.org/10.1016/j.ceramint.2019.07.252>
- Tareq, R., Akter, N., & Azam, M. S. (2019). Biochars and biochar composites: low-cost adsorbents for environmental remediation. In *Biochar from biomass and waste* (s. 169-209). Elsevier.
<https://doi.org/10.1016/B978-0-12-811729-3.00010-8>

AKTİF KARBON DESTEKLİ ÇİNKO NANOPARTİKÜLLERİN SENTEZLENMESİ VE METANOL BAZLI YAKIT HÜCRELERİNE KARŞI OKSİDASYONU

Elif Esra ALTUNER

Program of Medical Laboratory Techniques, Department of Medical services and Techniques, Europe
Vocational School, Kocaeli Health and Technology University, Kocaeli,

ORCID ID: 0000-0001-7663-6898

Fatih ŞEN

Sen Research Group, Department of Biochemistry, Science&Art Faculty, Kutahya Dumlupınar
University, Kutahya

ORCID ID: 0000-0001-6843-9026

ÖZET

Bu çalışmada aktif karbon (AC) destekli monometalik çinko nanopartikülleri (Zn NPs) sentezlenmiş olup metanole karşı verdiği oksidasyon reaksiyonları gözlemlenerek (MOR) yakıt hücrelerine karşı bir elektrokimyasal hassasiyet gerçekleştirilmiştir. Bunun için öncelikli olarak Zn @AC NP'ler kimyasal metot vasıtasıyla sentezlenmiştir. Özellikle metanol ile çalışan yakıt hücreleri günümüzde oldukça yaygın oldur. Metanol alkoller içinde en düşük karbon sahip sayısına sahip olması nedeniyle oksidasyon reaksiyonları hızlı gerçekleşir. Dolayısıyla metanol çabuk parçalanarak oksidasyon gerçekleşir. Bu çalışmada elektrokimyasal Zn@AC NP'ler çalışma elektroduna modifiye edilerek yakıt hücresi çalışmalarına geçilmiştir. Çalışma elektrodu olarak camsı karbon elektrot (GCE), referans elektrot olarak (Ag/AgCl) ve hesaplayıcı elektrot olarak platin levha kullanılmıştır. Dolayısıyla hücre hattımız üçlü hücre hattıdır. Elektrokimyasal oksidasyon çalışmaları döngüsel voltametrik analiz (CV) kullanılarak gerçekleştirilmiştir. CV'ler alınarak yapılan analiz çalışmalarında öncelikle bir elektroda Zn NP'ler modifiye edilmiştir. Diğer ikinci ve üçüncü çalışmalarda ise sırasıyla AC ve Zn NPs@AC modifiye edilerek CV'ler alınmıştır. Elde edilen sonuçlara göre Zn@AC NP'lerin metanole karşı daha etkili ve duyarlı bir MOR reaksiyonu verdiği gözlemlenmiştir. Bu çalışmada sentezlenen Zn@AC NP'lerin henüz karakterizasyonu çekilmemiştir. Ancak CV analizleri sonucu elde edilen değerlerin MOR reaksiyonu verecek etkili bir şekilde yakıt hücresini çalıştırdığı gözlemlenmiştir. Bu çalışma yakıt hücreleri çalışmalarına yönelik geliştirilecek oksidasyon reaksiyon sitemlerine öncü olacak ve fikir verici bir nitelikte bir çalışmadır.

Anahtar Kelimeler: Yakıt; Elektrokimyasal çalışmalar; MOR; Zn@AC NPs.

SYNTHESIS OF ACTIVE CARBON SUPPORTED ZINC NANOPARTICLES AND THEIR OXIDATION AGAINST METHANOL-BASED FUEL CELLS

ABSTRACT

In this study, activated carbon (AC) supported monometallic zinc nanoparticles (Zn NPs) were synthesized and an electrochemical sensitivity to fuel cells was achieved by observing their oxidation reactions against methanol (MOR). For this purpose, primarily Zn@AC NPs were synthesized via chemical method. Fuel cells, especially those running on methanol, are quite common today. Since methanol has the lowest carbon number among alcohols, oxidation reactions occur quickly. Therefore, methanol breaks down quickly and oxidation occurs. In this study, electrochemical Zn@AC NPs were modified into the working electrode and fuel cell studies were started. Glassy carbon electrode (GCE) was used as the working electrode, (Ag/AgCl) as the reference electrode and platinum plate as the calculating electrode. Therefore, our cell line is a triple cell line. Electrochemical oxidation studies were performed using cyclic voltammetric analysis (CV). In the analysis studies carried out by taking CVs, Zn NPs were first modified on one electrode. In the other second and third studies, CVs were obtained by modifying AC and Zn NPs@AC, respectively. According to the results obtained, it was observed that Zn@AC NPs gave a more effective and sensitive MOR reaction against methanol. The Zn@AC NPs synthesized in this study have not been characterized yet. However, it has been observed that the values obtained as a result of CV analyzes effectively operate the fuel cell by giving a MOR reaction. This study is an insightful study that will pioneer the oxidation reaction systems to be developed for fuel cells.

Keywords: Fuel; Electrochemical studies; MOR; Zn@AC NPs.

1. INTRODUCTION

Energy is an important need today (Wu *et al.*, 2022). For this reason, humankind has turned to fossil fuels to meet this need, but as fossil fuels pollute the environment and their reserves decrease, researchers have started to search for cleaner energy (Altuner, El Houda Tiri, *et al.*, 2022). Alcohol fuel cells are one of these areas (Altuner, Gur and Şen, 2021).

Fuel cells are the most effective, healthiest and the most useful energy source because they convert chemical energy directly to fuel energy. The types of fuel cells are alkaline (AFC), olten carbonate (MCFC), phosphoric acid (PAFC), proton exchance membrane (PEMFC) and solid oxide (SOFC) fuel cells (Altuner, Bekmezci, *et al.*, 2021; Altuner, Gur and Şen, 2021). Fuel cells use hydrogen, methane and some organic materials, carbon monoxide, and methanol (methyl alcohol) as fuel (Altuner, Arıkan, *et al.*, 2021; Altuner, Bekmezci, *et al.*, 2021; Altuner,

Gur and Şen, 2021). Methanol fuel cells are a subcategory of proton exchange membrane fuel cells (PEMFC). In these cells, methanol is used as fuel. Methanol produces electrical energy by oxidizing to hydrogen and carbon dioxide. In methanol fuel cells, methanol is oxidized at the anode electrode. In this study, zinc nanoparticles (Zn NPs) were synthesized by chemical synthesis method and stabilized with activated carbon (AC). The obtained Zn@AC NPs were tested in electrochemical studies in methanol and a useful fuel cell was obtained. In this reaction, methanol is split into hydrogen and carbon dioxide. Hydrogen is split into protons and electrons. Protons pass through the electrolyte to the cathode electrode (Altuner, Bekmezci, *et al.*, 2021). Electrons produce electricity by flowing through an external circuit. At the cathode electrode, hydrogen and oxygen combine to form water. The advantages of methanol fuel cells are as follows: Methanol is easier to store and transport than hydrogen and has a lower cost (Altuner, Akin, *et al.*, 2022).

Nanotechnology covers scientific studies between 1-100 nm (Altuner, Bekmezci and Sen, 2022). Therefore, the working area is very wide. Nanotechnology has a wide range in sensor studies, fuel cells, and energy studies, and in the field of health and medicine (Altuner, Erduran and Sen, 2023). For example, *Bayat and his colleagues* synthesized platinum nanoparticles using the green synthesis method and achieved significant efficiency in fuel cells (Bayat *et al.*, 2023). Likewise, *Sen Research Group* has many studies reported in the literature on fuel cells. In this study, zinc nanoparticles (Zn NPs) were synthesized by chemical synthesis method and stabilized with activated carbon (AC). The obtained Zn@AC NPs were tested in electrochemical studies in methanol and a useful fuel cell was obtained.

2. Materials & Methods

2.1. Materials

Methrohm Dropsens µstat-i 400s brand potentiostat was used for electrochemical analyses.

2.2. Instruments

Methrohm Dropsens µstat-i 400s brand potentiostat was used for electrochemical analyses.

2.3. Synthesis of Zn@AC NPs

Zn@AC NPs were synthesized according to the work previously reported in the literature by *Ameen et al* (Ameen *et al.*, 2022).

3. RESULTS & DISCUSSION

In this study, a methanol fuel cell (MOR) was created by analyzing the reaction of Zn@AC NPs synthesized against methanol. For this reason, in the electrochemical analyzes performed, a triple cell line was used, glassy carbon electrode (GCE) was used as the working electrode, silver/silver chloride electrode (Ag/AgCl) was used as the reference electrode, and platinum

(Pt) plate was used as the calculating electrode. The NPs synthesized here are a catalyst that initiates oxidation in the MOR system. For this reason, GCE was first modified with AC and then Zn@AC NPs and compared with the bare electrode. This comparison is as in figure 1.

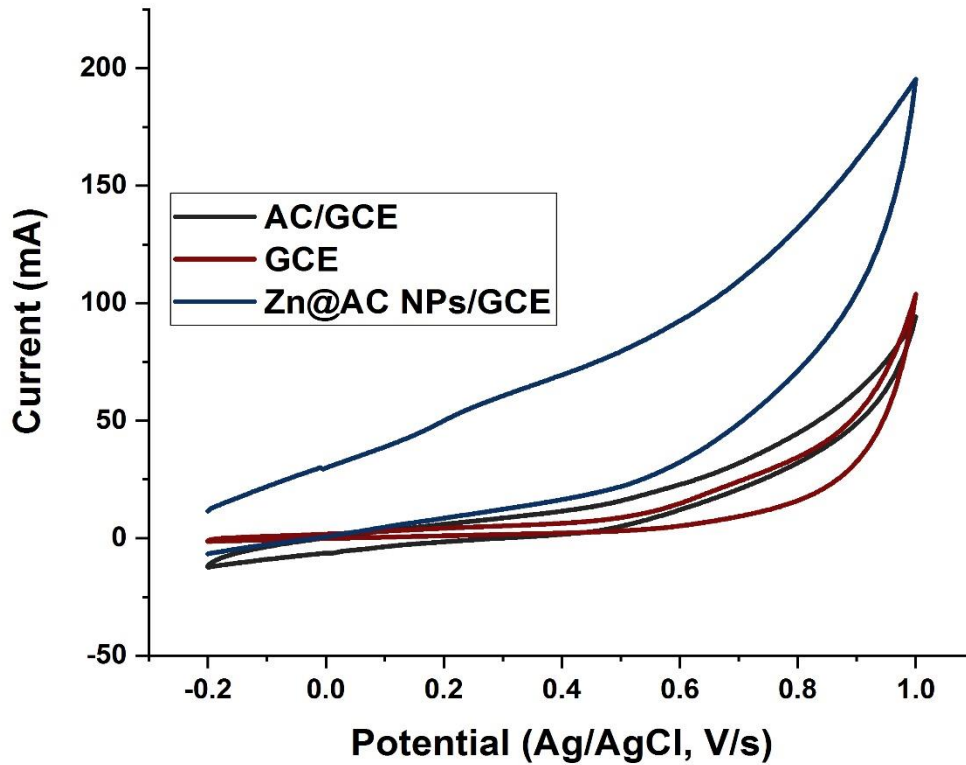


Figure 1. MOR system by using Zn@AC NPs.

According to Figure 1, as the modification increases, the MOR reaction increases. Therefore, the highest oxidation level was reached with the introduction of metallic nanoparticles. against the AC coated electrode.

Oxidation is partially at a lower level and oxidation is almost non-existent against the bare electrode.

4. CONCLUSION

In this study, Zn@AC NPs were synthesized with the help of chemical method and a fuel cell was created by examining the methanol oxidation reaction (MOR) against methanol. Compared to the obtained MOR fuel cell, the MOR fuel cell operated at higher sensitivity and current with the introduction of metallic nanoparticles. In the absence of metallic nanoparticles, the current against the AC is relatively low and in the absence of any agent, the MOR system did not work at all.

REFERENCES

- Altuner, E. E., Arıkan, K., *et al.* (2021) ‘Commercial aspects of direct alcohol fuel cells’, *Nanomaterials for Direct Alcohol Fuel Cells*, pp. 511–524. doi: 10.1016/B978-0-12-821713-9.00012-3.
- Altuner, E. E., Bekmezci, M., *et al.* (2021) ‘Dendrimer-based nanocomposites for alcohol fuel cells’, *Nanomaterials for Direct Alcohol Fuel Cells*, pp. 337–352. doi: 10.1016/B978-0-12-821713-9.00007-X.
- Altuner, E. E., Akin, M., *et al.* (2022) ‘Challenges in commercialization of carbon nanomaterial-based sensors’, *Carbon Nanomaterials-Based Sensors: Emerging Research Trends in Devices and Applications*, pp. 381–392. doi: 10.1016/B978-0-323-91174-0.00020-2.
- Altuner, E. E., El Houda Tiri, R. N., *et al.* (2022) ‘Hydrogen production and photocatalytic activities from NaBH₄ using trimetallic biogenic PdPtCo nanoparticles: Development of machine learning model’, *Chemical Engineering Research and Design*. doi: 10.1016/J.CHERD.2022.05.021.
- Altuner, E. E., Bekmezci, M. and Sen, F. (2022) ‘Manufacturing Techniques of Magnetic Polymer Nanocomposites’, *Handbook of Magnetic Hybrid Nanoalloys and their Nanocomposites*, pp. 1–16. doi: 10.1007/978-3-030-34007-0_12-1.
- Altuner, E. E., Erduran, V. and Sen, F. (2023) ‘Green synthesized nanomaterials for bioimaging’, in *Synthesis of Bionanomaterials for Biomedical Applications Micro and Nano Technologies*. Elsevier, pp. 265–286. doi: 10.1016/B978-0-323-91195-5.00023-4.
- Altuner, E. E., Gur, T. and Şen, F. (2021) ‘Ternary/quaternary nanomaterials for direct alcohol fuel cells’, *Nanomaterials for Direct Alcohol Fuel Cells*, pp. 157–172. doi: 10.1016/B978-0-12-821713-9.00001-9.
- Ameen, F. *et al.* (2022) ‘Highly active iron (II) oxide-zinc oxide nanocomposite synthesized Thymus vulgaris plant as bioreduction catalyst: Characterization, hydrogen evolution and photocatalytic degradation’, *International Journal of Hydrogen Energy*. doi: 10.1016/J.IJHYDENE.2022.11.229.
- Bayat, R. *et al.* (2023) ‘Biogenic platinum based nanoparticles: Synthesis, characterization and their applications for cell cytotoxic, antibacterial effect, and direct alcohol fuel cells’, *Chemical Engineering Journal Advances*, 14, p. 100471. doi: 10.1016/J.CEJA.2023.100471.
- Wu, Y. *et al.* (2022) ‘Synthesis of novel activated carbon-supported trimetallic Pt–Ru–Ni nanoparticles using wood chips as efficient catalysts for the hydrogen generation from NaBH₄ and enhanced photodegradation on methylene blue’, *International Journal of Hydrogen Energy*. doi: 10.1016/J.IJHYDENE.2022.07.152.

MR GÖRÜNTÜLERİNDEN BEYİN TÜMÖRÜ BÖLÜTLEMESİ VE ORANSAL BÜYÜKLÜK TESPİTİ

Funda ASLANTAŞ BEYİN

National Defence University Army NCO Vocational HE School, Department of Electronic Communication Technology

ORCID ID: 0000-0002-9387-7703

Ahmet KORKMAZ

National Defence University Army NCO Vocational HE School, Department of Electronic Communication Technology

ORCID ID: 0000-0001-8706-7272

Haydar ÖZKAN

Bursa Technical University, Faculty of Engineering and Natural Sciences, Department of Computer Engineering

ORCID ID: 0000-0002-7528-8091

ÖZET

Beyin, insan vücudunun en önemli ve hayati organıdır. Diğer tüm hayati yapıların kontrolü ve koordinasyonu beyin tarafından gerçekleştirilir. Beyin Tümörü, beyindeki bazı hücrelerin sınırsız büyümesi ve hücre bölünmesinin kontrolsüz çoğalmasıyla oluşmaktadır. Beyin tümörleri, ne kadar hızlı büyüdüklerine ve tedaviden sonra tekrar büyüme olasılıklarına göre derecelendirilir. Beyin tümörü segmentasyonu, kanser tanısı ve tedavisi ile tedavi sonuçlarının değerlendirilmesinde kritik bir rol oynarken, beyin tümörü dokusunu yağ, ödem, normal beyin dokusu ve beyin omurilik sıvısı gibi diğer dokulardan ayırmak için yapılmaktadır. Beyin tümörü tespiti, tümörün tam boyutunu, şeklini, sınır çıkarımını ve yerini bulmaya yardımcı olmaktadır. Beyin organının insan vücudundaki önemi düşünüldüğünde, beyin tümörü tespiti ve segmentasyonu alanında yapılacak çalışmalara büyük ihtiyaç duyulmaktadır. Manyetik rezonans (MR) görüntülerinin işlenmesi çok karmaşıktır ve doktorlara hastaları daha iyi teşhis etme yeteneği kazandırmak için araştırmacılar tarafından sürekli olarak incelenmektedir. Bu çalışmada, beyin MR görüntülerinde tümör tespiti ve segmentasyonu için görüntü işleme tekniklerini kullanan morfoloji tabanlı bir tespit sistemi önerilmiştir. Önerilen yöntemde, beyin tümörü tespit etmek için ön işleme, eşikleme ve morfolojik işlemler ile segmentasyon işlemi gerçekleştirilmiştir. Beyin tümörünü tespit etmek için taranmış MR görüntüleri girdi olarak verilmektedir. Toplam 155 tümörlü beyin görüntüsünün tamamında tümör başarılı bir şekilde tespit edilerek görüntüdeki tümörün beyinde kapladığı alan oransal olarak ortaya konulmuştur. Hesaplanan tümör alanı, tümörün evresinin belirlenmesinde ve hastalığın tedavisinde önemli bir rol oynamaktadır.

Anahtar Kelimeler: Beyin tümör segmentasyonu; manyetik rezonans görüntü (MR), tümör bölütleme, eşikleme.

BRAIN TUMOR SEGMENTATION AND PROPORTIONAL SIZE DETECTION FROM MR IMAGES

ABSTRACT

The brain is the most important and vital organ of the human body. Control and coordination of all other vital structures is carried out by the brain. Brain Tumor occurs due to unlimited growth of some cells in the brain and uncontrolled cell division. Brain tumors are graded based on how fast they grow and how likely they are to grow back after treatment. While brain tumor segmentation plays a critical role in cancer diagnosis and treatment and evaluation of treatment results, it is performed to separate brain tumor tissue from other tissues such as fat, edema, normal brain tissue and cerebrospinal fluid. Brain tumor detection helps find the exact size, shape, border extraction and location of the tumor. Considering the importance of the brain organ in the human body, there is a great need for studies in the field of brain tumor detection and segmentation. The processing of magnetic resonance (MRI) images is very complex and is constantly being studied by researchers to give doctors the ability to better diagnose patients. In this study, a morphology-based detection system that uses image processing techniques for tumor detection and segmentation in brain MR images is proposed. In the proposed method, pre-processing, thresholding and morphological processes and segmentation were performed to detect brain tumor. Scanned MRI images are given as input to detect brain tumor. The tumor was successfully detected in all 155 brain images with tumors, and the area covered by the tumor in the brain in the image was revealed proportionally. The calculated tumor area plays an important role in determining the stage of the tumor and in the treatment of the disease.

Keywords: Brain tumor segmentation; magnetic resonance imaging (MR), tumor segmentation, thresholding.

1. GİRİŞ

Beyin, insan vücudundaki kontrol mekanizma organı ve koordinasyon merkezi olması sebebi ile kritik öneme sahiptir. Vücut ana fonksiyonlarında meydana gelen herhangi bir aksamanın sebebi beyin hücrelerinin kontrolsüz ve anormal çoğalması ile oluşan beyin tümörleri olabilir. Beyin tümörlerinin tedavisi hasta kişinin tümör yapısının karakteristik olmasından dolayı kişiye özeldir ve erken teşhisin tedavideki rolü oldukça büyüktür.

Medikal görüntülerde segmentasyon, farklı dokuların veya yapıların ayrıştırılması için kullanılır. Bu, doktorların hastalıkları teşhis etmesine ve tedavi planlarını oluşturmasına yardımcı olmaktadır. Ayrıca, segmentasyon teknikleri, tıbbi görüntülerin analizinde kullanılan diğer yöntemlerin temelini oluşturur. Bu nedenle, doğru bir şekilde yapıldığında,

segmentasyonun hastalara ve doktorlara birçok faydası vardır. Beyin segmentasyonu, beyin görüntülerinde farklı dokuların ayrıştırılması için kullanılan bir görüntü işleme tekniğidir ve nörobilim araştırmalarında da yaygın olarak kullanılmaktadır.

Literatürde MR görüntülerinden beyin tümörünün tespiti konusunda birçok çalışma mevcuttur. Badran ve arkadaşları MR görüntülerini kullanarak beyindeki tümör bölgesini tanımlamaya yönelik bilgisayar tabanlı bir yöntem sunmuşlardır. Sinir ağı teknikleri kullanarak ön işleme, görüntü bölütleme, özellik çıkarma ve görüntü sınıflandırma adımlarını içeren, tümörlü beyin ile sağlıklı beyin sınıflandırması gerçekleştirmişlerdir ve tüm işlevleri yerine getirmek için MATLAB’da bir arayüz oluşturmuşlardır (Badran, Mahmoud ve Hamdy, 2010). Murthy ve Sadashivappa çalışmalarında beyin tümör segmentasyonu gerçekleştirmek için görüntüye Sobel filtresi uygulayarak ön işleme yapmışlardır. Histogram eşitleme, eşikleme ve morfolojik işlemler kullanarak segmentasyon ile tümör tespiti sağlamışlardır. Aynı zamanda tıbbi uygulamalarda kullanılmak üzere tümörlere ait bazı özellikler çıkarmışlardır (Murthy ve Sadashivappa, 2014). Hunnur ve arkadaşları beyin tümörünün eşikleme yöntemi ile saptanmasını açıkladıkları çalışmalarında kenar çıkarma algoritması kullanarak tümörün boyutlarını hesaplayarak tümörün evresi hakkında da bilgi vermişlerdir (Hunnur, Raut ve Kulkarni, 2017). Kapil ve Shukla’nın çalışmaları, MR görüntülerinden tümörün çıkarılması için sinir ağları, bulanık ortalamalar, işaretleyici tabanlı, K-ortalamları ve histogram, bölge büyütme gibi farklı segmentasyon tekniklerinin karşılaştırmalı bir analizini sunmuşlardır (Shukla ve Kapil, 2017). Bulut ve arkadaşları Markov Random Field (MRF), Kapur, Kittler ve Otsu algoritmaları ile MR görüntülerindeki tümörlü bölgeleri elde etmeyi amaçlamışlardır. Yöntemler, veri setindeki her görüntünün daha önceden tespit edilmiş bölgelerine (ROI – Region of Interest) ayrı ayrı uygulanmıştır (Bulut, Kılıç ve İnce, 2018). Maurya ve Wadhvani, beyin MR görüntülerinde tümör segmentasyonu için morfoloji tabanlı bir görüntü işleme tekniği önermişlerdir. Yüksek frekanslı gürültü bileşenlerini elimine etmek amacı ile anizotropik difüzyon filtresi ve kafatası ayırma ön işleme adımları kullanılarak tümörü doğru bir şekilde tespit etmişlerdir (Maurya ve Wadhvani, 2021). Khan ve arkadaşları, MR görüntülerinde beyin tümörlerini tespit etmek için ön işleme, segmentasyon, eşikleme, özellik çıkarma ve sınıflandırma kullanmışlardır. Görüntüleri yüklemek, sonuçları çizmek ve kullanıcıya ya da doktora, MR görüntüsünün sağlıklı bir deneğe mi yoksa bir tümör hastasına mı ait olduğunu göstermek için bir GUI (Grafik Kullanıcı Arayüzü) tasarlamışlardır (Khan, Khan, Arshad, Baloch, Shaheen ve Tariq, 2021). Divya ve arkadaşları, tümörlerin şüpheli bölgelerini kesin olarak ayırt etmek için kenar bölme ve morfolojik aktivite ile desteklenen başka bir yöntem kullanmışlardır. Geliştirilen yöntem; gürültü giderme, filtreleme,

segmentasyon, tümör sınırlarını belirleyen çerçeve, tek başına tümör, tümör taslağı ve saptamayı içermektedir (Dharshini, Divya, Manjula, Regin, Hussein ve Al-Attar, 2022). Prabha ve arkadaşları, çeşitli filtreler yoluyla gürültüyü azaltarak görüntüyü iyileştirmek için ön işleme adımları yapmışlardır. Eşik segmentasyonu temeline dayanan çalışmada morfolojik işlemler ile görüntü çıkarma yöntemi kullanılarak tümör bölgesi çıkarımı gerçekleştirmişlerdir (Prabha, Gujjarlapudi, Ravi, Satuluri ve Nekkanti, 2023).

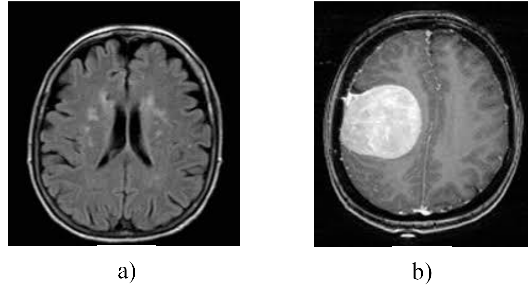
Bu çalışmada görüntülerde öncelikli olarak ön işleme yapılmıştır. Veri setinde bulunan görüntülerde tümör ve beyin görüntülerinin renk tonları farklı hastalarda çok farklılık içermektedir. Tüm görüntüleri benzer tonla normalize etmek için bir referans görüntü ile histogram eşleştirme yöntemi gerçekleştirildi. Bu sayede tüm görüntülerin histogramları birbirlerine benzer aralığa getirildi. Bu aşamadan sonra görüntülerden kafa tası kaldırıldı ve gürültü bileşenlerini kaldırmak için Gauss yumuşatma filtresi uygulandı. Daha sonra adaptif eşikleme yöntemi kullanılarak farklı tümör yapılarını tespit edebilen beyin segmentasyonu gerçekleştirildi. Ancak bölütlenen parçanın kenarlarında ve içinde istenmeyen çentikler ve boşluklar yer alması sebebiyle bu problemlerin giderilmesi için de morfolojik işlemler kullanıldı. Böylece beyin içerisindeki konumuna bağlı olarak gerçek şekil ve boyutlarda tümör bölütleme işlemi gerçekleştirildi. Daha sonra piksel büyüklük ve sayılarına bağlı olarak da tümörün beyinde ne kadarlık bir alan kapladığı oransal olarak ortaya konuldu.

Çalışmanın kalan kısmı üç bölümden oluşmaktadır. II. bölümde çalışmada kullanılan materyal ve yöntemin açıklamasına, III. bölümde elde edilen deneysel sonuçlara ve son bölümde ise sonuç ve tartışma kısmına yer verilmiştir.

2. MATERYAL VE YÖNTEM

2.1. Veri Seti

Literatürde beyin tümör segmentasyonu gerçekleştirmek için kullanılan farklı veri setleri mevcuttur. Bu çalışmada 'Brain MR Images for Brain Tumor Detection' isimli, toplamda 253 beyin MR görüntüsü içeren Kaggle veri seti kullanılmıştır (Chakrabarty, 2023). Bu veri setinde 98 tümörsüz, 155 tümörlü görüntü bulunmaktadır. Veri setindeki beyin MR görüntülerinde tümörler farklı büyüklükte ve beynin farklı kısımlarında yer almaktadır. Şekil 1-a'da sağlıklı bir bireyin beyin MR görüntüsü, Şekil 1-b'de ise veri setinden rastgele seçilmiş beyin tümörüne sahip bir hastanın beyin MR görüntüsü verilmiştir.

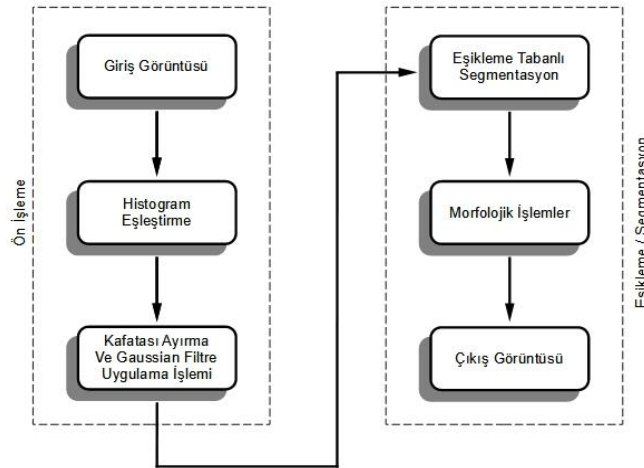


Şekil 1. a) Veri setinde yer alan normal beyin görüntüsü. b) Veri setinde yer alan tümörlü beyin görüntüsü

2.2. Yöntem

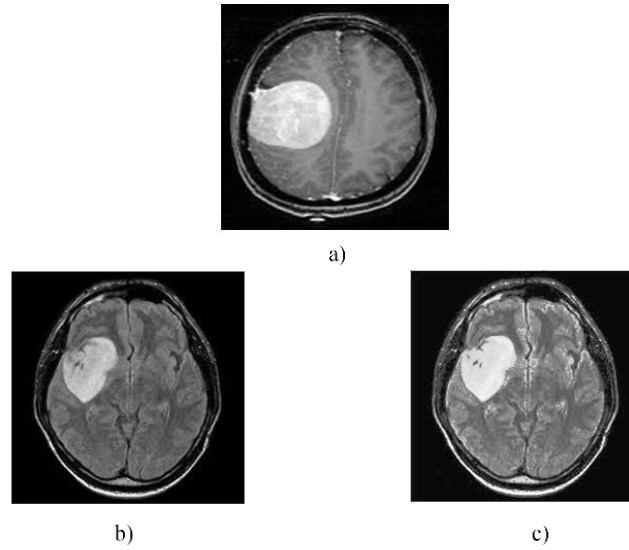
Bu çalışmada MR görüntülerinden beyin tümör bölütleme yapılırken izlenen aşamalar Şekil 2’de gösterilmiştir. Her beyin MR görüntüsünün karakteristik yapısı birbirinden farklıdır. Bu farklılık MR görüntüsünün elde edilmiş şekline, tümör yapısındaki öznelliklere, tümör büyüklüğüne, tümörün konumuna bağlı olabilmektedir. Bu aşamada görüntüleri belirli bir standarda taşımak için, görüntünün belirli ön işleme adımlarından geçirilerek eşik segmentasyonuna hazır hale getirilmesi işlemi gerçekleştirilmiştir.

Ön işleme adımları tüm MR görüntüleri gri seviyeli görüntülere dönüştürüldükten sonra gerçekleştirilmiştir. Birinci aşama olarak histogram eşleştirme uygulanmıştır. Histogram eşleştirme, kontrastı artırmak için yapılan bir ön işleme adımıdır. Buna bağlı olarak, görüntünün kontrastı artar ve ayrıntılar belirginleşir. Bu aşamaya, bazı MR görüntülerinin karanlık bir histogram dağılımına sahip olması ihtiyaç doğurmuştur.



Şekil 2. Beyin tümörü bölütleme yönteminin akış diyagramı

Histogram eşleştirmede referans seçilen bir görüntünün histogramı ile hedef görüntünün histogramı eşleştirilir. Böylece hedef görüntüde tümörün piksel değeri ile beynin diğer bölümleri arasındaki fark artmış olduğundan tümör daha görünür hale gelmiş olur.



Şekil 3. a) Referans seçilen görüntü **b)** Orijinal MR görüntüsü **c)** Referans görüntü ile Orijinal görüntü histogram eşleştirme sonucu

Şekil 3.a’da referans seçilen görüntü, Şekil 3.b’de orijinal MR görüntüsü ve Şekil 3.c’de histogram eşleştirme uygulandıktan sonra elde edilmiş beyin MR görüntüsü verilmiştir.

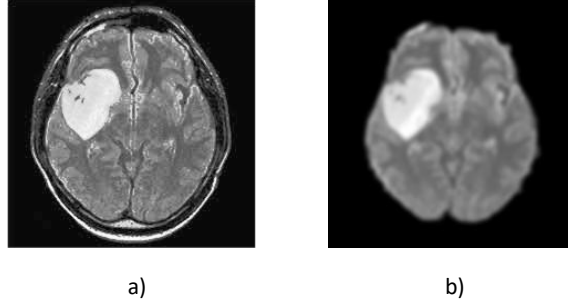
Tümör tespitinde görüntüdeki kafatası bölgesi ilgilenilmeyen kısımdır. Kemiksi yapıların MR görüntülerinde beyaz gözükmeleri sebebiyle ile tümör ile benzer değerlerden oluşmaktadır. Bu benzerlik daha sonra görüntüde yapılacak olan morfolojik işlemler sırasında tümör yerine kafatası bölgesinin tespit edilmesi gibi yanlış sonuçlar üretilmesine sebebiyet verebilmektedir. Bu yanlışlığın önüne geçmek için, ilgilenilmeyecek olan kafatası bölgesinin beyinden ayrılması gerekmektedir. Kafatası ayırma işlemi, eşikleme prensibine dayanılarak yapılmıştır. Kafatası ayırma işleminde sabit bir eşik değeri belirlenmiş ve girdi görüntüsüne uygulanmıştır. Morfolojik işlemler ile kafatası bölgesi belirginleştirildikten sonra kafatası kısmı orijinal görüntüden çıkarılarak kafatası ayırma işlemi gerçekleştirilmektedir.

Görüntülerin standardizasyonu sağlandıktan sonra yapılan ön işleme adımlarından bir diğeri filtrelemedir. Bu aşamada Gauss filtresi kullanılmıştır. Gauss filtresi, alçak geçiren bir filtre türüdür. Bu filtre, yüksek frekans bileşenlerini azaltarak gürültüyü azaltır ve daha pürüzsüz bir görüntü elde edilmesine yardımcı olur.

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

Denklem (1)’de verilen ifade iki boyutlu Gauss fonksiyonu ifadesidir ve $G(x,y)$ filtrelenmiş pikselin değerini, x ve y piksel koordinatlarını, σ standart sapmayı ifade etmektedir (Cabello,

León, Iano ve Arthur, 2015). Referans çalışmadaki ön işleme adımlarından bir tanesi olan ortalama filtresi de benzer şekilde gürültüyü azaltmak için kullanılabilir, ancak Gauss filtresi daha iyi sonuçlar vermekte olup kenarları daha yumuşak hale getireceğinden görüntünün daha doğal görünmesini sağlamaktadır. Şekil 4.a'da histogram eşleştirme ile elde edilen görüntü ve Şekil 4.b'de kafatası ayırma işlemi ile gauss filtresi uygulanmış görüntü verilmiştir.

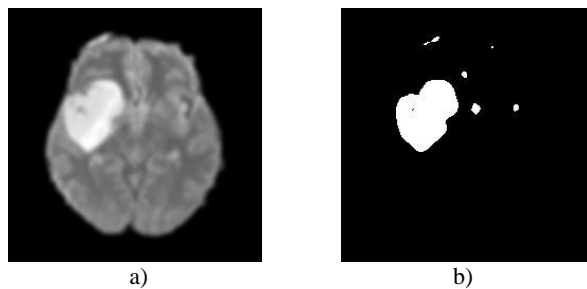


Şekil 4. a) Histogram eşleştirilmiş görüntü **b)** Kafatası ayrılmış ve Gauss filtre uygulanmış görüntü

Görüntü işlemede eşikleme, bir görüntüdeki piksellerin belirli bir eşik değerine göre sınıflandırılması işlemidir. Eşik değeri Denklem 2'deki gibi elde edilmiştir.

$$F(x, y) = \begin{cases} 1, & F(x, y) > t + \frac{a_{max} + a_{min}}{2} \\ 0, & F(x, y) < t + \frac{a_{max} + a_{min}}{2} \end{cases} \quad (2)$$

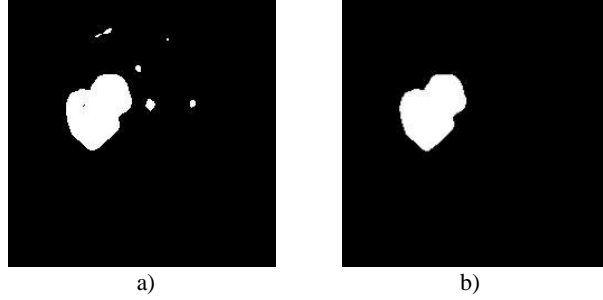
Denklem (2)'de t eşikleme sabitini, a_max görüntünün maksimum piksel değerini, a_min görüntünün minimum piksel değerini temsil etmektedir. Bu şekilde her görüntüye kendi piksel değerlerine özgü bir eşik değeri hesaplanmış olur. Şekil 5.a'da kafatası ayırma işlemi ile gauss filtresi uygulanmış görüntü ve Şekil 5.b'de eşiklenmiş görüntü verilmiştir.



Şekil 5. a) Kafatası ayrılmış ve Gauss filtre uygulanmış görüntü **b)** Eşiklenmiş görüntü

Eşiklemeden sonra MR görüntüsünde sadece tümörün gözükmesi için bağlantılı bileşen analizi uygulanarak, beyin tümörünün alanı maksimum etiketli bileşen olarak atanmıştır. Bu aşamada elde edilen görüntü sadece tümör görüntüsüdür.

Son aşamada tümör bölgesinin içinde boşluklar varsa daha düzgün bir çıkış görüntüsü için genişletme işlemi yapılmıştır. Benzer şekilde tümör etrafındaki süreksiz, beyaz fakat tümöre dahil olmayan farklı piksel grupları da aşındırma işlemi ile görüntüden temizlenmiştir. Şekil 6.a'da eşiklenmiş görüntü ve Şekil 6.b'de morfolojik işlemler sonucu elde edilen çıkış görüntüsü verilmiştir.



Şekil 6. a) Eşiklenmiş görüntü b) Morfolojik işlemler sonucu elde edilen çıkış görüntüsü

Tümörün büyüklüğü, tümör tespit aşamasında hastalığın evresi ve uygulanacak tedavi yöntemleri hakkında bilgi vermektedir. Bu yüzden tümörün alanının hesaplanması önem arz etmektedir. Tümör segmentasyonu yapıldıktan sonra veri setindeki tek kesitlik görüntülerdeki tümörün büyüklüğünü tespit etmek için pikselin kenar uzunluğu kullanılmaktadır. 1 piksel uzunluğu 0.264 mm'dir (Selvakumar, Lakshmi ve Arivoli, 2012). Tek bir pikselin alanı biliniyorsa tümörlü bölgenin alan hesabı yapılabilmektedir.

$$\text{piksel alanı} = 0.264 \times 0.264 = 0.069696 \text{mm}^2 \quad (3)$$

Denklem (3)'ten faydalanarak bir pikselin alanı hesaplanmaktadır. Buna göre Denklem (4)'te verilen ifadede tümörlü bölgenin alanı (T.A.), bağlantılı bileşen analizi kullanılarak hesaplanan piksel sayısı ile bir pikselin alanının çarpımı sonucu hesaplanmaktadır.

$$T.A. = \text{tümörlü bölgedeki piksel sayısı} \times \text{piksel alanı} \quad (4)$$

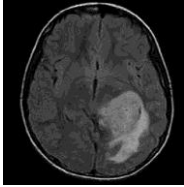
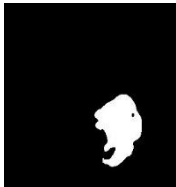
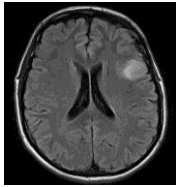
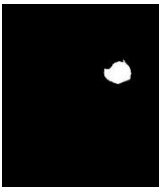
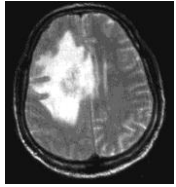
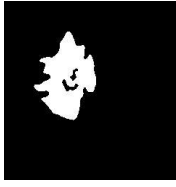
$$\text{tümör/beyin oranı} = \frac{\text{tümör alanı}}{\text{beyin toplam alanı}} \times 100 \quad (5)$$

Denklem (5)'te tümörlü alanın beynin toplam alanına oranı yüzde olarak ifade edilmiştir.

3. DENEYSEL SONUÇLAR

Bu çalışmada kullanılan veri setinden alınan 3 farklı hastaya ait MR görüntüleri ile uygulanan beyin tümörü bölütleme işlemi sonucu elde edilen sonuç görüntüleri ve tümör/beyin oranları Tablo 1'de birlikte verilmiştir.

Tablo 1. Beyin Tümör Oranı

No	Orijinal MR Görüntüsü	Tümör	Tümör/ Beyin Oranı
1			12.71%
2			3.05%
3			18.93%

Tablo 1’de görüldüğü gibi bu çalışmada geliştirilen sistem ile MR görüntülerinden tümör bölütlenmiş ve veri setinde bulunan görüntüde tümörün beyin ne kadarını kapladığı yüzde olarak verilmiştir. Kaggle veri setinde her bir hastaya ait tümörlü beyin görüntüsü tek bir kesit olarak verildiği için tümör/beyin oranı alan hesabıyla verilmiştir. Ancak eğer bir hastaya ait MR görüntülerinin tüm kesitleri varsa bu çalışmada geliştirilen aynı yöntemlerle gerçekleştirilecek işlemler sayesinde tümör/beyin oranı hacimsel olarak da verilebilir.

4. SONUÇ VE TARTIŞMA

Bu çalışmada beyin tümörü segmentasyonu işlemi yapan bir yöntem geliştirilmiştir. Önerilen yöntemde histogram eşleştirme filtreleme, otomatik eşikleme ve morfolojik işlemler ile beyin segmentasyonu gerçekleştirilmiştir. Elde edilen sonuçlar, hekimlerin manuel olarak göz ile belirlediği sınırlar ile örtüşen sınırlarda bölütleme işlemlerinin gerçekleştirildiğini ortaya koymuştur. Ayrıca tümörün kapladığı alanının beyin alanının yüzde olarak ne kadarını kapladığı hesaplanarak raporlanmıştır.

Beyin tümör segmentasyonu ve tümör tespiti başlıkları literatürde oldukça popülerdir. Bu çalışmalara katılacak her bir yenilik veya iyileştirme insan hayatı için önem arz etmektedir. Yapılan bu çalışma uygulama açısından oldukça pratiktir. Uygulanacak farklı morfolojik

işlemler ile beraber ilerleyen çalışmalarda yapay sinir ağlarının ortak bir çalışması ile daha fazla medikal görüntünün taranabileceği bir kontrol mekanizması geliştirilebilir.

KAYNAKÇA

- Badran, E. F., Mahmoud, E. G., & Hamdy, N. (2010, November). An algorithm for detecting brain tumors in MRI images. In *The 2010 International Conference on Computer Engineering & Systems* (pp. 368-373). IEEE.
- Murthy, T. D., & Sadashivappa, G. (2014, October). Brain tumor segmentation using thresholding, morphological operations and extraction of features of tumor. In *2014 international conference on advances in electronics computers and communications* (pp. 1-6). IEEE.
- Hunnur, S. S., Raut, A., & Kulkarni, S. (2017, July). Implementation of image processing for detection of brain tumors. In *2017 International Conference on Computing Methodologies and Communication (ICCMC)* (pp. 717-722). IEEE.
- Shukla, S. Brain Tumor Extraction From MRI Images Using Segmentation Techniques: A Review. Bulut, F., Kılıç, İ., & İnce, İ. F. (2018). Beyin Tümörü Tespitinde Görüntü Bölütleme Yöntemlerine Ait Başarımların Karşılaştırılması Ve Analizi. *Dokuz Eylül Üniversitesi Mühendislik Fakültesi Fen Ve Mühendislik Dergisi*, 20(58), 173-186.
- Maurya, R., & Wadhvani, S. (2021, November). Morphology based brain tumor identification and segmentation in MR images. In *2021 IEEE Bombay Section Signature Conference (IBSSC)* (pp. 1-6). IEEE.
- Khan, M. U., Khan, H., Arshad, A., Baloch, N. K., Shaheen, A., & Tariq, F. (2021, November). Brain tumor detection based on magnetic resonance imaging analysis using segmentation, thresholding and morphological operations. In *2021 6th International Multi-Topic ICT Conference (IMTIC)* (pp. 1-6). IEEE.
- Dharshini, V. D., Divya, A., Manjula, G., Regin, R., Hussein, S. M., & Al-Attar, W. M. A. M. (2022). Brain Tumor Detection Using Image Processing Technique from MRI Images Based on OTSU Algorithm. *Central Asian Journal of Theoretical and Applied Science*, 3(5), 45-66.
- V. R. Prabha K, R. Gujjarlapudi, S. Ravi, Y. Satuluri, C. Nekkanti and R. P, "Detection of Brain Tumor Using Image Processing Techniques," 2023 International Conference on Advances in Intelligent Computing and Applications (AICAPS), Kochi, India, 2023, pp. 1-5, doi: 10.1109/AICAPS57044.2023.10074053.
- Chakrabarty, N., <https://www.kaggle.com/datasets/navoneel/brain-mri-images-for-brain-tumor-detection>, erişim tarihi: 05.March.2023
- Cabello, F., León, J., Iano, Y., & Arthur, R. (2015, September). Implementation of a fixed-point 2D Gaussian Filter for Image Processing based on FPGA. In *2015 Signal Processing: Algorithms, Architectures, Arrangements, and Applications (SPA)* (pp. 28-33). IEEE.
- Selvakumar, J., Lakshmi, A., & Arivoli, T. (2012, March). Brain tumor segmentation and its area calculation in brain MR images using K-mean clustering and Fuzzy C-mean algorithm. In *IEEE-international conference on advances in engineering, science and management (ICAESM-2012)* (pp. 186-190). IEEE.

LİF TAKVİYELİ MİKRO BETONLARIN ERKEN YAŞ MEKANİK VE DURABİLİTE ÖZELLİKLERİ

Melek AKGÜL

Munzur Üniversitesi, Tunceli MYO, Aktuluk, Tunceli
Munzur University, Tunceli Vocational School, Aktuluk, Tunceli

ORCID ID: 0000-0001-8815-3762

Serkan ETLİ

Munzur Üniversitesi, Sağlık Bil. Fak., Acil Yardım ve Afet Yönetimi Böl., Aktuluk, Tunceli
Munzur University, Fac. of Health Sciences, Emergency Aid and Disaster Man., Aktuluk, Tunceli

ORCID ID: 0000-0003-3093-4106

ÖZET

Özellikle yapısal sistem onarımlarında, yüksek çekme mukavemetine sahip kendiliğinden yerleşen beton/harç türevi malzemelerin kullanımı ön plana çıkmaktadır. Diğer yandan endüstriyel zemin sistemlerinde uygun mekanik ve dayanıklılık özelliklerine sahip yüzey kaplamalarına doğru bir eğilim söz konusudur. Bu çalışmada, onarım ve yüzey kaplamalarında kullanılmak üzere mikro beton karışımları üretilmiştir. Bu karışımlarda dere kumu, kireçtaşı kumu ve kırılmış doğal kumdan oluşan beton karışımlarında kullanılan 0-4 mm kum türevleri 0-1 mm aralığında elenerek mikro agrega olarak kullanılmıştır. Elde edilen karışımlara ilave edilen lif katkıları ile mikro betonların erken yaş özelliklerindeki değişimler incelenmiştir. Mekanik özellikleri değerlendirmek için basınç ve eğilme dayanımları gerçekleştirilmiştir. Erken yaş dayanıklılık özellikleri için sorptivite testi yapılmıştır. Eğilme ve basınç dayanımı testleri için 40x40x160 mm prizma numuneler kullanılmıştır. Yarma çekme ve sorptivite için 50x50x50 mm küp numuneler kullanılmıştır. Elde edilen deneysel veriler çalışma kapsamında aşağıdaki alt başlıklar altında detaylı olarak sunulmuştur. Bu çalışma kapsamında lif katkısının mikro betonun erken yaş mekanik özelliklerini sınırlı da olsa artırdığı ortaya konmuştur.

Anahtar Kelimeler: Mikro beton, cam lif, mekanik özellikler, durabilite

EARLY AGE MECHANICAL AND DURABILITY PROPERTIES OF FIBER REINFORCED MICRO CONCRETES

ABSTRACT

Especially in structural system repairs, the use of self-compacting concrete/mortar derivative materials with high tensile strength is coming to the fore. On the other hand, there is a trend towards surface coatings with appropriate mechanical and durability properties in industrial floor systems. In this study, micro concrete mixtures were produced for use in repair and surface coatings. In these mixtures, 0-4 mm sand derivatives used in concrete mixtures consisting of river sand, limestone sand and crushed natural sand were sieved in the range of 0-1 mm and

used as micro aggregates. Changes in the early age properties of micro concretes were investigated with fiber admixtures added to the mixtures obtained. Compressive and flexural strengths were performed to evaluate the mechanical properties. Sorptivity test was performed for early age durability properties. 40x40x160 mm prism specimens were used for flexural and compressive strength tests. 50x50x50 mm cube specimens were used for splitting tensile and sorptivity tests. The experimental data obtained are presented in detail under the following subheadings. Within the scope of this study, it was revealed that fiber admixture increased the early age mechanical properties of micro concrete, albeit to a limited extent.

Keywords: Micro concrete, glass fiber, mechanical properties, durability

1. INTRODUCTION

In the definitions made in the literature for micro concrete (MC), it is stated that it is a special type of concrete prepared with "different types of powder materials with the largest grain size ranging between 0.1-1 mm". For the type of aggregate used in this statement, the information of the micro aggregate produced is given. Therefore, a parallel approach can be made to the statement that concrete is a composite building material containing cement, water, fine aggregate and coarse aggregate due to its production (Felekoğlu, 2007; Felekoğlu et al., 2009; Thomas et al., 2021). However, in MC, as mentioned above, the coarse aggregate and fine aggregate phase was removed from the system and replaced by finely ground inert or pozzolanic materials. This change in production content reveals that it may bring significant differences in terms of rheological behavior, which is an important concept in fresh state properties, and mechanical properties and durability in the hardened state, which is of great importance after production. On the other hand, as in the case of self-compacting concrete or mortars, a plasticizing admixture is often used in micro concrete design to ensure the appropriate consistency in the fresh state (Felekoğlu, 2007; Felekoğlu et al., 2009; Thomas et al., 2021).

In the literature, the study by Felekoğlu et al (Felekoğlu et al., 2009) presents the results of the evaluation of the performance of two polymer-containing microfibers (polypropylene and polyvinyl alcohol) in different matrices (high strength and relatively low strength with fly ash addition). In the study, the researchers designed these matrices with a very high fiber content (1% by volume), with the main principle being the preservation of the self-compacting properties. To ensure that the rheological behavior of the matrices in the fresh state because of fiber reinforcement is as desired, mixtures were produced with maximum attention to the water / cement ratio and the dosage of additives used. In terms of hardened properties, the mechanical properties of the prismatic specimens (initial crack strength and displacement, flexural strength,

and relative toughness), three-point bending loading test were included in the experimental studies (Felekoğlu et al., 2009). They obtained microstructural results using the results of the typical behavior of the composite contents they selected from the experimental data they obtained and the collapse mechanisms of PP and PVA fibers in these matrices they produced. In their study, these properties were used in the characterization of the MC produced. From this point of view, they concluded that when a fiber with high strength is used, a matrix with high strength capacity can be formed and high performances can be achieved in terms of flexural strength and toughness performances. In addition, within the scope of their study, they reported that serious decreases in composite matrix performance can be prevented with the effect of increasing the adherence of the matrix-fiber interface formed in the MC matrix because of the addition of fly ash to MC (Felekoğlu et al., 2009).

Within the scope of the study conducted by Etlı (Etlı, 2023) in the literature, it was evaluated by creating a usage scenario whether glass, which is a waste in MC, can be used to provide sufficient performance when it is ground and used instead of micro aggregate. Glass has been the subject of research in this study because it is a waste in the natural cycle that can maintain its mineral crystalline form intact even if it is ground due to its mineral structure and therefore poses serious hazards to natural life. In the study conducted by Etlı (Etlı, 2023), MC mixtures contained 4 different binder dosages. From these MC mixtures, different mixtures were produced by replacing the control mixture with 12%, 27% and 50% micro aggregate MA and glass sand (GS) obtained by grinding from waste. The study on GS-substituted MC mainly consists of three parts. The variation of standard mechanical properties with age was investigated, followed by freeze-thaw effects (to which structures are frequently exposed) and temperature effects (for use in industrial structures) to simulate possible spatial and environmental effects Etlı (Etlı, 2023).

Within the scope of the study conducted by Etlı (Etlı, 2022), research on the changes in MC properties due to the use of silica fume (SF), nano silica (NS) and fly ash (FA) together or separately in MC production were presented in the literature. In addition, it was aimed to evaluate the changes in the mechanical properties of MC mixtures using SF, FA, and NS because of two different curing conditions (water and air curing). In the study of Etlı (Etlı, 2022), all specimens produced with MC were first water cured for 7 days and then divided into two different groups. In the scope of the study, flexural and compressive strength tests were carried out for 7-56 days and 28-56 days for water and air cured specimens, respectively. In addition, porosity, and unit volume weight values, which are important parameters in the durability properties of the specimens, were examined experimentally. The results obtained

within the scope of this study by Etlı (Etlı, 2022) showed that 28-day curing has significant effects on both flexural and compressive strengths of micro concretes depending on water curing. Three different aggregate types were used in the MC mixtures produced within the scope of the study. These aggregate types were natural sand (NS) obtained by sieving from river sand, crushed limestone (CLS) (by sieving crushed sand centered on limestone) and crushed natural sand (CNS) (by sieving sand obtained by crushing naturally obtained aggregates). Fibers were then added to these mixtures and the changes in mechanical, physical and durability properties were investigated. The results obtained are presented below in detail under headings.

2. EXPERIMENTAL STUDIES AND RESULTS

2.1. Experimental studies

Within the scope of the study, CEM-I 42.5R Portland cement, silica fume, city mains water, Sika Visco Crete Hi-Tech-28 coded polycarboxylate-based high water reducer (HRWR) was used in accordance with the relevant standards (TS EN 197-1,2011; ASTM C1240, 2020; TS EN 1008; 2003 TS EN 934-2+A1,2013). Company data for CEM-I 42.5R Portland cement are given in Table 1 and factory data for silica fume are given in Table 2. The grain density for natural sand (NS) obtained by sieving from river sand, crushed limestone (CLS) (by sieving crushed sand centered on limestone) and crushed natural sand (CNS) (by sieving sand obtained by crushing naturally obtained aggregates) for micro mortars prepared using three different fine aggregates (0-1 mm) is 2.57, 2.15, 2.23 gr/cm³ respectively and the sieve analysis for NS, CLS, CNS is given in Table 3 (TS EN 933-1,2012). In the study, 6 mm length chopped glass fiber was used and the technical data of the company are as given in Table 4.

Table 1. Properties of CEM-I 42.5R cement

Chemical composition (%)	
CaO	63.37
SiO ₂	19.34
Al ₂ O ₃	3.75
Fe ₂ O ₃	4.15
MgO	3.1
SO ₃	3.15
K ₂ O	0.81
Na ₂ O	0.41
Loss of ignition	1.92
Blaine (m ² /kg)	366

Table 2. Silica fume technical specifications

Amorphous SiO ₂	Min 93% (true 96.1%)
H ₂ O (moisture)	Max 0.3% (true 0.19%)
Loss of ignition	(L.O.I max 3.5%) (true 1.81%)
+45 above micron	Max 2.5% (true 0.58%)
Bulk Density	0.55-0.65 kg/dm ³
Blaine	Min 1 5-28 m ² /gr (true 23.36 m ² /gr)

Table 3. NS, CLS, CNS sieve analysis

Sieve size (mm)	Cumulative passing (%)		
	NS	CLS	CNS
1 mm	100.00	100.00	100.00
0.5 mm	57.00	54.10	60.80
0.25 mm	11.90	17.80	16.50
0.125 mm	7.72	9.45	10.90
0.063 mm	0.95	0.23	0.48
Pan	0.00	0.00	0.00

Table 4. Technical properties of glass fiber

Tensile strength (MPa)	3400
Modulus of Elasticity (GPa)	77
Application temperature limit (°C)	-60, +650
Melting temperature (°C)	1120
Specific gravity (gr/cm ³)	2.60
Fiber diameter (micron)	13

In this study, the effect of glass fiber admixture on the fresh state and early age mechanical properties of micro concretes produced with different micro aggregates was investigated. For this purpose, water/binder (w/b) ratio was taken as 0.475 and total binder amount was taken as 800 kg/m³ for micro mortars produced with 6 sets. Since micro concrete workability and viscosity are important fresh state properties, the w/b ratio was kept constant while HRWR was taken as a variable in the mix design. The amount of glass fiber was determined because of

preliminary study and literature evaluations and was taken as 2.5 % of the total micro concrete volume. The mix design for 1m³ is given in Table 5.

Table 5. Mix design for micro-mortar for 1 m³ (kg/m³)

Mix-ID	Cement	Silica Fume	HRWR	Water	NS	CLS	CNS	Cam Lif
MC(NS)F0	650	150	7.51	380	876			0.00
MC(CLS)F0	650	150	8.75	380		733		0.00
MC(CNS)F0	650	150	8.5	380			760	0.00
MC(NS)F2.5	650	150	8.65	380	876			6.56
MC(CLS)F2.5	650	150	8.6	380		733		6.56
MC(CNS)F2.5	650	150	8.55	380			760	6.56



Figure 1. Micro aggregates used in the experimental study

Prism specimens with 40x40x160 mm and cube specimens with 50x50x50 mm were kept in the laboratory for 24 hours, then demolded and coded (Figure 2) and matured in lime-saturated water cure until the 3rd and 7th test day.



Figure 2. General view of the samples

Coding data for the sample mixtures are as given in Table 5. The 3- and 7-day age prism specimens were subjected to porosity and oven dry unit volume weight tests. In addition to porosity and oven dry unit volume weight tests, capillary water absorption and splitting tensile

tests were performed on 7-day age cube specimens in accordance with the relevant standards. Figure 3 shows the visuals of the experimental study.

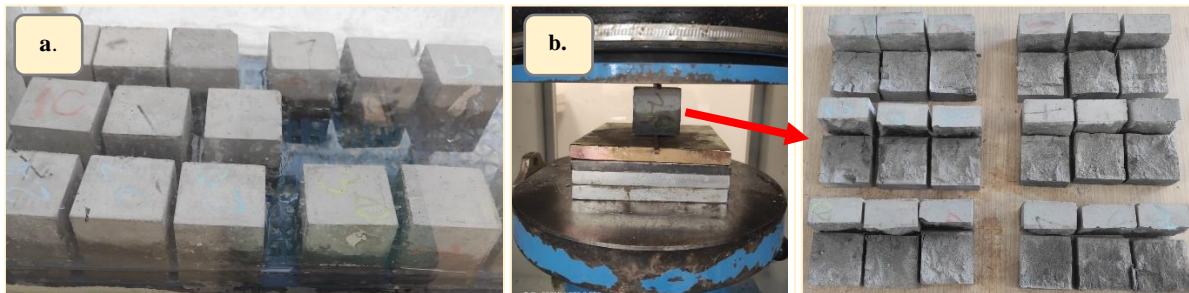


Figure 3. a. capillary water absorption test b. splitting tensile test

The prism specimens of all MC sets were subjected to flexural tensile tests according to ASTM C348 followed by compressive strength tests according to ASTM C349 on the 3rd and 7th test days (Figure 4) (ASTM C349-08,2008; ASTM C348-19, 2018).



Figure 4. General view of the specimen after flexural tensile and compressive strength tests

2.2. Experimental Results

Porosity and Dry Unit Volume Weight

A decrease in porosity data was recorded between the 3-day samples and 7-day samples of all sets due to the advancing sample age. The highest porosity change between the glass fiber doped sample sets and the non-glass fiber doped sets is from MC(CLS)F0 to MC(CNS)F2.5 and this value is 21.4%. The decreasing porosity data in all sets is associated with the maturation of all sample sets by lime saturated water curing.

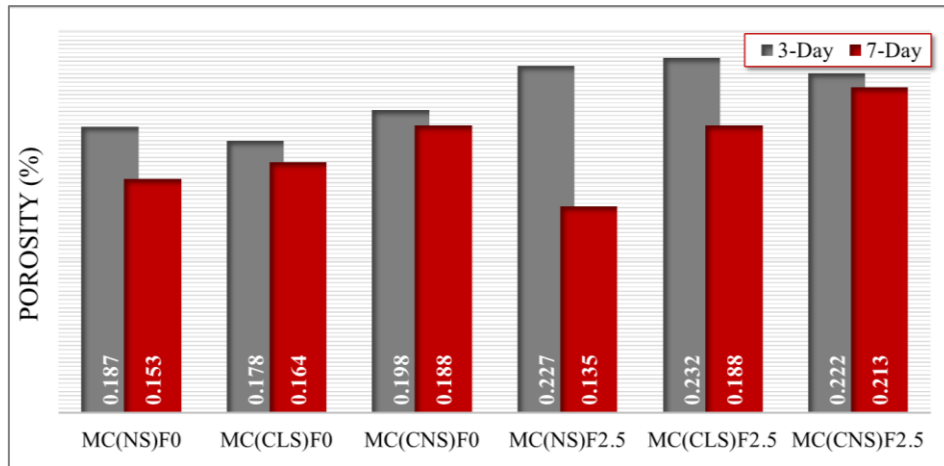


Figure 5. 3- and 7-days porosity change

The 3 and 7 day old specimens and the data related to the determination of the dry oven dry unit volume weight are as shown in Figure 6. The unit weight change increases from test day 3 to test day 7 in all sets and the increase is parallel between glass fiber reinforced micro concretes and non-glass fiber reinforced concretes. The unit weight tends to decrease relatively and acceptably in the glass fiber reinforced sets.

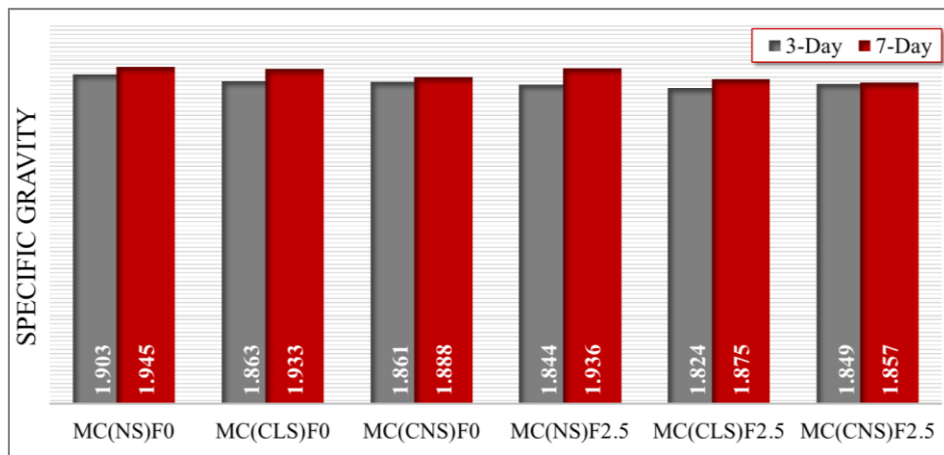


Figure 6. Unit volume weight change for 3 and 7 days

Flexural strength, Compressive strength and Splitting strength

Flexural tensile tests were performed with 40x40x160 mm prismatic specimens of all sets on the 3rd and 7th test day. The highest flexural tensile strength value from the sets without glass fiber additives belongs to MC(CNS)F0 set. Similar evaluation was reported for the glass fiber reinforced sets and the highest flexural tensile strength value belongs to MC(CNS)F2.5 set produced with CNS micro sand. Due to the fine grain structure of micro concrete, glass fiber

admixture increases the flexural tensile strength in all sets. In this case, the tensile strength of all sets is at an acceptable level (Figure 7).

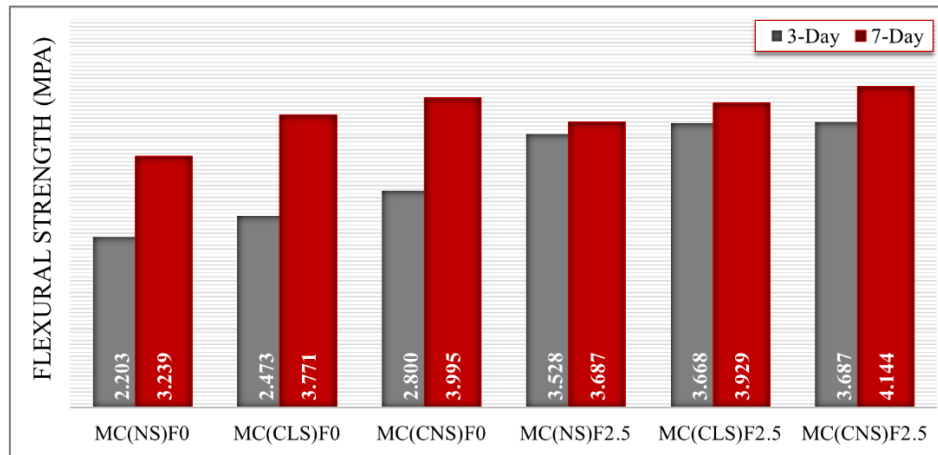


Figure 7. Variation of flexural tensile strength for 3 and 7 days

The results of the compressive strength test performed with 40x40x160 mm prismatic specimens after the flexural tensile test are given in Figure 8. As a general assumption, there is an increase in axial compressive strength from day 3 to day 7 of all sets. There is an increase in the compressive strength of glass fiber reinforced micro concretes for all sets. The increase was recorded with a similar trend at day 3 and day 7.

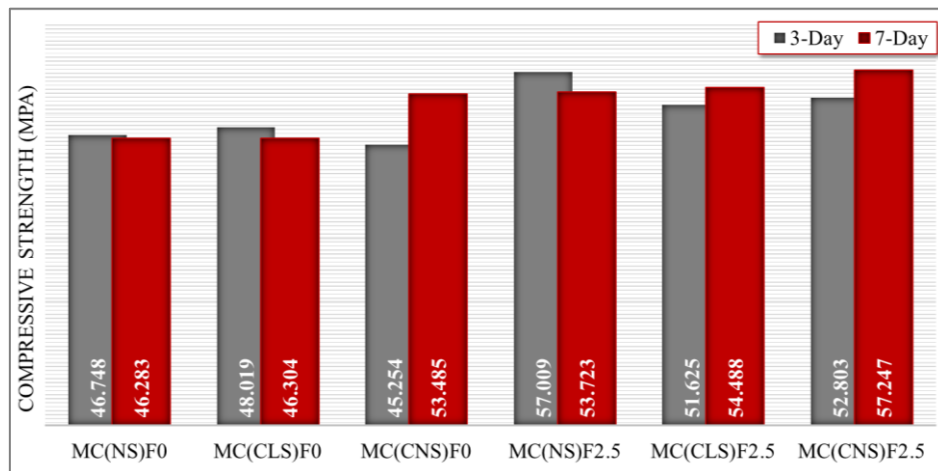


Figure 8. Compressive strength variation at 3 and 7 days

The splitting tensile test was performed on the 7th test day with 50x50x50 mm split cube specimens and the data are presented in Figure 9. Except for the sets produced with NS micro sand, the glass fiber additive provides a relatively small increase in the tensile strength at splitting in all sets. In this case, the splitting tensile data of all sets, including the sets produced with NS micro sand, are acceptable.

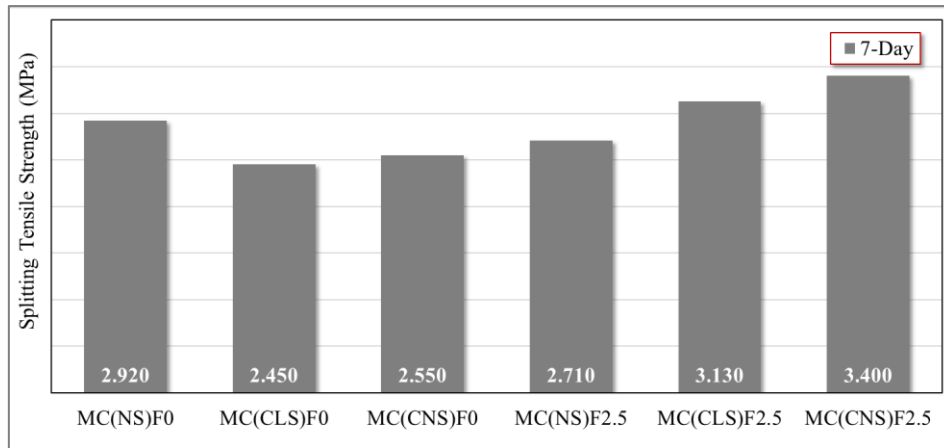


Figure 9. Variation of splitting tensile strength

Sorptivity Test

Capillary water absorption tests were performed with 7-day old 50x50x50 mm split cube specimens. The results are presented graphically in Figure 10. The two sets of the highest water absorption data are MC(CLS)F0 and MC(CLS)F2.5 sets produced with CLS micro sand.

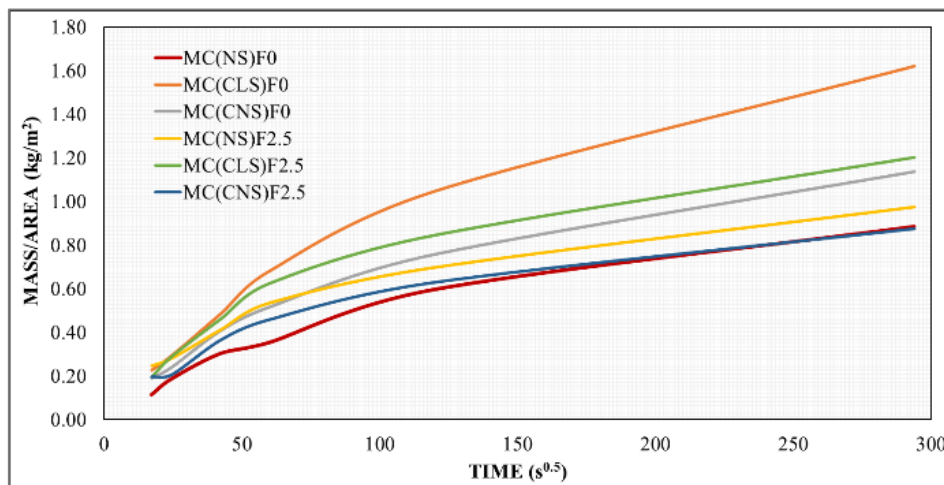


Figure 10. Sorptivity test results

3. CONCLUSIONS

3 different micro concrete mixtures were produced by partial replacement of cement and silica fume used as binder with different micro sands. Subsequently, 3 more micro concrete mixtures with glass fiber additives were produced while keeping these mixtures the same. According to this experimental study, which examined the early age mechanical, durability and physical properties of the specimens produced from these 6 MC sets, the following conclusions were reached.

- As a result of the very small diameter and high specific surface area of glass fiber, it aggregates in the mortar matrix and creates undesirable weak zones. In concrete and mortar systems, it is often reported that the compressive strength decreases when used above the optimum amount. However, in this study, the grain structure and fineness of 3 different micro sands used as the main component of micro concrete and the optimum level of glass fiber usage ratio affected the tensile and compressive strength data with a different trend.
- In all sets, glass fiber addition increases the tensile strength in flexural and splitting as well as the compressive strength. Although the tensile strength in flexural was higher in the sets with fiber additives on the 3rd test day, the values of tensile strength in bending were close to each other for the sets with and without glass fiber additives on the 7th test day.
- Capillary water absorption data is mostly related to the structure of the micro sand used. Since the glass fiber admixture used was kept at optimum level, its determinants on the unit volume weight and water absorption data are relatively small. Increasing the glass fiber admixture, which was kept at 2.5 % in this study, will have an effect on workability and agglomeration and will have an effect on many fresh state and early age mechanical and physical properties of micro concrete. In this study, it was observed that 3 different micro sands were suitable for glass fiber admixture with similar tendencies. For micro concrete with relatively low tensile and compressive strengths, glass fiber admixture will provide a positive contribution in appropriate methods and ratios.

REFERENCES

- ASTM C1240, (2020). Standard Specification for Silica Fume Used in Cementitious Mixtures
- ASTM C348-19. (2018). Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars. Annual Book of ASTM Standards, 03(Reapproved), 98–100.
- ASTM C349-08. (2008). Standard test method for compressive strength of hydraulic-cement mortars (using portions of prisms broken in flexure). ASTM International, 1–4.
- Etli, S. (2022). Evaluation of Curing Time for Micro Concrete Mixes Containing Silica Fume, Nano-Silica and Fly Ash. *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, 21(42), 304-316. <https://doi.org/10.55071/ticaretfb.1093891>
- Etli, S. (2023). Effect of glass sand used as aggregate on micro-concrete properties. *Journal of the Croatian Association of Civil Engineers*, 75(01), 39-51. <https://doi.org/10.14256/JCE.3538.2022>
- Felekoğlu, B. (2007). Effects of PSD and surface morphology of micro-aggregates on admixture requirement and mechanical performance of micro-concrete. *Cement and Concrete Composites*, 29(6), 481-489. <https://doi.org/10.1016/j.cemconcomp.2006.12.008>
- Felekoğlu, B., Tosun, K., & Baradan, B. (2009). Effects of fibre type and matrix structure on the mechanical performance of self-compacting micro-concrete composites. *Cement and Concrete Research*, 39(11), 1023-1032. <https://doi.org/10.1016/j.cemconres.2009.07.007>

- Thomas, C., Tamayo, P., Setién, J., Ferreño, D., Polanco, J. A., & Rico, J. (2021). Effect of high temperature and accelerated aging in high density micro-concrete. *Construction and Building Materials*, 272, 121920. <https://doi.org/10.1016/j.conbuildmat.2020.121920>
- TS EN 1008. (2003). Mixing water for concrete - Specifications for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete. Türk Standartları Enstitüsü, Ankara. 2003.
- TS EN 197-1. (2011). Cement–Part 1: Composition, specifications and conformity criteria for common cements. Türk Standartları Enstitüsü.
- TS EN 933-1. (2012). Tests for geometrical properties of aggregates Part 1: Determination of particle size distribution sieving method. Türk Standartları Enstitüsü, Ankara. 2012.
- TS EN 934-2+A1. (2013). Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling. Türk Standartları Enstitüsü, Ankara.

SAKROKOKSİGEAL PİLONİDAL SİNÜS HASTALIĞINDA SİNÜS LAZER TEDAVİSİNİN ETKİNLİĞİ

Özhan ÇETİNDAG

Dr Özhan Çetindağ Özel Muayehanesi İzmir/Türkiye
ORCID ID: 0000-0003-4518-9305

ÖZET

Sakrokoksigeal pilonidal sinüs hastalığı (SPSH) kronik bir rahatsızlıktır ve tedavi yöntemlerinde yenilikçi yaklaşımlara ihtiyaç duyulmaktadır. Geleneksel cerrahi yöntemlerin ana tedavi seçeneği olarak benimsenmesine karşın, sinüs lazer tedavisi (SiLaT) gibi alternatif tekniklerin potansiyelini araştırmak esastır.

Bu retrospektif çalışma, 2021-2023 yılları arasında SPSH tedavisi için SiLaT uygulanan hastaların sonuçlarını değerlendiriyor. Toplamda 20 katılımcı (18 erkek, 2 kadın) incelendi. Bu bireylerin %60'ı ana semptom olarak ağrılı şişlik ve mukopürülan akıntı bildirdi. Özellikle katılımcıların yarısı öğrenciydi ve tedavi edilenlerin %80'ine SiLaT birincil müdahale olarak uygulandı.

Hastaların hastanede kalış süresi ortalama $30 \pm 21,5$ saat olarak belirlendi. Yara iyileşmesi $6,5 \pm 6,6$ haftada tamamlandı ve yaraların %90'ı komplikasyonsuz iyileşti. Tekrarlama oranları, SiLaT'in birincil müdahale olarak uygulandığı vakalarda %10 iken genelde %20 olarak kaydedildi. Postoperatif komplikasyonlar arasında yara enfeksiyonları %15 oranında gözlemlendi. Hastaların ağrı seviyeleri ilk haftalarında önemli derecede azaldı ve genel memnuniyet oranı %80 olarak belirtildi.

Sonuç olarak, SiLaT teknolojisi, SPSH tedavisinde umut verici sonuçlar sunan uygulanabilir bir alternatiftir. Bu teknolojinin etkinliği ve güvenilirliği üzerine daha kapsamlı çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: pilonidal sinus, Silat, spSH,

EFFICACY OF SINUS LASER TREATMENT IN SACROCOCCYGEAL PILONIDAL SINUS DISEASE

ABSTRACT

Sacrococcygeal pilonidal sinus disease (SPSD) is a chronic condition that necessitates innovative approaches in treatment. While traditional surgical methods are primarily embraced for therapy, the potential of alternative techniques such as sinus laser treatment (SiLaT) needs exploration.

This retrospective study evaluated the outcomes of patients treated with SiLaT for СПSD between 2021 and 2023. A total of 20 participants (18 males, 2 females) were reviewed. 60% of these individuals reported painful swelling and mucopurulent discharge as their main symptoms. Notably, half of the participants were students, and SiLaT was employed as the primary intervention for 80% of the treated individuals.

The average hospital stay duration for patients was determined to be 30 ± 21.5 hours. Wound healing was completed in 6.5 ± 6.6 weeks, with 90% of wounds healing without complications. Recurrence rates stood at 10% for cases where SiLaT was the primary intervention and 20% overall. Postoperative complications, including wound infections, were observed in 15% of patients. Pain levels significantly decreased in the initial weeks, and an overall satisfaction rate of 80% was reported.

In conclusion, SiLaT technology presents a promising and applicable alternative in СПSD treatment. There is a pressing need for more comprehensive studies on the efficacy and reliability of this technology.

Keywords: pilonidal sinus, SiLaT, СПSD.

SYNTHESIS AND CHARACTERIZATION OF POLY(DIAMINOPYRIDINE) CONTAINING BROMINE BY ENZYME-CATALYZED POLYMERIZATION

Elif KARACAN YELDİR

Çanakkale Onsekiz Mart University, Department of Chemistry, Polymer Synthesis and Analysis Laboratory, 17020, Çanakkale, Turkey

ORCID ID: 0000-0001-8638-1198

Feyza KOLCU

Çanakkale Onsekiz Mart University, Department of Chemistry, Polymer Synthesis and Analysis Laboratory, 17020, Çanakkale, Turkey

Lapseki Vocational School, Department of Chemistry and Chemical Processing Technologies, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

ORCID ID: 0000-0002-2004-8859

İsmet KAYA

Çanakkale Onsekiz Mart University, Department of Chemistry, Polymer Synthesis and Analysis Laboratory, 17020, Çanakkale, Turkey

ORCID ID: 0000-0002-9813-2962

ÖZET

Bromlu bileşikler ve bromca zengin polimer, uçucu olmayan özellikleri sayesinde genellikle yanıcı malzemelerde yangın geciktirici madde üretiminde kullanılır. Bu çalışma kapsamında 2,3-diamino-5-bromopiridin bileşiğinin dioksan:su ortamında Horse Radish Peroksidaz Enzimi (HRP) ile oksidatif polimerizasyonu gerçekleştirildi. Bu polimerik malzemenin yapısal, optik, elektrokimyasal ve termal özellikleri incelendi. Yapılan çalışmalar sonucunda monomerin herhangi bir floresans özelliğine sahip olmadığı ancak sentezlenen polimerin 440 nm'de uyarıldığında 500 nm'de yeşil emisyon ürettiği görüldü. Ayrıca UV spektrumlarında elde edilen elektrokimyasal bant boşluğu (Eg) değerleri hesaplanmış ve buna bağlı olarak polimerin Eg değerinin monomere göre çok daha düşük olması, elde edilen polimerin optik uygulamalarda tercih edilebileceğini ortaya çıkarmıştır. Termal özellikleri incelenen polimerin iki aşamada bozunduğu ve maksimum kütle kaybının meydana geldiği sıcaklıkların 369 ve 681 °C olduğu belirlendi. 1000 °C'ye kadar ısıtılan numunelerde %24,51 oranında polimerin kalıntı olarak kaldığı ortaya çıktı. Ayrıca yangın önleme özelliğinin incelenmesi amacıyla literatürdeki formüller kullanılarak limit oksijen indeksi (LOI) ve ısı direnç indeksi (THRI) değerleri hesaplanmıştır. Enzim katalizli oksidatif polimerizasyon ürünü polimerin termal olarak stabil olduğu ve düşük yanıcılık özelliğine sahip olduğu belirlendi.

Anahtar Kelimeler: Enzimatik polimerizasyon, Termal özellikler, Elektrokimyasal ve optik bant boşluğu.

SYNTHESIS AND CHARACTERIZATION OF POLY(DIAMINOPYRIDINE) CONTAINING BROMINE BY ENZYME-CATALYZED POLYMERIZATION

ABSTRACT

Brominated compounds and bromine-rich polymer are generally used in the production of fire retardant agents in flammable materials, thanks to their non-volatile properties. Within the scope of this study, oxidative polymerization of 2,3-diamino-5-bromopyridine compound was carried out in dioxane:water environment with Horseradish Peroxidase Enzyme (HRP). The structural, optical, electrochemical and thermal properties of this polymeric material were examined. As a result of the studies, it was seen that the monomer did not have any fluorescent properties, but the synthesized polymer produced a green emission at 500 nm when excited at 440 nm. In addition, the electrochemical band gap (E_g) values obtained in the UV spectra were calculated and accordingly, the E_g value of the polymer was much lower compared to the monomer, which revealed that the obtained polymer could be preferred in optical applications. It was found that the polymer, whose thermal properties were examined, degraded in two steps and the temperatures at which maximum mass loss occurred were 369 and 681 °C. It was revealed that 24.51% of the polymer remained as residue from the samples heated to 1000 °C. In addition, in order to examine its fire prevention feature, limit oxygen index (LOI) and heat resistance index (T_{HRI}) values were calculated using the formulas in the literature. It was determined that the enzyme-catalyzed oxidative polymerization product polymer was thermally stable and had low flammability.

Keywords: Enzymatic polymerization, Thermal properties, Electrochemical and optical band gap

1. Introduction

Polymers, known as materials that can easily burn or catch fire due to their carbon-based structure, have become very durable and efficient fire retarders by preparing various modifications or composites in their structures (Gao et al. 2020; Troitzsch 2023). In the light of recent studies, it has been revealed that polymer composites and even biopolymer composites obtained from biopolymers can be used for this purpose (Hazwani et al. 2024). Halogenated substances, which are among the oldest fire retardant agents, are generally preferred as fillers (Ren et al. 2023). In addition to polymer composites, halogen-containing and therefore spontaneously halogenated polymeric materials that serve this purpose have begun to be synthesized (Kolcu, Çulhaoğlu, and Kaya 2019).

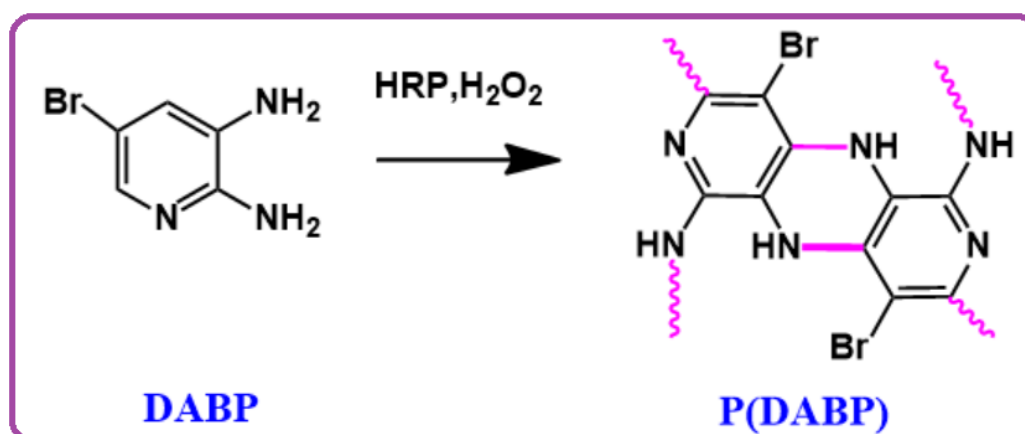
It is seen in the literature that among halogenated polymers, the most common fire retardant halogens are chlorine and bromine (Khani, Martin, and Pułaski 2023). The amount and type of bonding as well as the type of halogen in the structure affect all the chemical and physical properties of the material. Therefore, among the methods used to obtain fire retardant halogenated polymers, modification of the polymer with halogen and synthesis of halogenated polymer from a monomer already containing halogen stand out in terms of improving properties (Hazwani et al. 2024; Sykam et al. 2023).

Within the scope of this study, oxidative polymerization of 2,3-diamino-5-bromopyridine (DABP) monomer, a pyridine compound containing halogens and amine groups, was carried out by Horse Radish Peroxidase enzyme catalysis, and after its structure was elucidated, its optical, thermal and especially thermal characteristics were examined. The potential of the self-halogenated polymeric material obtained as a result of this reaction to be used as a new fire prevention material was investigated.

2. Methods and Results

2.1. Synthesis of P(DABP)

A solution of 5 mg Horse Radish Peroxydase (HRP) in pH:7 phosphate buffer saline (PBS) was added to the solution of 2 mmol DABP in dioxane. After adding 35% H_2O_2 solution dropwise to this mixture, it was stirred at room temperature for 48 hours. The brown-black product formed at the end of the reaction was filtered off, washed with water and dried. The yield of the reaction was found to be relatively low at 22%. Schematic representation of polymerization was shown in Scheme 1.



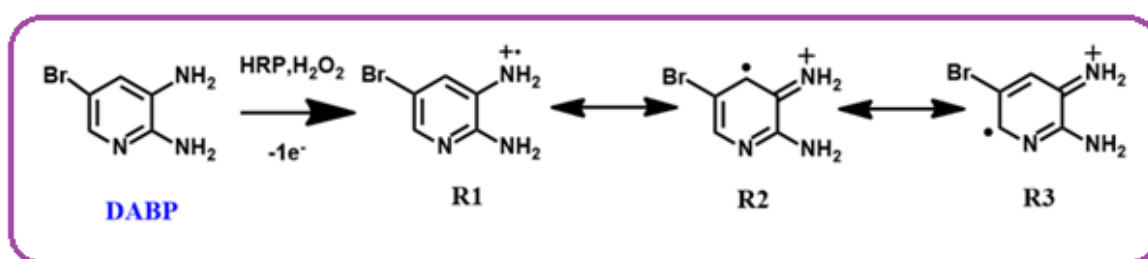
Scheme 1. Polymerization procedure of DABP

2.2. Characterization methods

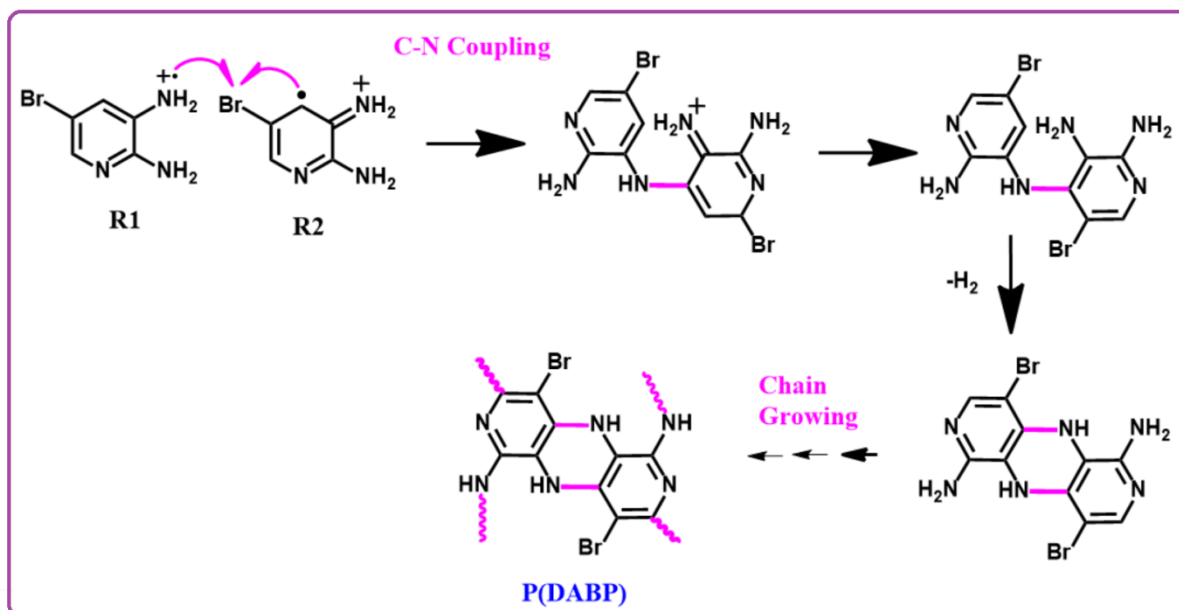
The infrared spectra of monomer and polymer were measured by PerkinElmer Frontier FT-IR-FIR Spectrometer (USA) in the range of 400-4000 cm^{-1} . The UV-Vis spectra of the compounds dissolved in DMSO were recorded in the range of 250 to 800 nm wavelength in quartz cells via Analytikjena Specord 210 Plus instrument. The photoluminescence properties of the DABP and P(DABP) were examined with Shimadzu RF-5301PC spectrofluorophotometer. Electrochemical properties of structures were examined by cyclic voltammograms (CV) with CH instruments 660 C electrochemical Analyzer (CH Instruments, Texas, USA). Voltammograms were obtained using a glassy carbon electrode as a working electrode and a Pt wire as a counter electrode in the presence of an Ag wire reference electrode in a 0.1 M tetrabutylammoniumhexafluorophosphate (TBHFP) solution as a supporting electrolyte. Thermogravimetric analysis graphics were obtained with Perkin Elmer Sapphire Differential Scanning Calorimetry by measuring the mass loss of the compound against 10° C temperature increase per minute in N_2 atmosphere.

2.3. Results and Discussion

It has been mentioned in previous studies that the most probable route in enzyme-catalyzed oxidative polymerization reactions carried out in amine compounds is C-N and C-C couplings (Ćirić-Marjanović et al. 2017; Karacan Yeldir 2023; Kurioka, Uyama, and Kobayashi 1998). Therefore, it was thought that the first radical formed with H_2O_2 by HRP catalysis would start on NH_2 groups. Considering the reaction conditions, the radicals that can be formed from DABP monomer are given in Scheme 2. It was thought that the most likely route would be to initiate the reaction with C-N coupling, which would occur by combining R1 and R2 from these radicals, followed by polymerization from Cs in the o- or p-position. Possible reaction route is given in Scheme 3.



Scheme 2. Resonance forms of DABP radicals



Scheme 3. Possible polymerization route of DABP

FT-IR spectra of DABP and enzyme-catalyzed oxidative polymerization reaction product P(DABP) were obtained and are given in Figure 1. Accordingly, while the peaks of the monomer observed at 3354 and 3307 cm^{-1} were the characteristic signal of the primary amine in the structure, it was revealed that as a result of polymerization, this peak turned into a wide band in the range of 3400-3300 cm^{-1} , which belongs to the signal of the secondary amine. This showed that the reaction continued through amine groups. Again, it was concluded that the C-H vibration signal observed at 3030 cm^{-1} in the monomer was not observed as a result of polymerization, but also took place in the C's at the *ortho* and *para* positions in the pyridine ring in the polymerization reaction. In addition, due to increased conjugation with polymerization, the sharp peaks in the monomer became noticeably wider in the polymeric structure. The C-Br signal located at 807 cm^{-1} in the spectrum of the monomer was also observed in the polymer at the same location.

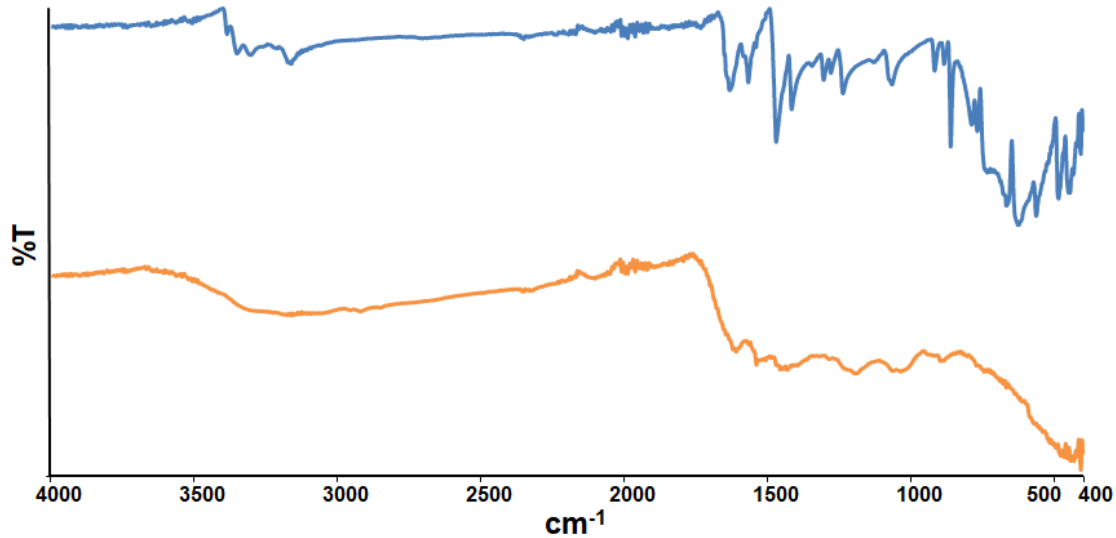


Figure 1. FTIR spectra of DABP and P(DABP)

UV-Vis and fluorescence spectroscopy methods were used to determine the optical properties of DABP and P(DABP). UV spectra obtained from solutions of monomer and polymer prepared in DMSO are given in Figure 2. While the monomer had maximum absorption at 327 nm, caused by the $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$ transitions in the pyridine ring, the polymer had broad band absorption maximums at 328 and 443 nm. While the maximum absorption at 328 nm was due to the transitions in the pyridine ring as in the monomer, the transition at 443 nm that occurred after polymerization belonged to the $n \rightarrow \pi^*$ transition resulting from NH-groups. In addition, E_g values were calculated for both monomer and polymer from the formula $E_g = 1242/\lambda_{\text{onset}}$, which is given in the literature and used to calculate the optical band gap. λ_{onset} values are roughly defined as the wavelength at which absorption begins, and this value was found from the absorption spectra as 364 nm for the monomer and 742 nm for the polymer. Therefore, the calculated E_g values were 3.41 for DABP and 1.67 eV for P(DABP).

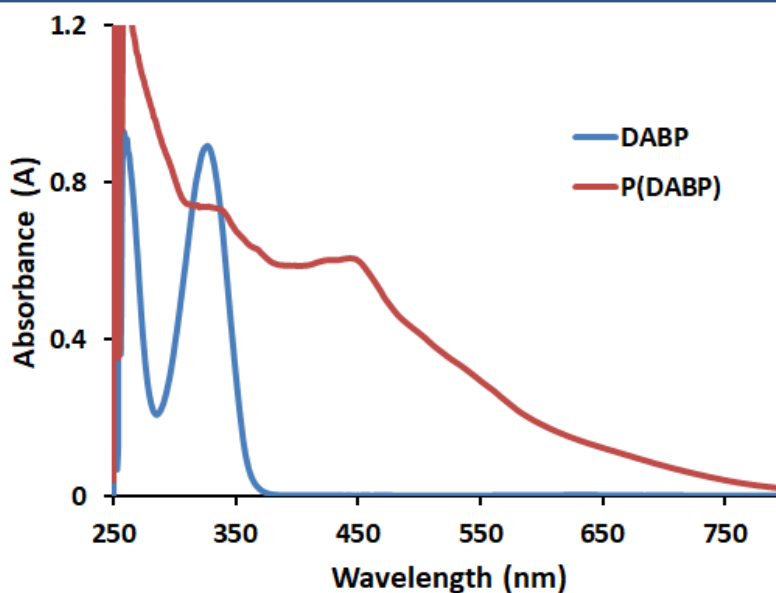


Figure 2. UV-Vis spectra of DABP and P(DABP) (solvent: DMSO)

The study of optical properties was deepened by the acquisition of fluorescence spectra. DABP and P(DABP) were prepared at a concentration of 1×10^{-3} M in DMSO and diluted to appropriate concentrations with DMSO during the measurements. When the emission properties of samples excited with light at various wavelengths in the wavelength range of 300-500 nm were examined, it was observed that the monomer did not emit any emissions and therefore did not have a fluorescent character. When P(DABP) was excited with light at a wavelength of 440 nm, it was revealed that it emitted green color at 500 nm and that the emission depended on the concentration and the emission intensity increased with increasing concentration. Figure 3.B and Figure 3.C show the emission colors of the P(DABP) solution in daylight, UV light and fluorescent light.

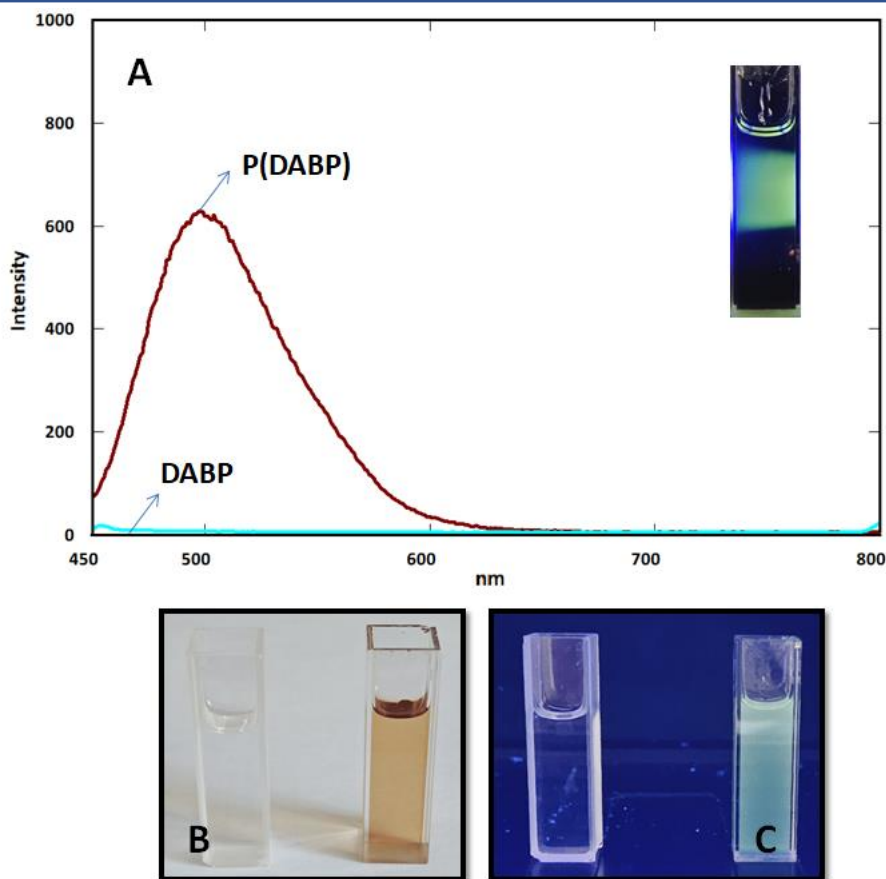


Figure 3. A) Fluorescence spectra B) Image under daylight C) Image under UV light of DABP and P(DABP) (solvent: DMSO)

The wavelength-emission intensity graph of the solutions of DABP and P(DABP) prepared at the same concentrations is given in Figure 4A. Accordingly, it was clearly seen that the emission intensity of the monomer was 23 au under the same conditions, while the emission intensity of P(DABP) obtained at the end of enzymatic polymerization was 641 au. In photographs of the solutions of both substances under UV light, it was observed that P(DABP) gave off a green glow. It was revealed that the quenching of the polymeric product obtained at the end of the reaction increased with increasing conjugation and bonding type. Additionally, when the wavelength-intensity graph obtained by excitation of P(DABP) solutions in DMSO in the 5×10^{-6} - 5×10^{-5} M concentration range at 440 nm was examined, it was revealed that quenching increased with the amount of substance (Figure 4B).

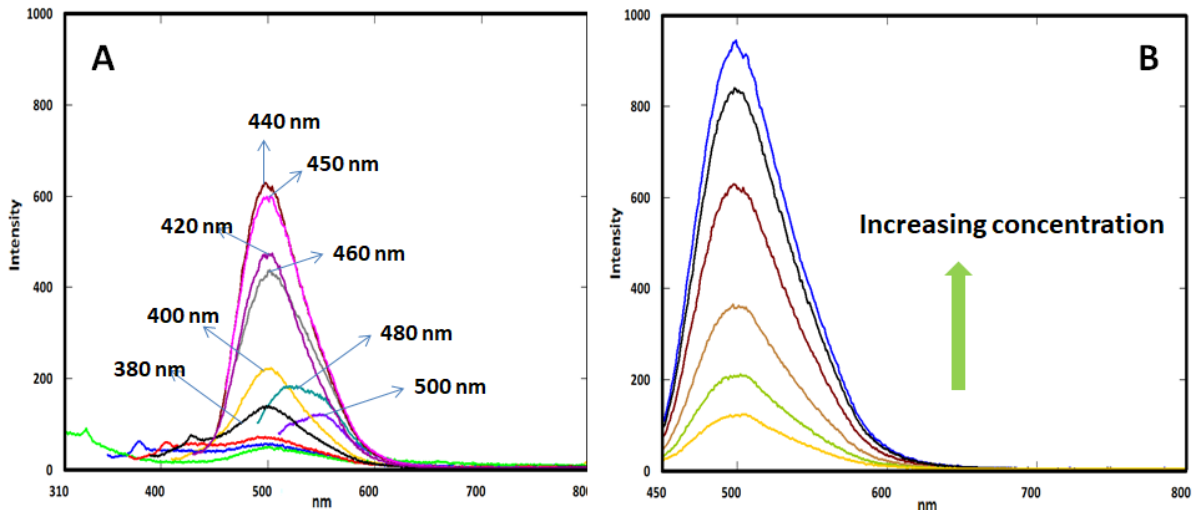


Figure 4. A) P(DABP) emission intensity versus wavelength of excited light B) Dependence of emission intensity on the concentration of P(DABP)

Electrochemical properties were determined by the potential of highest occupied molecular orbital (E_{HOMO}), the potential of the lowest unoccupied molecular orbital (E_{LUMO}) and the potential of the electrochemical band gap ($E'g$) values calculated from oxidation (E_{ox}) and reduction (E_{red}) potentials obtained from cyclic voltammograms. 0.1 M solution of TBAHFP in acetonitrile was used as the support electrolyte solution and the voltammograms of DABP and P(DABP) dissolved in this solution are given in Figure 5. Accordingly, E_{HOMO} - E_{LUMO} - $E'g$ values for DABP and P(DABP) were calculated using the formulas in the literature and given below (Kolcu 2019). are given in Table 1. When these values given in Table 1 were examined, it was concluded that the low $E'g$ value of the material would be advantageous in optoelectronic applications.

$$E_{HOMO} = -(4.39 + E_{ox}) \quad (1)$$

$$E_{LUMO} = -(4.39 + E_{red}) \quad (2)$$

$$E'g = E_{LUMO} - E_{HOMO} \quad (3)$$

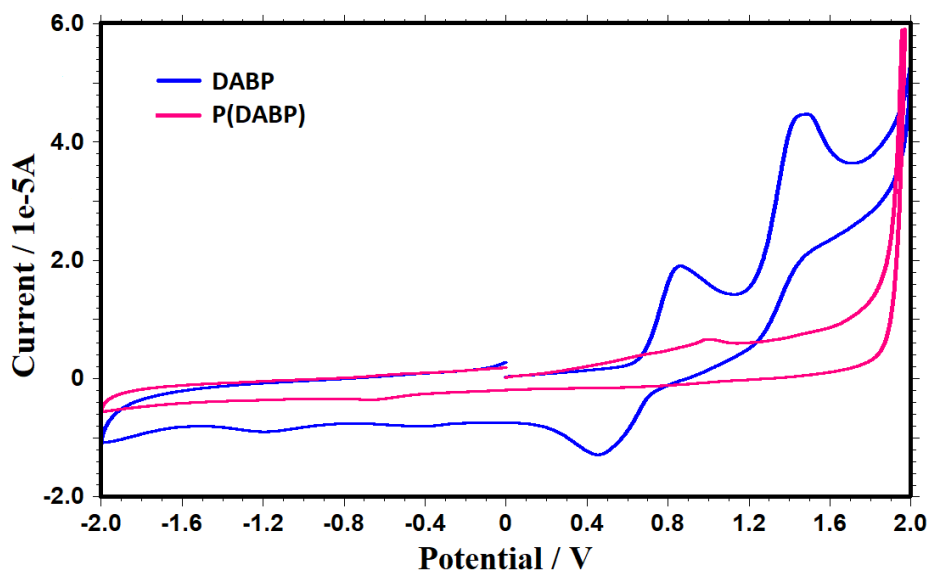


Figure 5. Cyclic voltammograms of DABP and P(DABP)

Table 1. Electrochemical data of DABP and P(DABP)

	E_{ox} (eV)	E_{red} (eV)	E_{HOMO} (eV)	E_{LUMO} (eV)	E'_g (eV)
DABP	0.85 1.47	-1.21	-5.96	-3.28	2.68
P(DABP)	1.01	-0.68	-5.50	-3.81	1.69

The thermal curves obtained from Thermogravimetry (TG) and Derivative Thermogravimetry (DTG) are depicted in Figure 6. Based on the TG-DTG curves, it was observed that the monomer and polymer exhibited two distinct weight loss steps, respectively. The initial degradation temperatures (T_{on}) for the monomer and polymer were identified as 203 °C and 207 °C, respectively. Furthermore, the temperature corresponding to the maximum weight loss (T_{max}) for the monomer was determined to be 238 °C and 688 °C. Specifically, the monomer exhibited a 91.50% weight loss in the temperature range of 140-456 °C, followed by a 5.07% weight loss until 1000 °C, with only 4.17% for residual remaining. Figure 2.5 illustrates that a weight loss of approximately 7.0% attributed to adsorbed solvent and surface water on the polymer occurred in the temperature range of 25 to 150 °C. Subsequently, the decomposition of the polymer was discerned as approximately 39.60% (attributed to the loss of C-N linkages) and 35.88% (associated with the degradation of phenylene rings) within the temperature intervals of 150-622 °C and 622-1000 °C, respectively. Two degradation steps with peaks observed at $T_{max} = 369$ °C and 681 °C in the DTG curve. At 1000 °C, the polymer retained a

higher residue value of 24.51% compared to the monomer. The temperatures corresponding to 20% weight loss (T_{20}) were determined to be 217 and 370 °C, while those related to 50% weight loss (T_{50}) were found to be 239 and 763 °C for the monomer and polymer, respectively. The glass transition temperature (T_g) serves as a critical characteristic property and is identified through Differential Scanning Calorimetry (DSC) analysis. T_g of the synthesized polymer was achieved at 169 °C, accompanied by a ΔC_p value of 0.058 J/g°C.

Additionally, brominated aromatic compounds are used in the synthesis of brominated flame retardants (BFRs), which are added into polymers in order to reduce their flammability, since they increase polymers' resistance to ignition and they delay the combustion (Charitopoulou et al. 2022). In this context, LOI and THRI values can help to investigate the flame resistance property of the enzymatically synthesized polymer.

Limiting Oxygen Index (LOI), which is a commonly used measure of material flammability can be determined using Equation (4) derived by van Krevelen (van Krevelen 1975):

$$LOI = 17.7 + 0.4x \text{ (residue \%)} \tag{4}$$

The calculated LOI of 27.20, suggests that the polymer exhibits good thermal stability and low flammability. To corroborate the observed thermal stability evident in TG curves, an analysis of the heat-resistance index is conducted. Heat-Resistance Index, THRI, is a measurement of the ability of a material to resist a heat flow (Icduygu et al. 2019), and is given by Equation (5):

$$THRI = 0.49 \times [T_5 + 0.6 \times (T_{30} - T_5)], \tag{5}$$

where T_5 and T_{30} are the temperatures where 5% and 30% weight losses occur, respectively. THRI was determined to be 178.07 °C, indicating that the polymer possesses a moderate level of resistance to heat.

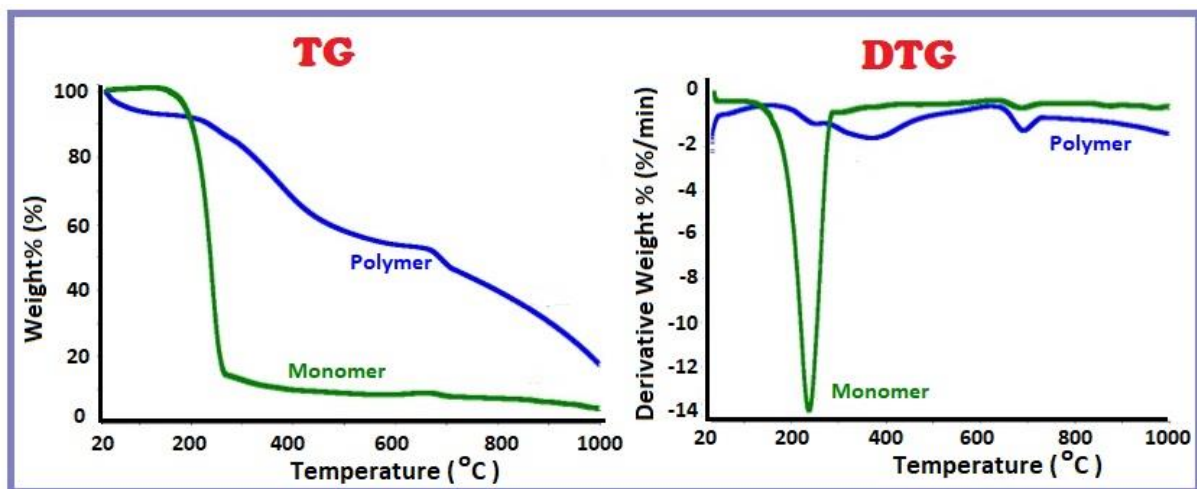


Figure 6. TG and DTG curves of DABP and P(DABP)

3. Conclusion

- HRP-catalyzed H₂O₂ and DABP were polymerized by oxidative method, and it was concluded that the structure of the polymeric material proceeded with the amine in the structure, due to the broadening observed due to conjugation in the peaks in the FT-IR spectrum obtained and the disappearance of the primary amine peaks. In addition, the disappearance of the C-H vibration peaks in the pyridine ring revealed that polymerization also occurred from the Cs in the o- and p- positions in the pyridine ring.
- It was observed that the obtained polymeric material had a green emission at a wavelength of 500 nm when interacted with light at a wavelength of 440 nm, and also had a high potential to be used in optical applications with its low E_g value.
- Finally, looking at the thermal properties of the polymeric material containing Br in its structure, it was undeniable that it had high thermal stability and was advantageous as a flame retardant material with the calculated LOI and THRI values.

REFERENCES

- Charitopoulou, Maria Anna, Stylianos D. Stefanidis, Angelos A. Lappas, and Dimitris S. Achilias. 2022. "Catalytic Pyrolysis of Polymers with Brominated Flame-Retardants Originating in Waste Electric and Electronic Equipment (WEEE) Using Various Catalysts." *Sustainable Chemistry and Pharmacy* 26: 100612.
- Ćirić-Marjanović, Gordana et al. 2017. "Enzymatic Oligomerization and Polymerization of Arylamines: State of the Art and Perspectives." *Chemical Papers* 71(2): 199–242.
- Gao, Yanshan, Lei Qiu, Dermot O'Hare, and Qiang Wang. 2020. 2008 Layered Double Hydroxide Polymer Nanocomposites *Thermal Properties and Flame-Retardant Characteristics of Layered Double Hydroxide Polymer Nanocomposites*. Elsevier Ltd. <http://dx.doi.org/10.1016/B978-0-08-101903-0.00008-8>.
- Hazwani, M et al. 2024. "Materials Today : Proceedings Mechanical Properties and Flammability of Pineapple Leaf Fiber (PALF) Reinforced Polymer Composite with Hybridized Fire Retardants." *Materials Today: Proceedings* (July 2023). <https://doi.org/10.1016/j.matpr.2023.09.198>.
- Icduygu, M. Galip et al. 2019. "Three-Dimensional Nano-Morphology of Carbon Nanotube/Epoxy Filled Poly(Methyl Methacrylate) Microcapsules." *Materials* 12(9).
- Karacan Yeldir, Elif. 2023. "Fluorescent Oligomeric Nanoparticle from Diaminopyridine Compound Via Enzyme-Catalyzed Oxidation." *Journal of Fluorescence* 33(5): 2105–17. <https://doi.org/10.1007/s10895-023-03371-4>.
- Khani, Leila, Leonardo Martin, and Łukasz Pułaski. 2023. "Cellular and Physiological Mechanisms of Halogenated and Organophosphorus Flame Retardant Toxicity." *Science of the Total Environment* 897(July).
- Kolcu, Feyza. 2019. "Characterization and Spectroscopic Study of Enzymatic Oligomerization of Phenazopyridine Hydrochloride." *Journal of Molecular Structure* 1188: 76–85. <https://doi.org/10.1016/j.molstruc.2019.03.083>.
- Kolcu, Feyza, Süleyman Çulhaoğlu, and İsmet Kaya. 2019. "Synthesis, Optical and Electrochemical Abilities of Highly Soluble Poly(Epoxy-Ether)s Bearing Perylene Bisimide Units and Their Enhanced Thermal Properties by Curing Process." *Progress in Organic Coatings* 137.
- van Krevelen, D. W. 1975. "Some Basic Aspects of Flame Resistance of Polymeric Materials." *Polymer* 16(8): 615–20.
- Kurioka, Hideharu, Hiroshi Uyama, and Shiro Kobayashi. 1998. "Peroxidase-Catalyzed Dispersion Polymerization of Phenol Derivatives." *Polymer Journal* 30(6): 526–29.

- Ren, Helong et al. 2023. "Emission and Gas-Particle Partitioning Characteristics of Atmospheric Halogenated and Organophosphorus Flame Retardants in Decabromodiphenyl Ethane-Manufacturing Functional Areas." *Environmental Pollution* 329(February): 121709.
<https://doi.org/10.1016/j.envpol.2023.121709>.
- Syakam, Kesavarao et al. 2023. "Non-Halogenated UV-Curable Flame Retardants for Wood Coating Applications: Review." *Progress in Organic Coatings* 179(February): 107549.
<https://doi.org/10.1016/j.porgcoat.2023.107549>.
- Troitzsch, Juergen H. 2023. "Fire Performance Durability of Flame Retardants in Polymers and Coatings." *Advanced Industrial and Engineering Polymer Research* (xxxx).
<https://doi.org/10.1016/j.aiepr.2023.05.002>.

KEMİK METAFİZER BÖLGESİNDE DRİLL KULLANIMINDA OLASI RİSKLER

Dr. Doğaç KARAGÜVEN

Ufuk Üniversitesi Tıp Fakültesi Ortopedi ve Travmatoloji Anabilim Dalı Başkanlığı Dr. Rıdvan Ege Hastanesi / ANKARA

ORCID ID: 0000-0003-2360-3907

Dr. Sefa AKTI

Cumhuriyet Üniversitesi Tıp Fakültesi Ortopedi ve Travmatoloji Anabilim Dalı Başkanlığı Tıp Fakültesi Hastanesi / SİVAS

ORCID ID: 0000-0001-8873-1358

ÖZET

Ortopedik cerrahide matkap kullanımı temel bir gerekliliktir, ancak matkap ucunun uzak korteksi geçme riski, çevresel yumuşak dokulara zarar verme riski taşıyarak nörovasküler hasarlara neden olabilir. Özellikle metafizer bölgesini içeren cerrahi operasyonlarda bu tür komplikasyonlar daha sık görülmektedir. Nörovasküler yapıların, metafizer bölgelerinde kemik dokusuna daha yakın olması, yaralanma riskini artırır. Bu çalışma, kemik metafizer bölgesinin drillemesinde uzak korteksi geçme hissinin güvenilirliğini değerlendirmeyi amaçlamaktadır.

Çalışmamız, on yıldan fazla mesleki deneyime sahip iki ortopedik cerrah tarafından gerçekleştirildi. Her iki cerrah, toplam 4 adet sawbones Klavikula kemiklerini kullanarak (1:1 oranında) toplam 10 adet distale yani metafizer bölgeye 10 adet proksimale yani kortikal bölgeye delme işlemi gerçekleştirdiler. Her cerrah, 2 adet sawbones Klavikula kemiğine delme işlemi uyguladı. Bu şekilde, her iki cerrah da uzak korteksi görmeksizin toplamda 40 metafizer ve 40 diafizer delme işlemi gerçekleştirdi. Delme derinlikleri, balistik jel kullanılarak ölçüldü.

Cerrahlar arasında uzak korteksi geçen delme derinliği açısından anlamlı bir fark gözlenmedi ($p>0,05$). Ayrıca, sawbones kemikleri arasında uzak korteksi geçen delme derinliği açısından da anlamlı bir fark saptanmadı ($p>0,05$). Ancak, metafizer kemiklerde uzak korteksi geçen delme derinliği ($5,62 \pm 2,74$), diafizer kemiklerdeki değerden ($3,02 \pm 1,95$) anlamlı derecede yüksek bulundu ($p<0,05$).

Kemiklerin metafizer bölgelerine uygulanan cerrahilerde, uzak korteksi geçme hissi deneyimli cerrahlarda bile azalmaktadır. Bu nedenle, nöral ve vasküler yapıların kemiklere yakın olduğu bu bölgelerde komplikasyonlardan kaçınmak sebebiyle delme derinliğini belirlemek için yardımcı yöntemler veya araçlara ihtiyaç duyulabilir.

Anahtar Kelimeler: Metafizer Kemik, Drill Kullanımı, Matkap Kullanımı Komplikasyonları

ABSTRACT

The use of a drill is a basic necessity in orthopedic surgery, but the risk of the drill bit passing the remote cortex carries the risk of damaging the surrounding soft tissues, which can cause neurovascular damage. Such complications are more common, especially in surgical operations involving the metaphyseal region. The closer proximity of neurovascular structures to bone tissue in the metaphyseal regions increases the risk of injury. This study aims to evaluate the reliability of the sensation of passing the distant cortex in drilling the bone metaphyseal region.

Our study was performed by two orthopedic surgeons with more than ten years of professional experience. Both surgeons performed a total of 10 drilling operations in the distal, that is, metaphyseal region, and 10 drilling in the proximal, that is, cortical region, using a total of 4 sawbones and clavicle bones (in a 1:1 ratio). Each surgeon drilled 2 sawbones into the Clavicle bone. In this way, both surgeons performed a total of 40 metaphyseal and 40 diaphyseal drilling operations without visualizing the remote cortex. Penetration depths were measured using ballistic gel.

No significant difference was observed between surgeons in terms of drilling depth past the distal cortex ($p>0.05$). Additionally, no significant difference was detected between the sawbones in terms of the drilling depth passing the distal cortex ($p>0.05$). However, the drilling depth passing the distal cortex in the metaphyseal bones (5.62 ± 2.74) was found to be significantly higher than the value in the diaphyseal bones (3.02 ± 1.95) ($p<0.05$).

In surgeries involving internal fixation applied to the metaphyseal regions of the bones, the sensation of passing the distant cortex decreases even in experienced surgeons. Therefore, auxiliary methods or tools may be needed to determine the drilling depth in order to avoid complications in these regions where neural and vascular structures are close to the bones.

Key Words: Metaphyseal Bone, Drill Use, Complications of Drill Use

THE PROGNOSTIC EFFICACY OF HALP SCORE FOR IN-HOSPITAL MORTALITY PATIENTS WITH HOSPITALIZED DUE TO HEART FAILURE

İnanç ARTAÇ, MD

Kafkas University School of Medicine Department of Cardiology

ORCID ID: 0000-0003-2694-8978

ABSTRACT

Objectives: The combination of Hemoglobin, albumin, lymphocytes, and platelets, known as the HALP score, has been confirmed as an important risk biomarker in many cancers. We aimed to evaluate the prognostic value of the HALP score in patients hospitalized due to heart failure.

Material Method: This retrospectively design study included 242 patients who were hospitalized due to congestive heart failure and had an ejection fraction below <50% between January- May 2023. The baseline clinical characteristics and blood parameters were recorded from hospital files. HALP score was calculated as hemoglobin (g/L) × albumin (g/L) levels × lymphocyte count (/L)/platelet count (/L). The patients were divided in two groups according to the median value of HALP; being those with low HALP (Group 1) and high HALP (Group 2) scores. We examined the potential of the HALP score for the prediction of in-hospital mortality. Univariate and multivariate Cox regression analyses were performed to determine the prognostic factors associated with in-hospital mortality patients with HF. The prediction accuracy was evaluated by assessing the area under the receiver operating characteristic (AUC) curve.

Results: The mean age of the 242 patients included in the study was 72 ± 12 years, with 43.8% (n=106) females and 56.2% (n=136) males. The median value of the HALP score was 26.91. Group 1 comprised 122 patients, while Group 2 had 120 patients. The low HALP group was older, had increased levels of creatinine, CRP, and BNP, and decreased levels of WBC, eGFR, and sodium. Additionally, in-hospital mortality rates were higher in Group 1. The multivariate analyses revealed that systolic blood pressure, Killip class at admission, LVEF, and HALP score (HR: 0.945, 95% CI: 0.915-0.976, p=0.001) were independent predictors of mortality in patients hospitalized for HF. ROC curve analysis was used to determine diagnostic efficiency, and an area under the curve (AUC) of 0.785 was obtained (95% CI: 0.728-0.835, p < 0.001). The optimal cut-off value of HALP in predicting in-hospital mortality was ≤ 14.27 , with a sensitivity of 63.9% and specificity of 82%.

Conclusion: The HALP score in decompensated HF patients was closely related to the prognosis. Worse in-hospital mortality rates were found in patients with a low HALP score.

Key Words: HALP score, in-hospital mortality, heart failure

HOSPİTALİZE EDİLEN OLAN KALP YETMEZLİĞİ HASTALARINDA HALP SKORUNUN HASTANE İÇİ MORTALİTE İÇİN PROGNOSTİK ETKİNLİĞİ

ÖZET

Hedefler: Hemoglobin, albümin, lenfosit ve trombositlerin kombinasyonu olarak bilinen HALP skoru, birçok kanserde önemli bir risk belirteci olarak doğrulanmıştır. Bizde, kalp yetmezliği nedeniyle hastaneye yatırılan hastalarda HALP skorunun prognostik değerini değerlendirmeyi amaçladık.

Materyal ve Metot: Bu retrospektif tasarımlı çalışma, Ocak-Mayıs 2023 tarihleri arasında kalp yetmezliği nedeniyle hastaneye yatırılan ve ejeksiyon fraksiyonu <50% olan 242 hastayı içeriyordu. Temel klinik özellikler ve kan parametreleri hastane dosyalarından kaydedildi. HALP skoru, hemoglobin (g/L) × albümin (g/L) seviyeleri × lenfosit sayısı (/L) / trombosit sayısı (/L) olarak hesaplandı. Hastalar, HALP skorunun ortanca değerine göre iki gruba ayrıldı; düşük HALP (Grup 1) ve yüksek HALP (Grup 2) skorlarına sahip olanlar. Sonrasında, HALP skorunun hastane içi mortalite tahmini için potansiyelini incelendi. Hastaların içindeki hastane içi mortalite ile ilişkili prognostik faktörleri belirlemek için univaryant ve multivaryant Cox regresyon analizleri yapıldı. Tahmin doğruluğu, alıcı işletim karakteristiği (AUC) eğrisi altındaki alanı değerlendirilerek değerlendirildi.

Sonuçlar: Çalışmaya dahil edilen 242 hastanın ortalama yaşı 72 ± 12 yıldı, bunların %43.8'i (n=106) kadın ve %56.2'si (n=136) erkekti. HALP skorunun medyan değeri 26.91 idi. Grup 1'de 122 hasta bulunurken, Grup 2'de 120 hasta bulunmaktaydı. Düşük HALP grubundaki hastalar daha yaşlıydı, kreatinin, CRP ve BNP seviyeleri artmış, WBC, eGFR ve sodyum seviyeleri ise azalmıştı. Ayrıca, Grup 1'de hastane içi mortalite oranları daha yüksekti. Multivaryant analizler, sistolik kan basıncı, hastaneye başvuru anındaki Killip sınıfı, LVEF ve HALP skorunun (HR: 0.945, %95 GA: 0.915-0.976, p=0.001) hastaneye yatırılan HF hastalarında mortalitenin bağımsız prediktörleri olduğunu gösterdi. Tanısal verimliliği belirlemek için ROC eğri analizi kullanıldı ve 0.785 (0.728-0.835, %95 GA) olan bir eğri altındaki alan (AUC) elde edildi (p < 0.001). Hastane içi mortalitenin tahmininde HALP skorunun optimal kesim değeri ≤ 14.27 idi ve duyarlılık %63.9, özgüllük ise %82 idi.

Sonuç: Dekompanse HF hastalarındaki HALP skoru, prognoz ile yakından ilişkilendi. Düşük HALP skoruna sahip hastalarda daha kötü hastane içi mortalite oranları bulundu.

Anahtar Kelimeler: HALP skoru, hastane içi mortalite, kalp yetmezliği

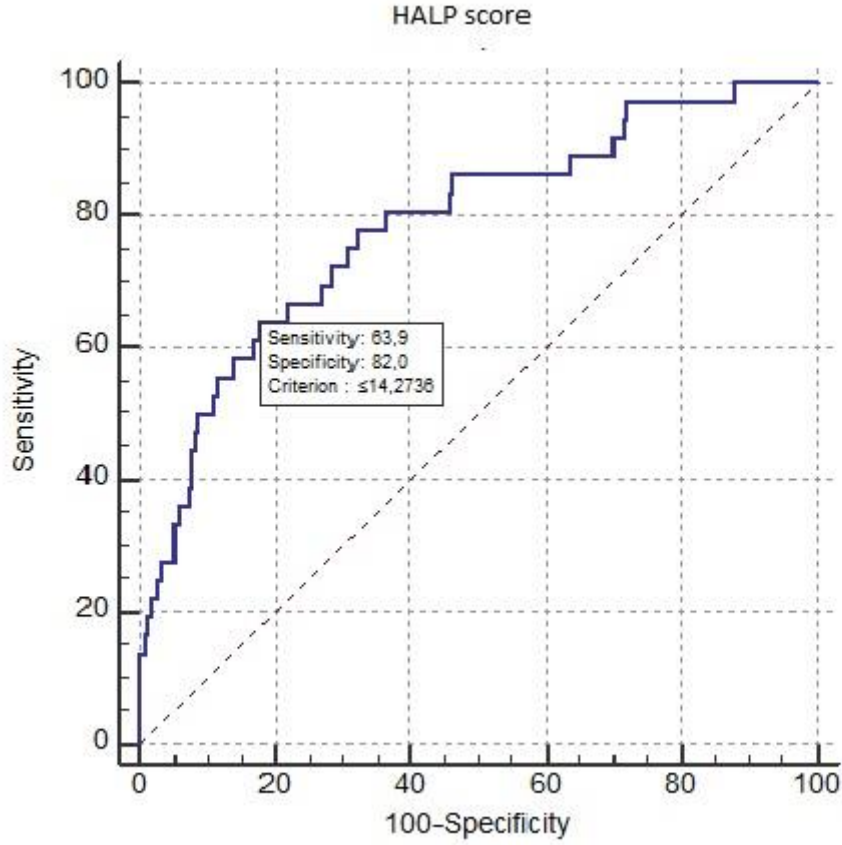


Figure 1. ROC curve analyses for HALP score in the prediction of in-hospital mortality patients with heart failure

HALP GROUPS

	Low, n:122	High, n:120	Total, n:242	p value
Age	74±12	70±12	72±12	0.001
Male, n(%)	62 (50.8%)	74 (61,7%)	136 (56,2%)	0.090
BMI, kg/m2	28,2±5,4	29,6±7,60	28,9±6,6	0.306
HT, n(%)	97 (79,%)	91 (75,8%)	188 (77,7%)	0.493
DM, n(%)	56 (45,9%)	59 (49,2%)	115 (47,5%)	0.612
CAD, n(%)	63 (51,6%)	72 (60%)	135 (55,8%)	0.191
Stroke, n(%)	11 (9%)	5(4,2%)	16 (6,4%)	0.125
AF, n(%)	67 (54,9%)	57 (47,5%)	124 (51,2%)	0.319
CKD, n(%)	51 (41,8%)	38 (31,6%)	89 (36,8%)	0.091
Smoking status	48 (39,4%)	56 (42,5%)	104 (41,2%)	0.075
Heart rate, bpm	97±24	102±28	99±26	0.449
Saturation, %	90±7	92±6	91±6	0.063
SBP, mm/Hg	126±30	130±26	128±28	0.200
DBP, mm/Hg	75±17	76±16	76±16	0.050
ASA, n(%)	51 (41,8%)	46 (38,3%)	97 (40,1%)	0.583
Other Antiplatelet, n(%)	12 (9,8%)	25 (20,8%)	37 (15,3%)	0.055
Oral Anticoagulant Use, n(%)	60 (49,2%)	47 (39,2%)	107(44,2%)	0.198
Beta blockers, n(%)	97 (79,5%)	92 (76,7%)	189(78,1)	0.594
ACEI or ARB, n(%)	71 (58,2)	66 (55%)	137(56,6%)	0.666
WBC, cells/uL	9,51±3,93	10,97±4,48	10,23±4,26	0.003
Neutrophil, cells/uL	6,61 (4,88-9,80)	7,40 (5,06-9,80)	7,01 (4,90-9,80)	0.679
Glucose, mg/dL	163±80	164±75	164±77	0.723
Creatinine, mg/dL	1,55±0,80	1,33±0,51	1,44±0,68	0.018
eGFR, mL/min/1.73m2	48,27±22,63	58,27±25,64	53,53±24,72)	0.003
Sodium, mEq/L	135±6	137±4,	136±5	0.006
Potassium, mEq/L	4,68±0,90	4,52±0,66	4,60±0,79	0.242
CRP, mg/dL	19,10 (9,21-42,20)	8,90 (3,10-22,80)	13 (5,18-33,20)	<0,001
Bnp, pg/mL	1081 (592-2078)	393 (259-1029)	691 (366-1440)	<0,001
Killip class, n(%)				
1	5 (4,1%)	7 (5,8%)	12 (5%)	
2	49 (40,2%)	41 (34,2%)	90 (37,2%)	
3	56 (45,9%)	60 (50%)	116 (47,9%)	0.660
4	12 (9,8%)	12 (10%)	24 (9,9%)	
Ejection Fraction, %	37±13	37±13	37±13	0.785
Hospital stay, days	9±3	9±4	9±3	0.520
Death, n(%)	28 (23%)	8 (6,7%)	36 (14,9%)	<0,001
HALP score	14,86 (9,66-21,36)	48,57 (35,39-72,94)	26,91 (14,61-48,31)	<0,001
Hemoglobin, g/dL	108,4±21,5	129,8±20,21	119,3±23,4	<0,001
Albumin, gr/dL	35±6	39±6	37±6	<0,001
Lymphocyte, cells /uL	0,83 (0,54-1,51)	2,02 (1,48-3,24)	1,33 (0,80-2,04)	<0,001
Platelet, cells/uL	247±94	221±75	234±85	0.041

Table 1. Demographic variables of the groups due to the median value of HALP score

	Univariate			Multivariate				
	HR	95% C.I.		p value	HR	95% C.I.		p value
Age	1,040	1,005	1,076	,025		-		
SBP	,960	,942	,977	,000	,970	(0,952	0,989)	,002
DBP	,946	,921	,972	,000		-		
CRP	1,014	1,005	1,023	,001		-		
Killip	3,040	1,738	5,317	,000	2,853	1,468	5,544	,002
EF	,950	,920	,981	,002	,962	,927	,999	0,04
HALP	,942	,914	,971	,000	,945	,915	,976	,001

Table 2. Univariate and Multivariate Analyses of the predictors for in-hospital mortality

A REVIEW OF THE PROTECTIVE PROPERTIES OF MEDICINAL PLANTS AGAINST DIABETES-RELATED HEART DISEASE

Omar BENAMARI*

Hassan AMHAMDI

Research Unit in Applied Chemistry, Faculty of Sciences and Techniques, Abdelmalek Essaadi University, Al-Hoceima 32003, Morocco

ABSTRACT

Since the beginning of time, humans have used many medicinal plants as a popular medicine to cure many human and livestock health problems, such as diabetes and cardiovascular disorders. In the Rif region of northern Morocco, as in all rural areas of the world, these plants have always held an important place in traditional medicine due to the low socio-economic situation in these areas, where people prefer to rely on traditional medicine rather than modern medicine.

Diabetes-related heart disease is a significant health burden with increasing prevalence. It remains the most common cause of morbidity and mortality worldwide.

This work aims to describe the mechanisms of action of some medicinal herbs that have been shown to have cardioprotective effects in diabetes.

Literature searching was performed using Google Scholar, PubMed, ScienceDirect, and Scopus. The keywords used for the search include: folk medicine, herbal medicine, diabetic problems, heart disorders, and cardiovascular diseases. After screening through the 14 English articles from 2010 to date, a total of seven medicinal plants have been reported to be used as traditional herbal medicines that would reduce risk factors associated with diabetes and cardiovascular diseases.

Keywords: Medicinal plants, Traditional medicine, Diabetes, Cardioprotective, Cardiovascular.

KOR KASLARININ ENDURANSI VE POSTURAL KONTROL**Hafize Hilal KARGIN**Dokuz Eylül Üniversitesi, Sağlık Bilimleri Fakültesi
Dokuz Eylül University, Faculty of Health Sciences**ORCID ID:** 0000-0001-5751-0413**Ata ELVAN***İzmir Ekonomi Üniversitesi, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü,
Izmir University of Economics, Faculty of Health Sciences, **Physiotherapy and Rehabilitation****ORCID ID:** 0000-0002-6478-433X**ÖZET**

Giriş: Kor kaslarının etkili bir şekilde postüral stabilite sağladığı, kasılma yoluyla karın içi basıncı arttırdığı ve stabiliteyi değiştiren pertürbasyonlardan önce aktive olduğu bilinmektedir. Bu çalışmanın amacı sağlıklı bireylerde antero-posterior eksternal pertürbasyonlar sırasında kor kaslarının dayanıklılığı ile postüral kontrol arasındaki ilişkiyi araştırmaktır.

Materyal ve Yöntem: Bu kesitsel araştırmaya dâhil olma kriterlerini karşılayan 24 kişi katıldı. Katılımcıların gövde kor kaslarının enduransları (Gövde Fleksör Endurans Testi, Gövde Ekstansör Endurans Testi, Lateral Köprü Testi) ve antero-posterior eksternal pertürbasyon sırasında postüral kontrol değerlendirmeleri yapıldı. Gövde endurans testleri McGill protokolüne uygun olarak yapılmıştır. Çalışmada postüral kontrol değerlendirmesi için Tekscan MatScan™ Pressure Mat System (Tekscan Inc. Boston, USA) cihazı kullanıldı. Katılımcıların yaş, vücut ağırlığı, boy uzunluğu ve BKİ gibi özellikleri ortalama ve standart sapma kullanılarak belirlenmiştir. Bağımlı değişkenler ve bağımsız değişkenler arasındaki ilişki parametrik koşullar sağlanmadığı için Spearman korelasyonu ile analiz edildi.

Bulgular: Gövde kor kaslarının enduransları ile anterior ve posteriordan oluşturulan eksternal pertürbasyon sırasındaki postüral kontrol verileri arasında birkaç anlamlı negatif ilişki bulunsa da ilişkilerin çoğu anlamsızdı ($p>0,05$).

Sonuçlar: Araştırmamızın sonucunda gövde kor kaslarının enduransları ile antero-posterior eksternal pertürbasyon sırasındaki postüral kontrol arasında anlamlı korelasyon bulunmamıştır. Antero-posterior eksternal pertürbasyon sırasındaki antisipatuar reaksiyon cevaplarına uygun spesifik endurans testleriyle değerlendirme yapan ileri araştırmalar önermekteyiz.

Anahtar Kelimeler: Kor Kasları, Endurans, Eksternal Pertürbasyon, Postural Kontrol

ENDURANCE OF CORE MUSCLES AND POSTURAL CONTROL

ABSTRACT

Introduction: The purpose of this cross-sectional study was to investigate the relationship between the endurance of core muscles and postural control during antero-posterior external perturbations in healthy individuals.

Material and Methods: A total of 24 participants meeting the inclusion criteria were included in the study. The participants' core muscle endurance (Trunk Flexor Endurance Test, Trunk Extensor Endurance Test, Lateral Bridge Test) and postural control assessments during antero-posterior external perturbations were conducted. The trunk endurance tests were performed according to the McGill protocol. The Tekscan MatScan™ Pressure Mat System (Tekscan Inc., Boston, USA) was used for postural control assessment in the study. Participant characteristics such as age, body weight, height, and BMI were determined using means and standard deviations. The relationship between dependent variables and independent variables was analyzed with Spearman correlation because parametric conditions were not met.

Results: Although there were some significant negative relationships between core muscle endurance and postural control data during anterior and posterior external perturbations, most of the relationships were not significant ($p > 0.05$).

Conclusion: In conclusion, there was no significant correlation between core muscle endurance and postural control during antero-posterior external perturbations. We recommend further research evaluating anticipatory reaction responses during antero-posterior external perturbations with specific endurance tests.

Key Words: Core Muscles, Endurance, External Perturbation, Postural Control

REAKSİYON SÜRESİNİN HİDROTERMAL YÖNTEMLE BÜYÜTÜLEN CuO İNCE FİMLERİN ÖZELLİKLERİ ÜZERİNE ETKİSİ

Aykut ASTAM

Erzincan Binali Yıldırım University, Faculty of Art and Science, Department of Physics
ORCID ID: 0000-0002-4321-3626

Ömer KAYA

Erzincan Binali Yıldırım University, Institute of Science and Technology
ORCID ID: 0000-0002-5019-3109

ÖZET

CuO ince filmler, flor katkılı kalay oksit (FTO) altlıklar üzerine hidrotermal yöntemle büyütüldü ve reaksiyon süresinin filmlerin yapısal, morfolojik ve optik özellikleri üzerine etkisi araştırıldı. Farklı reaksiyon sürelerinde (12, 16, 20 ve 24 saat) büyütülen CuO ince filmler, X-ışını kırınımı (XRD), taramalı elektron mikroskobu (SEM), enerji dağılımlı X-ışını analizi (EDAX) ve optik soğurma ölçümleri kullanılarak karakterize edildi. XRD sonuçları, tüm filmlerin herhangi bir safsızlık fazı içermeyen monoklinik kristal yapıya sahip polikristal CuO'dan oluştuğunu ortaya çıkardı. Sonuçlar ayrıca farklı reaksiyon sürelerinde büyütülen filmlerin kristalografik yapısında önemli bir değişiklik olmadığını ve artan reaksiyon süresinin filmlerin kristal yapısını iyileştirdiğini ortaya koydu. SEM görüntüleri, mikrometre ölçeğinde krizantem benzeri yapıların oluştuğunu ve hidrotermal reaksiyon süresinin artmasıyla bu yapıların sayısının arttığını gösterdi. EDAX ölçümleri Cu ve O elementlerinin varlığını kanıtladı ve tüm filmlerin Cu/O oranlarının bire oldukça yakın olduğunu gösterdi. Optik soğurma ölçümlerinden CuO ince filmlerin doğrudan yasak enerji aralığı değerlerinin hidrotermal reaksiyon süresine bağlı olarak 1,45 eV ile 1,55 eV aralığında olduğu bulundu.

Anahtar Kelimeler: CuO, İnce Film, Hidrotermal Yöntem, Süre Etkisi

EFFECT OF REACTION TIME ON THE PROPERTIES OF CuO THIN FILMS DEPOSITED BY HYDROTHERMAL METHOD

ABSTRACT

CuO thin films were deposited on fluorine-doped tin oxide (FTO) substrates via hydrothermal method and the effects of reaction time on the structural, morphological, and optical properties of the films were studied. CuO thin films deposited at different reaction times (12, 16, 20, and 24h) were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDAX), and optical absorption measurements. XRD results revealed that all the films consisted of polycrystalline CuO with a monoclinic crystal structure without any impurity phase. The results also indicated no significant variation in the crystallographic structure of the films deposited at different reaction times and increasing

hydrothermal reaction time improved the crystallinity. SEM images showed that micrometer-sized chrysanthemum-like structures were formed, the number of which increased with increasing hydrothermal reaction time. EDAX measurements confirmed the existence of Cu and O elements and showed that the Cu/O ratios of all films were very close to unity. From the optical absorption measurements, the direct forbidden energy gap values of the CuO thin films were found to be between 1.45 eV and 1.55 eV, depending on the hydrothermal reaction time.

Keywords: CuO, Thin Films, Hydrothermal Method, Time Effect

1. GİRİŞ

Metal oksitler, ayırt edici fiziksel ve kimyasal özelliklerinden dolayı mühendislik ve bilimsel uygulamalar için önemli malzemeler arasında yer almaktadırlar. Metal oksitler arasında bakır oksitler, cihaz uygulamaları için incelenen ilk yarıiletkenlerden biridir ve güneş pilleri (Wong, Zhuk, Masudy-Panah, ve Dalapati, 2016), gaz sensörleri (Keerthana, Arthina Titlin, Ravi Dhas, Venkatesh, ve Monica, 2023), nem sensörleri (Wang, Hsiao, Chang, Lam, Wen, Young, Hung, ve Huang, 2012) elektrokromik cihazlar (Ozer ve Lampert, 1998), elektrokimyasal enerji depolama cihazları (Dubal, Dhawale, Salunkhe, Jamdade, ve Lokhande, 2010) ve biyolojik kirleticilerin fotokatalitik giderimi (Ansari, Sheibani, ve Fernandez-Garcia, 2022) gibi çeşitli alanlarda yaygın olarak kullanılmaktadırlar. Ayrıca bakır oksitler kimyasal kararlılıkları, düşük üretim maliyetleri ve zehirli olmayan yapıları nedeniyle de ilgi çekmektedir. P-tipi elektriksel iletkenliğe sahip olduğu bilinen bakır oksitlerin iki yaygın formu, 1,0 eV ile 2,1 eV arasında değişen doğrudan bant aralığına sahip CuO (tenorite) ve 2,0 eV ile 2,6 eV arasında değişen doğrudan bant aralığına sahip Cu₂O (cuprite) dur (Ansari, Sheibani, ve Fernandez-Garcia, 2022). Yapılan çalışmalarda bakır oksit ince filmler kimyasal-termal oksidasyon (Ansari, Sheibani, ve Fernandez-Garcia, 2022), saçtırma (Karazmoudeh, Soltanieh, ve Hasheminasari, 2023), kimyasal buhar biriktirme (Chua, Kim, Li, ve Gordon, 2019), döner kaplama (Baturay, 2020), sıralı iyonik tabaka adsorpsiyonu ve reaksiyonu (Akaltun, 2015) ve hidrotermal (Liu, Chu, Li, Li, ve Dong, 2006) gibi çeşitli yöntemler kullanılarak elde edilmiştir. Bu yöntemler arasında hidrotermal yöntem, basitliği, düşük maliyeti ve nispeten düşük reaksiyon sıcaklıkları (100-300°C) nedeniyle ilgi çekmektedir. Düşük reaksiyon sıcaklıkları filmlerin çatlama olasılığını azaltarak altlık malzemenin yüzeyinin daha homojen bir şekilde kaplanmasına olanak sağlamaktadır (Wu ve Yan, 2008). İnce filmler cam, kuvars, paslanmaz çelik, yarıiletkenler veya metal folyolar gibi çeşitli alt malzemeler üzerine büyütülebilir. Hidrotermal yöntemle film büyütme işlemi altlık malzeme ve öncül çözeltilerin kapalı bir kap içerisinde konularak belirlenen sıcaklıklara kadar ısıtılması ile gerçekleşir ve elde edilen filmlerin

özellikleri öncül çözeltilerin konsantrasyonu ve pH'sı, reaksiyon süresi ve sıcaklığı gibi büyütme parametreleriyle kontrol edilebilir (Holi, Zainal, Talib, Lim, Yap, Chang, ve Ayal, 2016).

Bu çalışmada CuO ince filmler FTO altlıklar üzerine reaksiyon sıcaklığı sabit tutularak, farklı reaksiyon sürelerinde hidrotermal yöntemle büyütülmüş ve reaksiyon süresinin bu filmlerin birtakım yapısal ve optik özellikleri üzerine etkisi incelenmiştir.

2. ARAŞTIRMA VE BULGULAR

2.1. Deneysel Çalışmalar

CuO ince filmleri hidrotermal yöntemle elde etmek için bakır (II) sülfat pentahidrat ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) ve %32 amonyak çözeltisi (NH_4OH), altlık olarak ise flor katkılı kalay oksit (FTO) altlıklar kullanıldı. Yaklaşık boyutları $20 \text{ mm} \times 10 \text{ mm} \times 3 \text{ mm}$ olacak şekilde kesilen FTO altlıklar, büyütme işlemi öncesi 15 dakika boyunca sırasıyla deterjanlı su, aseton, 1:1 etanol-su çözeltileri içerisinde ultrasonik olarak temizlendi ve ultra saf su ile durulandı. Öncül çözeltiyi elde etmek için öncelikle 30 ml, 50mM $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ çözeltisi ultra saf su kullanılarak hazırlandı. Daha sonra çözeltiliye damla damla NH_4OH eklendi. Başlangıçta soluk mavi renge sahip olan çözelti daha sonra berrak, koyu mavi bir renge dönüştü. Bu noktada çözeltinin pH'sı 10,5 olarak ölçüldü. Hazırlanan öncül çözelti 50 ml kapasiteli, iç kabı teflon, dış kabı paslanmaz çelik otoklava aktarıldı. Önceden temizlenmiş olan FTO altlıklar çözelti içerisine dikey olarak yerleştirildi ve otoklav kapatıldı ve 180°C 'ye ısıtılmış olan fırın içerisine yerleştirildi. Hidrotermal reaksiyon süresinin CuO ince filmlerin özellikleri üzerine etkisini incelemek için 12, 16, 20 ve 24 saat reaksiyon sürelerinde dört farklı numune elde edildi. Elde edilen ince filmler ultra saf su ile birkaç kere yıkandı ve oda sıcaklığında hava ortamında kurutuldu. FTO altlıkların iletken olmayan yüzeylerinde oluşan filmler yıkama esnasında dökülürken altlıkların iletken yüzeylerinde koyu gri renkli hemen hemen homojen görünümlü CuO ince filmler elde edildi.

Farklı reaksiyon sürelerinde elde edilen CuO ince filmler yapısal, yüzey morfolojik, elementel ve optik özellikleri açısından karakterize edildi. Filmlerin fazı ve kristal yapısı $\lambda=1.5405 \text{ \AA}$ dalga boyuna sahip Cu- $K\alpha$ radyasyonu kullanan PANalytical Empyrean marka X-ışını difraktometresi kullanılarak incelendi. Kırınım desenleri, $2\theta=20^\circ-80^\circ$ aralığında kaydedildi. Filmlerin yüzey morfolojisi ve element analizi, FEI Quanta FEG 450 marka taramalı elektron mikroskobu (SEM) ve ona entegre edilmiş enerji dağılımlı X-ışını analizi (EDAX) cihazı ile incelendi. Optik analiz için absorpsiyon spektrumları oda sıcaklığında, 500-1100 nm dalga boyu aralığında UV-1810 DASPC UV-VIS çift ışınli spektrofotometre kullanılarak elde edildi. Filmlerin yasak enerji aralığı değerleri Tauc yöntemiyle belirlendi.

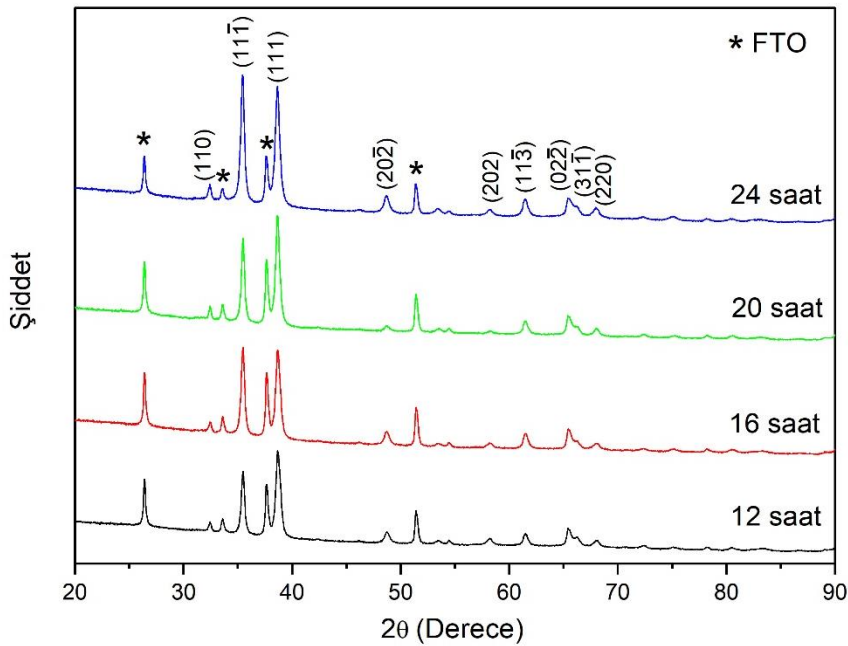
2.2. Deneysel Sonuçlar

Sabit 180°C reaksiyon sıcaklığında 12, 16, 20 ve 24 saat reaksiyon sürelerinde büyütülen CuO ince filmlerin fazı ve kristal yapısı XRD ölçümleri yardımıyla incelendi, elde edilen kırım desenleri Şekil 2.1’de verilmektedir. XRD desenleri, farklı reaksiyon sürelerinde büyütülen CuO ince filmlerin tamamının polikristal yapıya sahip olduğunu göstermektedir. Elde edilen kırınım piklerinin büyük bir bölümü monoklinik CuO’nun standart deseniyle (JCPDS No.:45-0937) uyumlu olup, geriye kalan pikler ise FTO altlıktan kaynaklanmaktadır ve şekilde * işaretiyle gösterilmiştir. XRD desenlerinde bunların dışında herhangi bir pikin gözlenmemesi, büyütülen filmlerin tamamen CuO’dan meydana geldiğini göstermektedir. Bunun yanı sıra Şekil 2.1 incelendiğinde, artan reaksiyon süresinin filmlerin fazında veya kristalografik yapısında herhangi bir değişikliğe neden olmadığı, yalnızca pik şiddetlerinde bir miktar artışa sebep olduğu görülmektedir. Farklı reaksiyon sürelerinde elde edilen CuO ince filmlerin ortalama tanecik büyüklüğü değerleri Denklem 1’de verilen Scherrer eşitliği kullanılarak hesaplanmıştır (Scherrer, 1918).

$$D = \frac{K\lambda}{\beta \cos\theta} \quad (1)$$

Burada;

- D : Ortalama tanecik büyüklüğü
- K : Yapı faktörü diye isimlendirilen bir sabit
- β : Pikin yarı maksimumdaki tam genişliği
- θ : Bragg açısını ifade etmektedir.



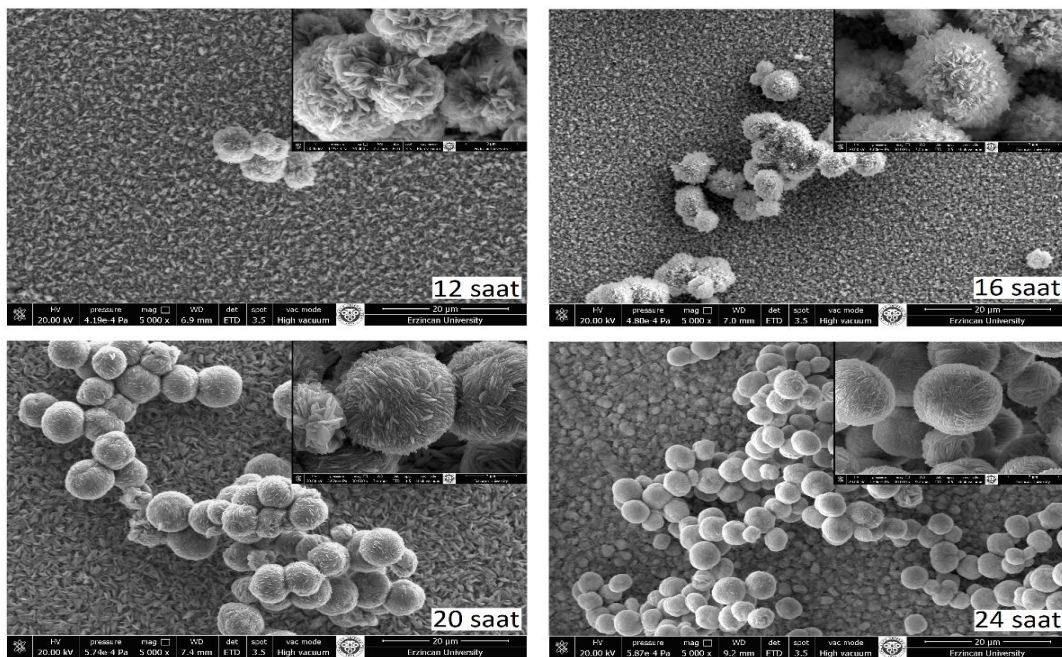
Şekil 2.1. Farklı reaksiyon sürelerinde büyütülen CuO ince filmlerin XRD desenleri

Hesaplanan ortalama tanecik büyüklüğü değerleri Tablo 2.1’de gösterilmektedir. Buna göre artan reaksiyon süresi ortalama tanecik büyüklüğü değerinde bir artışa neden olmaktadır. Bu durum artan reaksiyon süresinin kristalleşmeyi artırdığını gösterir.

Tablo 2.1. Farklı reaksiyon süreleri için CuO ince filmlerin tanecik büyüklüğü değerleri

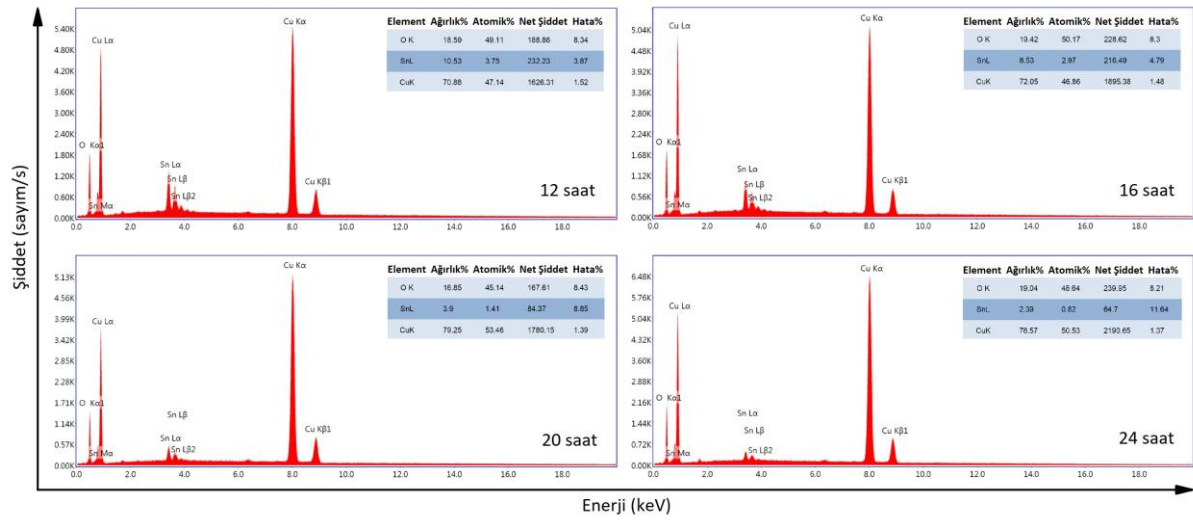
Reaksiyon Süresi (saat)	Tanecik Büyüklüğü (nm)
12	19,8
16	20,5
20	22,1
24	22,4

Reaksiyon süresinin hidrotermal yöntemle elde edilen CuO ince filmlerin yüzey özellikleri üzerine etkisi, SEM ölçümleri yardımıyla incelenmiş ve 12, 16, 20 ve 24 saat reaksiyon sürelerinde büyütülen CuO ince filmlerden elde edilen 5000 ve 30000 büyütmedeki SEM görüntüleri Şekil 2.2’de verilmiştir. Şekilden açıkça görüleceği üzere tüm filmlerin yüzeylerinde mikrometre ölçeğinde krizantem benzer küresel yapıların bir araya gelmesiyle oluşmuş adacıkların bulunduğu açıkça görülebilir. Benzer yapılar Bhuvaneshwari ve arkadaşları tarafından da elde edilmiştir (Bhuvaneshwari ve Gopalakrishnan, 2016). Bunun yanı sıra artan reaksiyon süresinin krizantem benzer bu küresel yapıların sayısının artmasına ve ayrıca daha kompakt hale gelmelerine neden olduğu belirlenmiştir (Kaya, 2019).



Şekil 2.2. Farklı reaksiyon sürelerinde büyütülen CuO ince filmlerin SEM görüntüleri

Farklı reaksiyon sürelerinde elde edilen CuO ince filmlerin elementel kompozisyonu EDAX ölçümleri yardımıyla incelenmiş ve elde edilen spektrumlar sayısal değerleri ile birlikte Şekil 2.3'te gösterilmiştir. EDAX spektrumlarının tamamında gözlenen Cu ve O elementlerine ait pikler filmlerin bu elementlerden oluştuğunu göstermekte, Sn elementine ait pikler FTO altlık malzemeden kaynaklanmaktadır. Bunun yanı sıra artan reaksiyon süresiyle Sn elementinin miktarının göreceli olarak azalması film kalınlığının artması nedeniyledir (Kaya, 2019).



Şekil 2.3. Farklı sentez sürelerinde büyütülen CuO ince filmlerin EDAX spektrumları

Farklı reaksiyon sürelerinde elde edilen CuO ince filmler için Cu/O atomik oranları hesaplanmış ve elde edilen sonuçlar Tablo 2.2'de verilmiştir. Buna göre Cu/O oranları düzenli olmayan bir şekilde değişmesine rağmen, değişimler çok küçüktür ve CuO ince filmlerin tamamında Cu/O oranı bire oldukça yakındır.

Tablo 2.2. Farklı reaksiyon süreleri için CuO ince filmlerin Cu/O oranları

Reaksiyon Süresi (saat)	Cu/O
12	0,96
16	0,93
20	1,18
24	1,04

Malzemelerin soğurma katsayıları ile yasak enerji aralıkları arasındaki ilişki 2 Denklemiyle verilmektedir,

$$\alpha = \frac{A(h\nu - E_g)^n}{h\nu} \quad (2)$$

Burada;

α : Soğurma katsayısı

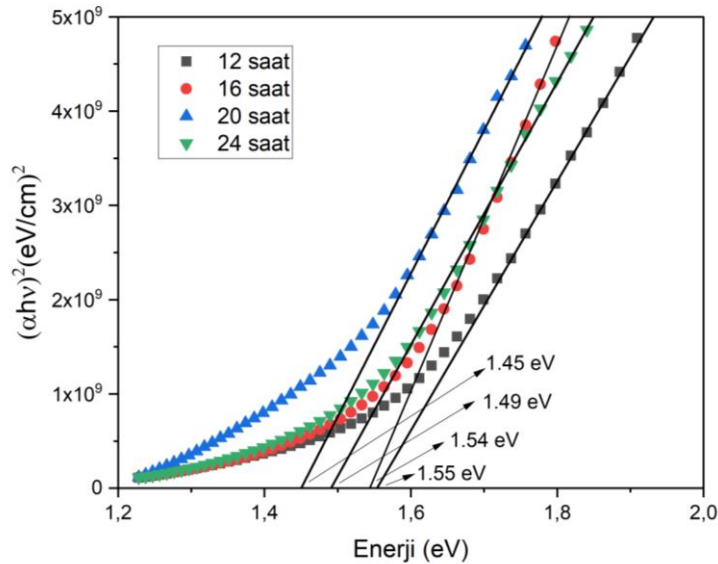
A : Bağımsız bir sabit

$h\nu$: Foton enerjisi

E_g : Yasak enerji aralığı

n : Geçişin doğasına göre değer alan (doğrudan geçiş için $n=1/2$, dolaylı geçiş için $n=2$) bir sabiti ifade etmektedir.

2 Denkleminde göre, malzemelerin doğrudan yasak enerji aralığı, $(\alpha h\nu)^2$ -Enerji grafiğindeki lineer bölgenin $\alpha=0$ da yatay eksene extrapole edilmesi ile bulunabilir. Farklı reaksiyon sürelerinde elde edilen CuO ince filmler için gerçekleştirilen optik soğurma ölçümleri kullanılarak çizilen $(\alpha h\nu)^2$ -Enerji grafikleri Şekil 2.4'te verilmektedir. Bu grafiklere göre CuO ince filmlerin doğrudan yasak enerji aralığı 1,55 eV ile 1,45 eV aralığında değerler almaktadır.



Şekil 2.4. Farklı sentez sürelerinde elde edilmiş CuO ince filmlerin $(\alpha h\nu)^2$ -Enerji grafikleri

3. SONUÇ

- 12, 16, 20 ve 24 saat reaksiyon sürelerinde hidrotermal yöntemle elde edilen CuO ince filmlerin tamamının monoklinik CuO'dan oluştuğu belirlenmiş, artan reaksiyon süresi filmlerde kristalleşmenin artmasına neden olmuştur.
- CuO ince filmlerin mikrometre ölçeğinde krizantem benzer küresel yapılardan meydana geldiği ve artan reaksiyon süresiyle bu yapıların sayısının arttığı ve daha kompakt hale geldiği belirlenmiştir.
- Farklı sentez sürelerinde elde edilen CuO filmlerin tamamında Cu/O oranının bire yakın olduğu görülmüştür.

- Elde edilen CuO filmlerin tamamının doğrudan optik geçişe sahip olduğu ve filmlerin yasak enerji aralığı değerlerinin 1,55 eV ile 1,45 eV aralığında değiştiği belirlenmiştir.

KAYNAKÇA

- Akaltun, Y. (2015). Effect of thickness on the structural and optical properties of CuO thin films grown by successive ionic layer adsorption and reaction. *Thin Solid Films*, 594, 30–34. <https://doi.org/10.1016/j.tsf.2015.10.003>.
- Ansari, F., Sheibani, S., & Fernandez-Garcia, M. (2022). Surface modification of Cu₂O-CuO photocatalyst on Cu wire through decorating with TiO₂ nanoparticles for enhanced visible light photocatalytic activity. *Journal of Alloys and Compounds*, 919, 165864. <https://doi.org/10.1016/j.jallcom.2022.165864>.
- Baturay, S. (2020). Structural and Optical Properties of Sb Doped CuO Films. *Academic Platform Journal of Engineering and Science*, 8, 84–90. <https://doi.org/10.21541/apjes.605822>.
- Bhuvaneshwari, S., & Gopalakrishnan, N. (2016). Hydrothermally synthesized Copper Oxide (CuO) superstructures for ammonia sensing. *Journal of Colloid and Interface Science*, 480, 76–84. <https://doi.org/10.1016/j.jcis.2016.07.004>.
- Chua, D., Kim, S. B., Li, K., & Gordon, R. (2019). Low Temperature Chemical Vapor Deposition of Cuprous Oxide Thin Films Using a Copper(I) Amidinate Precursor. *ACS Applied Energy Materials*, 2, 7750–7756. <https://doi.org/10.1021/acsaem.9b01683>.
- Dubal, D. P., Dhawale, D. S., Salunkhe, R. R., Jamdade, V. S., & Lokhande, C. D. (2010). Fabrication of copper oxide multilayer nanosheets for supercapacitor application. *Journal of Alloys and Compounds*, 492, 26–30. <https://doi.org/10.1016/j.jallcom.2009.11.149>.
- Holi, A. M., Zainal, Z., Talib, Z. A., Lim, H. N., Yap, C. C., Chang, S. K., & Ayal A., K. (2016). Effect of hydrothermal growth time on ZnO nanorod arrays photoelectrode performance. *Optik*, 127, (2016) 11111–11118. <https://doi.org/10.1016/j.ijleo.2016.09.015>.
- Karazmoudeh, N. J., Soltanieh, M., & Hasheminasari, M. (2023). Structural and photocatalytic properties of undoped and Zn-doped CuO thin films deposited by reactive magnetron sputtering. *Journal of Alloys and Compounds*, 947, 169564. <https://doi.org/10.1016/j.jallcom.2023.169564>.
- Kaya, Ö. (2019). Hidrotermal yöntemle büyütülen CuO ince filmlerde sentez süresi ve sıcaklığının filmlerin yapısal ve optik özellikleri üzerine etkisi. *Erzincan Binali Yıldırım Üniversitesi Fen Bilimleri Enstitüsü, Fizik Ana Bilim Dalı, Yüksek Lisans Tezi*.
- Keerthana, S., Arthina Titlin, M. B., Ravi Dhas, C., Venkatesh, R., & Esther Santhoshi Monica S. (2023). Unraveling the role of solvent type in the physical and chemiresistive gas sensing properties of nebulizer-sprayed CuO films. *Materials Science and Engineering B*, 297, 116821. <https://doi.org/10.1016/j.mseb.2023.116821>.
- Liu, Y., Chu, Y., Li, M., Li, L., & Dong, L. (2006). In situ synthesis and assembly of copper oxide nanocrystals on copper foil via a mild hydrothermal process. *Journal of Materials Chemistry*, 16, 192–198. <https://doi.org/10.1039/B512481F>.
- Ozer, N., & Lampert, C. M. (1998). Electrochromic characterization of sol—gel deposited coatings. *Solar Energy Materials and Solar Cells*, 54, 147–156. [https://doi.org/10.1016/S0927-0248\(98\)00065-8](https://doi.org/10.1016/S0927-0248(98)00065-8).
- Scherrer, P. (1918). Bestimmung der Grösse und der inneren Struktur von Kolloidteilchen mittels Röntgenstrahlen. *Mathematisch-Physikalische Klasse*, 26, 98–100.
- Wang, S. B., Hsiao, C. H., Chang, S. J., Lam, K. T., Wen, K. H., Young, S. J., Hung, S. J., & Huang, B. R. (2012). CuO nanowire-based humidity sensor. *IEEE Sensors Journal*, 12, 1884–1888. <https://doi.org/10.1109/JSEN.2011.2180375>.

Wong, T. K. S., Zhuk, S., Masudy-Panah, S., & Dalapati, G. K. (2016). Current Status and Future Prospects of Copper Oxide Heterojunction Solar Cells. *Materials*, 9, 271–292.
<https://doi.org/10.3390/ma9040271>.

Wu, J., & Yan, B. (2008). Photoluminescence intensity of $Y_xGd_{1-x}VO_4:Eu^{3+}$ dependence on hydrothermal synthesis time and variable ratio of Y/Gd. *Journal of Alloys and Compounds*, 455, 485–488.
<https://doi.org/10.1016/j.jallcom.2007.01.162>.

HİDROTERMAL YÖNTEMLE ELDE EDİLEN β -MnO₂ İNCE FİLMLERİN YAPISAL VE OPTİK ÖZELLİKLERİNİN İNCELENMESİ

Aykut ASTAM

Erzincan Binali Yıldırım University, Faculty of Art and Science, Department of Physics
ORCID ID: 0000-0002-4321-3626

ÖZET

Mangan dioksit (MnO₂), farklı kimyasal ve fiziksel özellikleri ile birlikte olağanüstü yapısal esnekliği nedeniyle iyonik ve moleküler elekler, manyetizma, katalizörler, şarj edilebilir piller ve süper kapasitörler gibi birçok farklı uygulamada kullanılan önemli bir malzemedir. Bu çalışmada β -MnO₂ ince filmler, MnSO₄'ün (NH₄)₂S₂O₈ ile oksitlenmesi yoluyla cam altlıklar üzerine kolay bir yöntem olan hidrotermal işleme elde edildi. β -MnO₂ ince filmlerinin yapısal, morfolojik ve optik özellikleri, X-ışını kırınımı (XRD), taramalı elektron mikroskobu (SEM), enerji dağılımlı X-ışını analizi (EDAX) ve optik soğurma ölçümlerine kullanılarak incelendi. XRD deseni, filmin polikristal yapıya sahip olduğunu ve tüm kırınım tepe noktalarının, β -MnO₂'nin tetragonal fazının standart modeliyle eşleştiğini gösterdi. SEM görüntüleri, filmlerin rastgele yönelimli nanoçubuklardan oluştuğunu ve bunların çap ve uzunluklarının sırasıyla yaklaşık 50–500 nm ve 1–3 μ m olduğunu ortaya çıkardı. EDAX spektrumu, Mn ve O elementlerinin 1:1.46 oranında varlığını ve MnO₂ stokiyometrisi ile karşılaştırıldığında O-eksik bir bileşimin mevcut olduğunu gösterdi. Oda sıcaklığında yapılan optik soğurma ölçümü yardımıyla β -MnO₂ ince filminin direkt yasak enerji aralığı 2,6 eV olarak bulundu.

Anahtar Kelimeler: MnO₂, İnce Film, Hidrotermal, Yapısal Özellikler, Optik Özellikler

INVESTIGATION OF STRUCTURAL AND OPTICAL PROPERTIES OF β -MnO₂ THIN FILMS OBTAINED BY HYDROTHERMAL METHOD

ABSTRACT

Due to its outstanding structural flexibility combined with novel chemical and physical properties, manganese dioxide (MnO₂) is an important material in several different applications, such as ionic and molecular sieves, magnetism, catalysts, rechargeable batteries, and supercapacitors. In the present study, β -MnO₂ thin films were synthesized by a facile hydrothermal process on glass substrates through oxidizing MnSO₄ with (NH₄)₂S₂O₈. The structural, morphological, and optical properties of the β -MnO₂ thin films were discussed based on X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDAX), and optical absorption measurements. The XRD pattern indicated that the film has polycrystalline nature, and all the diffraction peaks match with the standard pattern of the tetragonal phase of β -MnO₂. SEM images revealed that the films consist of randomly oriented nanorods and their diameter and length are about 50–500 nm and 1–3 μ m respectively. The EDAX spectrum shows the existence of Mn and O elements in a 1:1.46 ratio, which is an O-deficient composition when compared to MnO₂ stoichiometry. With the help of room temperature optical absorption measurement, the direct forbidden band gap of the β -MnO₂ thin film was found to be 2.6 eV.

Keywords: MnO₂, Thin Films, Hydrothermal, Structural Properties, Optical Properties

THE MERSENNE-PADOVAN SEQUENCE AND ITS BINET FORMULAS**Özgür ERDAĞ**Kafkas University, Faculty of Science and Letters, Department of Mathematics, Kars, Turkey
ORCID ID: 0000-0001-8071-6794**ABSTRACT**

The study of linear and recurrence sequences has been known for a long time and miscellaneous properties of these sequences have been studied by some authors. It defined some linear recurrence sequences and gave their various properties by matrix methods in many works. There are many studies in the literature about the Narayana sequence and the Jacobsthal sequence used in this work and it is well known that the Narayana sequence and the Jacobsthal sequence appear in modern research in many fields from mathematics, physics, computer science, architecture to nature and art. Again, in these researches, Binet formulas have been found along with many properties of these sequences. In this study, we define a new sequence called the Mersenne-Padovan sequence by using the characteristic polynomials of the Mersenne sequence and the Padovan sequence. Also, we give the generating matrix of the Mersenne-Padovan sequence and then we derive relations between the elements of the Mersenne-Padovan sequence and this generating matrix by the aid of the n th power of the generating matrix of the Mersenne-Padovan sequence. Finally, we produce the Binet formulas for the Mersenne-Padovan sequence.

Keywords: Mersenne sequence, Padovan sequence, matrix, Binet formula**1. INTRODUCTION**

A Mersenne number, by M_n , is a number of the form $M_n = 2^n - 1$. The Mersenne sequence $\{M_n\}_{n \geq 0}$ can also be defined recursively by

$$M_{n+2} = 3M_{n+1} - 2M_n$$

with initial values $M_0 = 0$ and $M_1 = 1$. It is worth noting that Mersenne numbers belong to the same family as Fermat numbers, and thus, they share the same properties. (Catarino, Campos, & Vasco, 2016)

The Padovan sequence is the sequence of the integer $\{P(n)\}$ defined by the following recurrence relation:

$$P(n) = P(n-2) + P(n-3)$$

for $n \geq 3$ and with initial values $P(0) = P(1) = P(2) = 1$.

It is easy to see that the characteristic polynomials of the Mersenne sequence and Padovan sequence are $k_1(x) = x^2 - 3x + 2$ and $k_2(x) = x^3 - x - 1$, respectively.

Let the $(n+k)$ th term of a sequence be defined recursively by a linear combination of the preceding k terms:

$$a_{n+k} = c_0 a_n + c_1 a_{n+1} + \dots + c_{k-1} a_{n+k-1}$$

with initial conditions c_0, c_1, \dots, c_{k-1} are real constants. Kalman (Kalman, 1982) derived a number of closed-form formulas for the generalized sequence by the companion matrix method as follows:

Let the matrix A be defined by

$$A_k = \begin{bmatrix} 0 & 1 & 0 & \dots & 0 & 0 \\ 0 & 0 & 1 & \dots & 0 & 0 \\ 0 & 0 & 0 & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 0 & 1 \\ c_0 & c_1 & c_2 & \dots & c_{k-2} & c_{k-1} \end{bmatrix}$$

Also, he showed that

$$A_k^n \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_{k-1} \end{bmatrix} = \begin{bmatrix} a_n \\ a_{n+1} \\ \vdots \\ a_{n+k-1} \end{bmatrix}$$

The study of linear and recurrence sequences has been known for a long time and miscellaneous properties of these sequences have been studied by some authors; see for example, (Bradie, 2010; Gogin & Myllari, 2007; Stakhov & Rozin, 2006; Tuğlu, Koçer, & Stakhov, 2011). It defined some linear recurrence sequences and gave their various properties by matrix methods in many works; see for example, (Deveci & Shannon, 2017; Erdağ & Deveci, 2020; Erdağ & Deveci, 2022; Kılıç, 2008; Kılıç & Taşçı, 2006). In this study, we define a new sequence called the Mersenne-Padovan sequence by using the characteristic polynomials of the Mersenne sequence and the Padovan sequence. In addition, we obtain the generating matrix of the Mersenne-Padovan sequence and then we derive the relationships between the generating matrices and the elements of the Mersenne-Padovan sequence. Finally, we obtain the Binet formulas for the Mersenne-Padovan sequence.

2. MAIN RESULTS

Now we define the Mersenne-Padovan sequence $\{M_n^{Pa}\}$ by the following homogeneous linear recurrence relation:

$$M_{n+5}^{Pa} = 3M_{n+4}^{Pa} - M_{n+3}^{Pa} - 2M_{n+2}^{Pa} - M_{n+1}^{Pa} + 2M_n^{Pa} \tag{2.1}$$

for $n \geq 0$ and with initial conditions $M_0^{Pa} = \dots = M_3^{Pa} = 0$ and $M_4^{Pa} = 1$.

By the recurrence relation (2.1), we have

$$\begin{bmatrix} M_{n+5}^{Pa} \\ M_{n+4}^{Pa} \\ M_{n+3}^{Pa} \\ M_{n+2}^{Pa} \\ M_{n+1}^{Pa} \end{bmatrix} = \begin{bmatrix} 3 & -1 & -2 & -1 & 2 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} M_{n+4}^{Pa} \\ M_{n+3}^{Pa} \\ M_{n+2}^{Pa} \\ M_{n+1}^{Pa} \\ M_n^{Pa} \end{bmatrix}$$

for the Mersenne-Padovan sequence $\{M_n^{Pa}\}$. Letting

$$E_{Pa}^M = \begin{bmatrix} 3 & -1 & -2 & -1 & 2 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

The companion matrix $E_{Pa}^M = [e_{ij}]_{4 \times 4}$ is called to be the Mersenne-Padovan matrix. For more detailed information about the companion matrices, see for example: (Lancaster & Tismenetsky, 1985; Lidl & Niederreiter, 1986). It can be readily established by mathematical induction that for $n \geq 4$

$$(E_{Pa}^M)^n = \begin{bmatrix} M_{n+4}^{Pa} & -M_{n+4}^{Pa} + P(n+4) - 1 & -M_{n+4}^{Pa} + P(n) & -P(n+2) + 1 & 2M_{n+3}^{Pa} \\ M_{n+3}^{Pa} & -M_{n+3}^{Pa} + P(n+3) - 1 & -M_{n+3}^{Pa} + P(n-1) & -P(n+1) + 1 & 2M_{n+2}^{Pa} \\ M_{n+2}^{Pa} & -M_{n+2}^{Pa} + P(n+2) - 1 & -M_{n+2}^{Pa} + P(n-2) & -P(n) + 1 & 2M_{n+1}^{Pa} \\ M_{n+1}^{Pa} & -M_{n+1}^{Pa} + P(n+1) - 1 & -M_{n+1}^{Pa} + P(n-3) & -P(n-1) + 1 & 2M_n^{Pa} \\ M_n^{Pa} & -M_n^{Pa} + P(n) - 1 & -M_n^{Pa} + P(n-4) & -P(n-2) + 1 & 2M_{n-1}^{Pa} \end{bmatrix}$$

We easily derive that $\det(E_{Pa}^M)^n = 2^n$.

Now we concentrate on finding the Binet formulas for the Mersenne-Padovan numbers. It is clear that each of the eigenvalues of the matrix E_{Pa}^M is distinct. Let $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5$ be the sets of the eigenvalues of the matrix E_{Pa}^M and let V_{Pa}^M be a 5×5 Vandermonde matrix as follows:

$$V_{Pa}^M = \begin{bmatrix} (\lambda_1)^4 & (\lambda_2)^4 & (\lambda_3)^4 & (\lambda_4)^4 & (\lambda_5)^4 \\ (\lambda_1)^3 & (\lambda_2)^3 & (\lambda_3)^3 & (\lambda_4)^3 & (\lambda_5)^3 \\ (\lambda_1)^2 & (\lambda_2)^2 & (\lambda_3)^2 & (\lambda_4)^2 & (\lambda_5)^2 \\ \lambda_1 & \lambda_2 & \lambda_3 & \lambda_4 & \lambda_5 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Assume that $V_{Pa}^M(i, j)$ is a 5×5 matrix derived from the Vandermonde matrix V_{Pa}^M by replacing the j th column of V_{Pa}^M by $W_{Pa}^M(i)$, where, $W_{Pa}^M(i)$ is a 5×1 matrix as follows:

$$W_{Pa}^M(i) = \begin{bmatrix} (\lambda_1)^{n+5-i} \\ (\lambda_2)^{n+5-i} \\ (\lambda_3)^{n+5-i} \\ (\lambda_4)^{n+5-i} \\ (\lambda_5)^{n+5-i} \end{bmatrix}$$

Theorem 2.1. Let $(E_{Pa}^M)^n = e_{ij}^n$, then

$$e_{ij}^n = \frac{\det V_{Pa}^M(i, j)}{\det V_{Pa}^M}$$

for $n \geq 4$.

Proof. Let us consider the matrix E_{Pa}^M . Since the eigenvalues of the matrix E_{Pa}^M is distinct, it is clear that E_{Pa}^M is diagonalizable. Let $D = \text{diag}(\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$, then it is readily seen that $E_{Pa}^M V_{Pa}^M = V_{Pa}^M D$. Since the matrix E_{Pa}^M is invertible, we obtain the equation $(V_{Pa}^M)^{-1} E_{Pa}^M V_{Pa}^M = D$.

Therefore, E_{Pa}^M is similar to D ; hence, $(E_{Pa}^M)^n V_{Pa}^M = V_{Pa}^M (D)^n$ for $n \geq 4$. So we have the following linear system of equations:

$$\begin{cases} e_{i1}^n (\lambda_1)^4 + e_{i2}^n (\lambda_1)^3 + e_{i3}^n (\lambda_1)^2 + e_{i4}^n \lambda_1 = (\lambda_1)^{n+5-i} \\ e_{i1}^n (\lambda_2)^4 + e_{i2}^n (\lambda_2)^3 + e_{i3}^n (\lambda_2)^2 + e_{i4}^n \lambda_2 = (\lambda_2)^{n+5-i} \\ e_{i1}^n (\lambda_3)^4 + e_{i2}^n (\lambda_3)^3 + e_{i3}^n (\lambda_3)^2 + e_{i4}^n \lambda_3 = (\lambda_3)^{n+5-i} \\ e_{i1}^n (\lambda_4)^4 + e_{i2}^n (\lambda_4)^3 + e_{i3}^n (\lambda_4)^2 + e_{i4}^n \lambda_4 = (\lambda_4)^{n+5-i} \\ e_{i1}^n (\lambda_5)^4 + e_{i2}^n (\lambda_5)^3 + e_{i3}^n (\lambda_5)^2 + e_{i4}^n \lambda_5 = (\lambda_5)^{n+5-i} \end{cases}$$

Then we conclude that

$$e_{ij}^n = \frac{\det V_{Pa}^M(i, j)}{\det V_{Pa}^M}$$

for each $n \geq 4$. □

Thus by Theorem 2.1. and the matrix E_{Pa}^M , we have the following useful result for the Mersenne-Padovan numbers.

Corollary 2.1. Let M_n^{Pa} be the n th element of the Mersenne-Padovan sequence, then

$$M_n^{Pa} = \frac{\det V_{Pa}^M(5, 1)}{\det V_{Pa}^M} = \frac{\det V_{Pa}^M(4, 5)}{2 \cdot \det V_{Pa}^M}.$$

3. CONCLUSION

In this study, we defined a new sequence called the Mersenne-Padovan sequence by using the characteristic polynomials of the Mersenne and Padovan sequence. Furthermore, using the generating matrix of the Mersenne-Padovan sequence, we derived the relationships between the generating matrices and the elements of the Mersenne-Padovan sequence. Finally, we obtained the Binet formulas for the Mersenne-Padovan sequence.

REFERENCES

- Bradie, B. (2010). Extension and Refinements of Some Properties of Sums Involving Pell Number. *The Missouri Journal of Mathematical Sciences*, 22(1), 37-43.
- Catarino, P., Campos, H., & Vasco, P. (2016). On the Mersenne sequence. *Annales Mathematicae et Informaticae*, 46, 37-53.
- Deveci, Ö., & Shannon, A. (2017). Pell–Padovan-circulant sequences and their applications. *Notes on Number Theory and Discrete Mathematics*, 23(3), 100-114.
- Erdağ, Ö., & Deveci, Ö. (2022). On the connections between Padovan numbers and Fibonacci p -numbers. *Jordan Journal of Mathematics and Statistics*, 15(3), 507-521.
- Erdağ, Ö., & Deveci, Ö. (tarih yok). On The Connections Between Padovan Numbers and Padovan p -Numbers. *International Journal of Open Problems in Computer Science and Mathematic*, 13(4), 33-47.
- Gogin, N., & Myllari, A. (2007). The Fibonacci-Padovan sequence and MacWilliams transform matrices. *Programming and Computer Software*, 33(2), 74-79.
- Kalman, D. (1982). Generalized Fibonacci numbers by matrix methods. *The Fibonacci Quarterly*, 20(1), 73-76.
- Kılıç, E. (2008). The Binet formula, sums and representations of generalized Fibonacci p -numbers. *European Journal of combinatorics*, 29(3), 701-711.
- Kılıç, E., & Taşçı, D. (2006). The Generalized Binet Formula, Representation and Sums of the Generalized order- k Pell Numbers. *The Taiwanese Journal of Mathematics*, 10(6), 1661-1670.

- Lancaster, P., & Tismenetsky, M. (1985). *The theory of matrices: with applications*. Elsevier.
- Lidl, R., & Niederreiter, H. (1986). *Introduction to finite fields and their applications*. Cambridge UP.
- Stakhov, A., & Rozin, B. (2006). Theory of Binet formulas for Fibonacci and Lucas p -numbers. *Chaos, Solitons & Fractals*, 27(5), 1162-1177.
- Tuğlu, N., Koçer, E., & Stakhov, A. (2011). Bivariate Fibonacci like p -polynomials. *Applied Mathematics and Computation*, 217(24), 10239-10246.

THE MERSENNE-PADOVAN SEQUENCE MODULO m

Özgür ERDAĞ

Kafkas University, Faculty of Science and Letters, Department of Mathematics, Kars, Turkey

ORCID ID: 0000-0001-8071-6794

ABSTRACT

Many authors have studied some special linear recurrence sequences in algebraic structures. Some of these proved that the lengths of the periods of the recurring sequences obtained by the reducing sequences by a modulo m are equal to the lengths of the ordinary recurrences in cyclic groups. Again in this sense, many studies in the literature obtained the rules for the orders of the cyclic groups generated by reducing the generating matrix of the sequence modulo m . In this study, we consider the Mersenne-Padovan sequence. In this sense, we investigate the Mersenne-Padovan sequence according to modulo m and the Mersenne-Padovan matrix, which is the generating matrix of this sequence. Furthermore, we obtain semigroups which are generated by the multiplicative orders of the Mersenne-Padovan matrix when read modulo m . Finally, we derive the relationship between the order of the cyclic groups obtained and the periods of the Mersenne-Padovan sequence when read modulo m .

Keywords: The Mersenne-Padovan sequence, modulo, group

1. INTRODUCTION

Erdağ (Erdağ, is submitted) defined the Mersenne-Padovan sequence $\{M_n^{Pa}\}$ by the following homogeneous linear recurrence relation:

$$M_{n+5}^{Pa} = 3M_{n+4}^{Pa} - M_{n+3}^{Pa} - 2M_{n+2}^{Pa} - M_{n+1}^{Pa} + 2M_n^{Pa} \tag{1.1}$$

for $n \geq 0$ and with initial conditions $M_0^{Pa} = \dots = M_3^{Pa} = 0$ and $M_4^{Pa} = 1$.

Also in (Erdağ, is submitted), they gave the generating matrix of the Mersenne-Padovan sequence $\{M_n^{Pa}\}$ as follows:

$$E_{Pa}^M = \begin{bmatrix} 3 & -1 & -2 & -1 & 2 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

The matrix $E_{Pa}^M = [e_{ij}]_{4 \times 4}$ is called as a Mersenne-Padovan matrix. By an inductive argument, we obtain that

$$(E_{Pa}^M)^n = \begin{bmatrix} M_{n+4}^{Pa} & -M_{n+4}^{Pa} + P(n+4) - 1 & -M_{n+4}^{Pa} + P(n) & -P(n+2) + 1 & 2M_{n+3}^{Pa} \\ M_{n+3}^{Pa} & -M_{n+3}^{Pa} + P(n+3) - 1 & -M_{n+3}^{Pa} + P(n-1) & -P(n+1) + 1 & 2M_{n+2}^{Pa} \\ M_{n+2}^{Pa} & -M_{n+2}^{Pa} + P(n+2) - 1 & -M_{n+2}^{Pa} + P(n-2) & -P(n) + 1 & 2M_{n+1}^{Pa} \\ M_{n+1}^{Pa} & -M_{n+1}^{Pa} + P(n+1) - 1 & -M_{n+1}^{Pa} + P(n-3) & -P(n-1) + 1 & 2M_n^{Pa} \\ M_n^{Pa} & -M_n^{Pa} + P(n) - 1 & -M_n^{Pa} + P(n-4) & -P(n-2) + 1 & 2M_{n-1}^{Pa} \end{bmatrix} \quad (1.2)$$

for $n \geq 4$. Also, It is easy to see that $\det(E_{Pa}^M)^n = 2^n$.

Many authors have studied some special linear recurrence sequences in algebraic structures. Some of these proved that the lengths of the periods of the recurring sequences obtained by the reducing sequences by a modulo m are equal to the lengths of the ordinary recurrences in cyclic groups; see for example, (Aydin & Dikici, 1998; Campbell, Doostie, & Robertson, 1990; Deveci, 2015; Deveci, Akuzum, & Karaduman, 2015; Doostie & Campbell, 2006; Karaduman & Aydin, 2003; Knox, 1992; Wilcox, 1986). Wall (Wall, 1960) proved that the lengths of the periods of the recurring sequences obtained by reducing Fibonacci sequences by a modulo m are equal to the lengths of the ordinary 2-step Fibonacci recurrences in cyclic groups. Lü and Wang (Lü & Wang, 2007) obtained the rules for the orders of the cyclic groups generated by reducing the k -generalized Fibonacci matrix modulo m . In this study, we examine the Mersenne-Padovan sequence modulo m . Then, we consider the Mersenne-Padovan matrix. Also, we obtain the semigroups which are generated by the multiplicative orders of the Mersenne-Padovan matrix when read modulo m . Furthermore, we discuss the connections between the order of the semigroups obtained and the periods of the Mersenne-Padovan sequence modulo m .

2. MAIN RESULTS

Reducing the Mersenne-Padovan sequence $\{M_n^{Pa}\}$ by a modulus m , then we obtain the repeating sequence, denoted by

$$\{M_n^{Pa}(m)\} = \{M_0^{Pa}(m), M_1^{Pa}(m), \dots, M_i^{Pa}(m), \dots\}$$

where $M_i^{Pa}(m) \equiv M_i^{Pa} \pmod{m}$. It has the same recurrence relation as in (1.1).

A sequence is periodic if, after a certain point, it consists only of repetitions of a fixed subsequence. The number of elements in the shortest repeating subsequence is called the period of the sequence. For example, the sequence $a, b, c, d, b, c, d, b, c, d, \dots$ is periodic after the initial

element a and has period 3. A sequence is simply periodic with period k if the first k elements in the sequence form a repeating subsequence. For example, the sequence $a, b, c, d, a, b, c, d, a, b, c, d, \dots$ is simply periodic with period 4.

Theorem 2.1. The sequence $\{M_n^{Pa}(m)\}$ is periodic for every positive integer m .

Proof. Let

$$S^P = \{(s_0, s_1, s_2, s_3, s_4) \mid s_i \text{'s are integers such that } 0 \leq s_i \leq m-1\}.$$

Then, we have $|S| = m^5$. Since there are m^5 distinct 5-tuples of elements of Z_m , at least one of the 5-tuples appears twice in the sequence $\{M_n^{Pa}(m)\}$. So, the subsequence following this 5-tuple repeats; therefore, it is obvious that the sequence $\{M_n^{Pa}(m)\}$ is periodic. \square

We denote the period of the sequence $\{M_n^{Pa}(m)\}$ by $h^{M_n^{Pa}(m)}$.

Given an integer matrix $H = [h_{ij}]$, $H \pmod{m}$ means that all entries of H are modulo m , that is $H \pmod{m} = (h_{ij} \pmod{m})$. Let us consider the set $\langle H \rangle_m = \{H^i \pmod{m} \mid i \geq 0\}$. If $\gcd(m, \det H) = 1$, then the set $\langle H \rangle_m$ is a cyclic group; if $\gcd(m, \det H) \neq 1$, then the set $\langle H \rangle_m$ is a semigroup. Let the notation $|\langle H \rangle_m|$ denote the order of the set $\langle H \rangle_m$.

Since $\det(E_{Pa}^M)^n = 2^n$, it is clear that the set $\langle E_{Pa}^M \rangle_m$ is a cyclic group if $\gcd(m, \det E_{Pa}^M) = 1$ and $\langle E_{Pa}^M \rangle_m$ is a semigroup if $\gcd(m, \det E_{Pa}^M) \neq 1$.

By (1.2), it is readily seen that $h^{M_n^{Pa}(m)} = |\langle E_{Pa}^M \rangle_m|$ when $\gcd(m, \det E_{Pa}^M) = 1$.

Theorem 2.2. Let r be a prime and let u is the largest positive integer such that $|\langle E_{Pa}^M \rangle_r| = |\langle E_{Pa}^M \rangle_{r^u}|$. Then $|\langle E_{Pa}^M \rangle_{r^v}| = r^{v-u} \cdot |\langle E_{Pa}^M \rangle_r|$ for every $v \geq u$.

Proof. Let z be a positive integer. Since $(E_{Pa}^M)^{h^{M_n^{Pa}(r^{z+1})}} \equiv I \pmod{r^{z+1}}$, we can write

$$(E_{Pa}^M)^{h^{M_n^{Pa}(r^{z+1})}} \equiv I \pmod{r^z} \text{ where } I \text{ is a } 5 \times 5 \text{ identity matrix. Then we show that } h^{M_n^{Pa}(r^{z+1})} \text{ is}$$

divisible by $h^{M_n^{Pa}(r^z)}$. Moreover, we may write $(E_{Pa}^M)^{h^{M_n^{Pa}(r^z)}} \equiv I + (e_{ij}^{(z)} \cdot r^z)$, then by the binomial expansion, we may write

$$(E_{Pa}^M)^{h^{M_n^{Pa}(r^z)}} = \left(I + (e_{ij}^{(z)} \cdot r^z) \right)^r = \sum_{i=0}^r \binom{r}{i} (e_{ij}^{(z)} \cdot r^z)^i \equiv I \pmod{r^{z+1}}.$$

This yields that $h^{M_n^{Pa}(r^{z+1})}$ divides $h^{M_n^{Pa}(r^z) \cdot r}$. Thus, $h^{M_n^{Pa}(r^{z+1})} = h^{M_n^{Pa}(r^z)}$ or $h^{M_n^{Pa}(r^{z+1})} = h^{M_n^{Pa}(r^z) \cdot r}$, and the latter holds if and only if there exists an $e_{ij}^{(z)}$ integer which is not divisible by r . Since u is the smallest positive integer such that $h^{M_n^{Pa}(r)} = h^{M_n^{Pa}(r^u)}$, we have $h^{M_n^{Pa}(r)} \neq h^{M_n^{Pa}(r^u)}$. Then there is an $e_{ij}^{(u+1)}$ which is not divisible by r . So we obtain that $h^{M_n^{Pa}(r^{u+1})} \neq h^{M_n^{Pa}(r^{u+2})}$. To complete the proof we may use an inductive method on u . □

Theorem 2.3. If $m = \prod_{i=1}^{\lambda} (r_i)^i$, ($\lambda \geq 1$) where r_i 's are distinct primes. Then

$$h^{M_n^{Pa}(m)} = lcm \left[h^{M_n^{Pa}((r_1)^1)}, h^{M_n^{Pa}((r_2)^2)}, \dots, h^{M_n^{Pa}((r_\lambda)^{\lambda})} \right].$$

Proof. Since $h^{M_n^{Pa}((r_i)^i)}$ is the length of the period of the sequence $\{M_n^{Pa}((r_i)^i)\}$, the sequence repeats only after blocks of length $\alpha \cdot h^{M_n^{Pa}((r_i)^i)}$, ($\alpha \in \mathbb{N}$). In addition $h^{M_n^{Pa}(m)}$ is the length of the period $\{M_n^{Pa}(m)\}$, which implies that $\{M_n^{Pa}((r_i)^i)\}$ repeats after $h^{M_n^{Pa}(m)}$ terms for all values i . Thus, $h^{M_n^{Pa}(m)}$ is of the form $\alpha \cdot h^{M_n^{Pa}((r_i)^i)}$ for all values of i , and since any such number gives a period of $h^{M_n^{Pa}(m)}$, we easily obtain that

$$h^{M_n^{Pa}(m)} = lcm \left[h^{M_n^{Pa}((r_1)^1)}, h^{M_n^{Pa}((r_2)^2)}, \dots, h^{M_n^{Pa}((r_\lambda)^{\lambda})} \right]. \quad \square$$

3. CONCLUSION

We have studied the Mersenne-Padovan sequence according to modulo m and then, we examined the periods of this sequence. In addition, we have considered the Mersenne-Padovan matrix and we obtained semigroups by taking the multiplicative order of this matrix according to m . Finally, we have reached that the periods of the Mersenne-Padovan sequence according to modulo m is equal to the order the cyclic groups obtained.

REFERENCES

- Aydin, H., & Dikici, R. (1998). General Fibonacci Sequences in Finite Groups. *Fibonacci Quarterly*, 36(3), 216-221.
- Campbell, C., Doostie, H., & Robertson, E. F. (1990). *Campbell Fibonacci Length of Generating Pairs in Groups in Applications of Fibonacci Numbers*. (E. G. al., Dü.) Kluwer Academic Publishers.
- Deveci, O. (2015). The Pell-Padovan Sequences and The Jacobsthal-Padoan Sequences in Finite Groups. *Utilitas Mathematica*, 98, 257-270.
- Deveci, O., Akuzum, Y., & Karaduman, E. (2015). The Pell-Padovan p -sequences and its applications. *Utilitas Mathematica*, 98, 327-347.
- Doostie, H., & Campbell, P. (2006). On the Commutator Lengths of Certain Classes of Finitely Presented Groups. *International journal of mathematics and mathematical sciences*, 1-9.
- Erdağ, Ö. (is submitted). The Mersenne-Padovan Sequence and Binet Formulas.
- Karaduman, E., & Aydin, H. (2003). On Fibonacci Sequences in Nilpotent Groups. *Mathematica Balkanica*, 17, 207-214.
- Knox, S. (1992). Fibonacci Sequences in Finite Groups. *Fibonacci Quarterly*, 30, 116-120.
- Lü, K., & Wang, J. (2007). k -step Fibonacci Sequence Modulo m . *Utilitas Mathematica*, 71, 169-178.
- Wall, D. D. (1960). Fibonacci series modulo m . *The American Mathematical Monthly*, 67, 525-532.
- Wilcox, H. J. (1986). Fibonacci Sequences of Period in Groups. *Fibonacci Quarterly*, 24(4), 356-361.

THE MERSENNE-JACOBSTHAL SEQUENCE MODULO m

Yeşim AKÜZÜM

Kafkas University, Faculty of Science and Letters, Department of Mathematics, Kars, Turkey

ORCID ID: 0000-0001-7168-8429

Ömür DEVECİ

Kafkas University, Faculty of Science and Letters, Department of Mathematics, Kars, Turkey

ORCID ID: 0000-0001-5870-5298

ABSTRACT

In this study, we consider the multiplicative orders of the generating matrix of the Mersenne-Jacobsthal sequences working m and we obtain the cyclic group and semigroup. Then, we study the Mersenne-Jacobsthal sequence modulo m . Finally, we discuss the connections between the order the cyclic groups obtained and the periods of the Mersenne-Jacobsthal sequence according to modulo m .

Keywords: Mersenne-Jacobsthal Sequence, Modulo, Group.

1. INTRODUCTION

Akuzum and Deveci (Akuzum & Deveci, is submitted) defined the Mersenne-Jacobsthal sequence for $n \geq 0$ as shown:

$$M_{n+4}^J = 4M_{n+3}^J - 3M_{n+2}^J - 4M_{n+1}^J + 4M_n^J \tag{1.1}$$

with initial conditions $M_0^J = M_1^J = M_2^J = 0$ and $M_3^J = 1$.

Also, they gave the generating matrix of the Mersenne-Jacobsthal sequences called the Mersenne-Jacobsthal matrix as follows:

$$C_J^M = \begin{bmatrix} 4 & -3 & -4 & 4 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

Then by an inductive argument, they derived that

i. If n is odd

$$(C_J^M)^n = \begin{bmatrix} M_{n+3}^J & -4M_{n+2}^J + 1 & -M_{n+3}^J & 4M_{n+2}^J \\ M_{n+2}^J & -4M_{n+1}^J & -M_{n+2}^J + 1 & 4M_{n+1}^J \\ M_{n+1}^J & -4M_n^J + 1 & -M_{n+1}^J & 4M_n^J \\ M_n^J & -4M_{n-1}^J & -M_n^J + 1 & 4M_{n-1}^J \end{bmatrix}$$

ii. If n is even

$$(C_J^M)^n = \begin{bmatrix} M_{n+3}^J & -4M_{n+2}^J & -M_{n+3}^J + 1 & 4M_{n+2}^J \\ M_{n+2}^J & -4M_{n+1}^J + 1 & -M_{n+2}^J & 4M_{n+1}^J \\ M_{n+1}^J & -4M_n^J & -M_{n+1}^J + 1 & 4M_n^J \\ M_n^J & -4M_{n-1}^J + 1 & -M_n^J & 4M_{n-1}^J \end{bmatrix}$$

It is important to note that $\det C_J^M = -4$.

The linear recurrence sequences appear in modern research in many fields from mathematics, physics, computer, architecture to nature and art; see, for example, (Alexopoulos & Leontsinis, 2014; Bruhn, Gellert, & Günther, 2015; Iwaniec, 1978; Pighizzini & Shallit, 2002). The study of recurrence sequences in groups first began with the earlier work of Wall (Wall, 1960) where the ordinary Fibonacci sequence in cyclic groups was investigated. Then, the concept extended to some special linear recurrence sequences by many studies; see for example, (Aydin & Smith, 1994; Deveci, Akuzum, & Karaduman, 2015; Deveci & Karaduman, 2017; Deveci & Karaduman, 2015; Doostie & Campbell, 2006; Knox, 1992) (Lü & Wang, 2007; Ozkan, Aydin, & Dikici, 2003). In most of these studies, the linear recurrence sequences were examined by modulo m and the cyclic groups via some special matrices were obtained. In this study, we study the Mersenne-Jacobsthal sequence modulo m and then, we consider the Mersenne-Jacobsthal matrix. Furthermore, we obtained the cyclic groups and semigroups which are generated by the multiplicative orders of the Mersenne-Jacobsthal matrix when read modulo m . Also, we derive the relationship between the order of the semigroups obtained and the periods of the Mersenne-Jacobsthal sequence according to modulo m .

2. MAIN RESULTS AND PROOFS

For given a matrix $G = [g_{ij}]$ with g_{ij} 's being integers, $G(\text{mod } m)$ means that each element of G are reduced modulo m , that is, $G(\text{mod } m) = (g_{ij}(\text{mod } m))$. Let us consider the set $\langle G \rangle_m = \{G^i(\text{mod } m) \mid i \geq 0\}$. If $\text{gcd}(m, \det G) = 1$, then the set $\langle G \rangle_m$ is a cyclic group; if

$\gcd(m, \det G) \neq 1$, then the set $\langle G \rangle_m$ is a semigroup. Let the notation $|\langle G \rangle_m|$ denote the order of the set $\langle G \rangle_m$.

Since $\det C_J^M = -4$, it is clear that the set $\langle C_J^M \rangle_m$ is a cyclic group if $\gcd(m, \det C_J^M) = 1$ and $\langle C_J^M \rangle_m$ is a semigroup if $\gcd(m, \det C_J^M) \neq 1$.

Theorem 2.1. Let q be a prime number and v the largest positive integer such that

$|\langle C_J^M \rangle_q| = |\langle C_J^M \rangle_{q^v}|$. Then $|\langle C_J^M \rangle_{q^w}| = q^{w-v} \cdot |\langle C_J^M \rangle_q|$ for every $w \geq v$. In particular, if $|\langle C_J^M \rangle_q| \neq |\langle C_J^M \rangle_{q^2}|$, then $|\langle C_J^M \rangle_{q^w}| = q^{w-1} \cdot |\langle C_J^M \rangle_q|$ for every $w \geq 2$.

Proof. Suppose that y is a positive integer and $|\langle C_J^M \rangle_{q^m}|$ is denoted by $t(q^m)$. Since $C_J^{M^{t(q^{y+1})}} \equiv I \pmod{q^{y+1}}$, we can write $C_J^{M^{t(q^{y+1})}} \equiv I \pmod{q^y}$ where I is the 4×4 identity matrix. Thus we get that $t(q^y)$ divides $t(q^{y+1})$. Also, writing $(C_J^M)^{t(q^y)} = I + (c_{ij}^{(y)} q^y)$, we obtain

$$(C_J^M)^{r(q^y)q} = (I + (c_{ij}^{(y)} q^y))^q = \sum_{i=0}^q \binom{q}{i} (c_{ij}^{(y)} q^y)^i \equiv I \pmod{q^{y+1}}$$

by the binomial expansion. So we get that $t(q^{y+1})$ divides $t(q^y) \cdot q$. Thus, $t(q^{y+1}) = t(q^y)$ or $t(q^{y+1}) = t(q^y) \cdot q$. It is clear that $t(q^{y+1}) = t(q^y) \cdot q$ holds if and only if there exists an $c_{ij}^{(y)}$ integer which is not divisible by q . Since z is the largest positive integer such that $t(q) = t(q^z)$, we have $t(q^z) \neq t(q^{z+1})$. Then there is an $c_{ij}^{(z+1)}$ which is not divisible by q . So we get that $t(q^{z+1}) \neq t(q^{z+2})$. The proof is finished by induction on z .

If we reduce the Mersenne-Jacobsthal sequence $\{M_n^J\}$ modulo m and denote $M_n^J \pmod{m}$ by $M_n^{J,m}$, then we obtain the following repeating sequence:

$$\{M_n^{J,m}\} = \{M_0^{J,m}, M_1^{J,m}, M_2^{J,m}, \mathbf{K}, M_i^{J,m}, \mathbf{K}\}$$

Note that it has the same recurrence relation as in (1.1).

A sequence is periodic if, after a certain point, it consists only of repetitions of a fixed subsequence. The number of elements in the shortest repeating subsequence is called the period of the sequence. For example, the sequence $a, b, c, d, b, c, d, b, c, d, K$ is periodic after the initial element a and has period 3. A sequence is simply periodic with period k if the first k elements in the sequence form a repeating subsequence. For example, the sequence $a, b, c, d, a, b, c, d, a, b, c, d, K$ is simply periodic with period 4.

Theorem 2.2. The sequence $\{M_n^{J,m}\}$ is periodic for every positive integer m .

Proof. Let us consider set $F = \{(f_0, f_1, f_2, f_3) \mid f_i\text{'s are integers such that } 0 \leq f_i \leq m-1\}$. Then, we have $|F| = m^4$. Since there are m^4 distinct 4-tuples of elements of Z_m , at least one of the 4-tuples appears twice in the sequence $\{M_n^{J,m}\}$. So, the subsequence following this 4-tuple repeats; hence, the sequence is periodic.

The period of the sequence $\{M_n^{J,m}\}$ is denoted by $l(m)$.

Theorem 2.3. If $m = \prod_{i=1}^b (q_i)^{s_i}$, ($b \geq 1$) where q_i 's are distinct primes. Then

$$l(m) = lcm \left[l((q_1)^{s_1}), l((q_2)^{s_2}), \dots, l((q_b)^{s_b}) \right].$$

Proof. Since $l((q_i)^{s_i})$ is the length of the period of the sequence $\{M_n^{J,(q_i)^{s_i}}\}$, the sequence repeats only after blocks of length $k.l((q_i)^{s_i})$, ($k \in N$). In addition, $l(m)$ is the length of the period $\{M_n^{J,m}\}$, which implies that $\{M_n^{J,(q_i)^{s_i}}\}$ repeats after $l(m)$ for all values i . Thus $l(m)$ is the form $k.l((q_i)^{s_i})$ for all values of i , and since any such number gives a period of $\{M_n^{J,m}\}$.

We easily obtain that

$$l(m) = lcm \left[l((q_1)^{s_1}), l((q_2)^{s_2}), \dots, l((q_b)^{s_b}) \right].$$

3. CONCLUSION

In this study, we have considered the Mersenne-Jacobsthal sequence and the Mersenne-Jacobsthal matrix. In this sense, we have examined the multiplicative order of this matrix according to m and we have obtained the cyclic groups and the semigroups. Also, we have studied the periods of the Mersenne-Jacobsthal sequence according to modulo m . Then, we

have obtain the relationship between the order of the semigroups obtained and the periods of the Mersenne-Jacobsthal sequence according to modulo m .

REFERENCES

- Akuzum, Y., & Deveci, O. (is submitted). The Mersenne-Jacobsthal Sequence and its Binet Formulas. *6. Uluslararası Marmara Bilimsel Araştırmalar ve İnovasyon Kongresi*.
- Alexopoulos, T., & Leontsinis, S. (2014). Benford's Law in Astronomy. *Journal of Astrophysics and Astronomy*, *35*, 639-648.
- Aydin, H., & Smith, G. (1994). Finite p -Quotients of Some Cyclically Presented Groups. *Journal of the London Mathematical Society*, *49*, 83-92.
- Bruhn, H., Gellert, L., & Günther, J. (2015). Jacobsthal Numbers in Generalised Petersen Graphs. *Electronic Notes in Discrete Mathematics*, *9*, 465-472.
- Deveci, O., & Karaduman, E. (2015). The Pell Sequences in Finite Groups. *Utilitas Mathematica*, *96*, 263-276.
- Deveci, O., & Karaduman, E. (2017). On The Padovan p -Numbers. *Hacettepe Journal of Mathematics and Statistics*, *46*, 579-592.
- Deveci, O., Akuzum, Y., & Karaduman, E. (2015). The Pell-Padovan p -Sequences and Its Applications. *Utilitas Mathematica*, *98*, 327-347.
- Doostie, H., & Campbell, P. (2006). On the Commutator Lengths of Certain Classes of Finitely Presented Groups. *International journal of mathematics and mathematical sciences*, 1-9.
- Iwaniec, H. (1978). On The Problem of Jacobsthal. *Demonstratio Math*, *11*, 225-231.
- Knox, S. (1992). Fibonacci Sequences in Finite Groups. *Fibonacci Quarterly*, *30*, 116-120.
- Lü, K., & Wang, J. (2007). k -step Fibonacci Sequence Modulo m . *Utilitas Mathematica*, *71*, 169-178.
- Ozkan, E., Aydin, H., & Dikici, R. (2003). 3-step Fibonacci series modulo m . *Applied Mathematics and Computation*, *143*, 165-172.
- Pighizzini, G., & Shallit, J. (2002). Unary Language Operations, State Complexity and Jacobsthal's Function. *International Journal of Foundations of Computer Science*, *13*, 145-159.
- Wall, D. D. (1960). Fibonacci series modulo m . *The American Mathematical Monthly*, *67*, 525-532.

THE REPRESENTATIONS AND FINITE SUMS OF THE MERSENNE-JACOBSTHAL SEQUENCE

Yeşim AKÜZÜM

Kafkas University, Faculty of Science and Letters, Department of Mathematics, Kars, Turkey

ORCID ID: 0000-0001-7168-8429

ABSTRACT

In this study, we consider the Mersenne-Jacobsthal matrix, which is the generating matrix of the Mersenne-Jacobsthal numbers. Firstly, we give relationships among the Mersenne-Jacobsthal numbers and the permanents and the determinants of certain matrices which are produced by using the generating matrices of the Mersenne-Jacobsthal sequence. Also, we obtain the generating function of the Mersenne-Jacobsthal numbers. Then, we derive the exponential representation for these numbers using obtained the generating function. Finally, we obtain the finite sums of the Mersenne-Jacobsthal numbers with the aid of the generating matrix of the Mersenne-Jacobsthal sequence.

Keywords: Mersenne-Jacobsthal Sequence, representation, sum.

1. INTRODUCTION

Akuzum and Deveci (Akuzum & Deveci, is submitted) defined the Mersenne-Jacobsthal sequence for $n \geq 0$ as follows:

$$M_{n+4}^J = 4M_{n+3}^J - 3M_{n+2}^J - 4M_{n+1}^J + 4M_n^J$$

with initial constants $M_0^J = M_1^J = M_2^J = 0$ and $M_3^J = 1$.

Also in (Akuzum & Deveci, is submitted), the Mersenne-Jacobsthal matrix was given as:

$$C_J^M = \begin{bmatrix} 4 & -3 & -4 & 4 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

Then the authors in (Akuzum & Deveci, is submitted) obtained that

i. If n is odd

$$(C_J^M)^n = \begin{bmatrix} M_{n+3}^J & -4M_{n+2}^J + 1 & -M_{n+3}^J & 4M_{n+2}^J \\ M_{n+2}^J & -4M_{n+1}^J & -M_{n+2}^J + 1 & 4M_{n+1}^J \\ M_{n+1}^J & -4M_n^J + 1 & -M_{n+1}^J & 4M_n^J \\ M_n^J & -4M_{n-1}^J & -M_n^J + 1 & 4M_{n-1}^J \end{bmatrix}$$

ii. If n is even

$$(C_J^M)^n = \begin{bmatrix} M_{n+3}^J & -4M_{n+2}^J & -M_{n+3}^J + 1 & 4M_{n+2}^J \\ M_{n+2}^J & -4M_{n+1}^J + 1 & -M_{n+2}^J & 4M_{n+1}^J \\ M_{n+1}^J & -4M_n^J & -M_{n+1}^J + 1 & 4M_n^J \\ M_n^J & -4M_{n-1}^J + 1 & -M_n^J & 4M_{n-1}^J \end{bmatrix}$$

Recently, Many authors have studied number theoretic properties such as these obtained from homogeneous linear recurrence relations relevant to this paper (Akuzum, Deveci, & Shannon, 2017; Deveci O. , 2016; Gogin & Myllari, The Fibonacci-Padovan sequence and MacWilliams transform matrices, 2007; Stakhov & Rozin, Theory of Binet formulas for Fibonacci and Lucas p-numbers, 2006; Tasci & Firengiz, 2010). It is defined some linear recurrence sequences and gave their various properties by matrix methods in many works (Deveci, 2016; Frey & Sellers, 2000; Gultekin & Deveci, 2016; Kilic, 2009). In this study, we examine the Mersenne-Jacobsthal number. Furthermore, we give some properties of the Mersenne-Jacobsthal numbers such as the permanental and determinantal representations, the generating function, exponential representation, the sums of these numbers.

2. MAIN RESULTS AND PROOFS

Definition 2.1. A $u \times v$ real matrix $M = [m_{i,j}]$ is called a contractible matrix in the k^{th} column (resp. row) if the k^{th} column (resp. row) contains exactly two non-zero entries.

Suppose that x_1, x_2, \dots, x_u are row vectors of the matrix M . If M is contractible in the k^{th} column such that $m_{i,k} \neq 0, m_{j,k} \neq 0$ and $i \neq j$, then the $(u-1) \times (v-1)$ matrix $M_{ij:k}$ obtained from M by replacing the i^{th} row with $m_{i,k}x_j + m_{j,k}x_i$ and deleting the j^{th} row. The k^{th} column is called the contraction in the k^{th} column relative to the i^{th} row and the j^{th} row.

Brualdi and Gibson (Brualdi & Gibson, 1977) obtained that $per(M) = per(N)$ if M is a real matrix of order $\alpha > 1$ and N is a contraction of M .

Suppose that $F(q) = [f_{i,j}^q]$ is the $q \times q$ super-diagonal matrices, defined by

$$F(q) = \begin{bmatrix} 4 & -3 & -4 & 4 & 0 & \cdots & 0 & 0 & 0 \\ 1 & 4 & -3 & -4 & 4 & 0 & \cdots & 0 & 0 \\ 0 & 1 & 4 & -3 & -4 & 4 & 0 & \cdots & 0 \\ \vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 1 & 4 & -3 & -4 & 4 & 0 \\ 0 & 0 & \cdots & 0 & 1 & 4 & -3 & -4 & 4 \\ 0 & 0 & 0 & \cdots & 0 & 1 & 4 & -3 & -4 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 4 & -3 \\ 0 & 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 4 \end{bmatrix}$$

Now we consider a permanental representation for the Mersenne-Jacobsthal.

Theorem 2.1. For $q \geq 4$,

$$perF(q) = M_{q+3}^J.$$

Proof. We prove this by mathematical induction. Let the equation be hold for $q \geq 4$, then we show that the equation holds for $q + 1$. If we expand the $perF(q)$ by the Laplace expansion of permanent according to the first row, then we obtain

$$perF(q+1) = 4perF(q) - 3perF(q-1) - 4perF(q-2) + 4perF(q-3)$$

Since $perF(q) = M_{q+3}^J$, $perF(q-1) = M_{q+2}^J$, $perF(q-2) = M_{q+1}^J$ and $perF(q) = M_q^J$, we easily reach that $perF(q+1) = M_{q+4}^J$. So the proof is complete.

Let $G(u) = [g_{i,j}^u]$ be the $q \times q$ matrix, as shown:

$$g_{i,j}^q = \begin{cases} 4 & \text{if } i = k \text{ and } j = k \text{ for } 1 \leq k \leq q-2, \\ & \text{and} \\ & i = k \text{ and } j = k+3 \text{ for } 1 \leq k \leq q-3, \\ -3 & \text{if } i = k \text{ and } j = k+1 \text{ for } 1 \leq k \leq q-2, \\ -4 & \text{if } i = k \text{ and } j = k+2 \text{ for } 1 \leq k \leq q-2, \\ & \text{if } i = k \text{ and } j = k-1 \text{ for } 2 \leq k \leq q-2, \\ 1 & i = q-1 \text{ and } j = q-1, \\ & \text{and} \\ & i = q \text{ and } j = q \\ 0 & \text{otherwise.} \end{cases}$$

Suppose that the $q \times q$ matrix $L(q) = [l_{i,j}^q]$ is defined by:

$$L(q) = \begin{matrix} & & & \text{\scriptsize } (q-2) \text{ th} \\ & & & \downarrow \\ \begin{bmatrix} 1 & \cdots & 1 & 0 \\ 1 & & & \\ 0 & & G(q-1) & \\ \vdots & & & \\ 0 & & & \end{bmatrix} & \text{for } q > 4. \end{matrix}$$

Theorem 2.2. (i). For $q \geq 4$,

$$perG(q) = M_{q+1}^J$$

(ii). For $q > 4$,

$$perL(q) = \sum_{i=0}^q M_i^J$$

Proof. (i). Now assume that $perG(q) = M_{q+1}^J$ for $q \geq 4$. We examine the case $q+1$. Then expanding the $perG(q)$ with the Laplace expansion relative to the first row, by the definition of the matrix $G(q)$, gives us

$$\begin{aligned} perG(q+1) &= 4perG(q) - 3perG(q-1) - 4perG(q-2) + 4perG(q-3) \\ &= 4M_{q+1}^J - 3M_q^J - 4M_{q-1}^J + 4M_{q-2}^J. \end{aligned}$$

It is clear that $perG(q+1) = M_{q+2}^J$. So the result holds.

(ii). Since we expand the $perL(q)$ with the Laplace expansion relative to the first row, we reach

$$perL(q) = perL(q-1) + perG(q-1).$$

The inductive argument and by the result of part (i) in Theorem 2.2, the result has been reached.

Let the notation $A \circ K$ denotes the Hadamard product of A and K . A matrix A is called convertible if there is an $m \times m$ $(1, -1)$ -matrix K such that $perA = \det(A \circ K)$.

Let $q > 4$ and let H be the $q \times q$ matrix, defined by

$$H = \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ -1 & 1 & 1 & \cdots & 1 & 1 \\ 1 & -1 & 1 & \cdots & 1 & 1 \\ \vdots & \ddots & \ddots & \ddots & \ddots & \vdots \\ 1 & \cdots & 1 & -1 & 1 & 1 \\ 1 & \cdots & 1 & 1 & -1 & 1 \end{bmatrix}$$

It is easy to see that $perF(q) = \det(F(q) \circ H)$, $perG(q) = \det(G(q) \circ H)$ and $perL(q) = \det(L(q) \circ H)$. Then we have the following useful results.

Corollary 2.1. (i). $\det(F(q) \circ H) = M_{q+3}^J$

(ii). $\det(G(q) \circ H) = M_{q+1}^J$

and

(iii). $\det(L(q) \circ H) = \sum_{i=0}^q M_i^J$.

Now we will be concerned the exponential representation of the Mersenne-Jacobsthal numbers.

Using direct calculation, we obtained the generating function of $\{M_n^J\}$ as shows:

$$g^J(x) = \frac{x^3}{1 - 4x + 3x^2 + 4x^3 - 4x^4}.$$

Theorem 2.4. The Mersenne-Jacobsthal numbers have the following exponential representation:

$$g^J(x) = x^3 \exp\left(\sum_{i=1}^{\infty} \frac{x^i}{i} (4 - 3x - 4x^2 + 4x^3)^i\right).$$

Proof. It is clear that

$$\ln \frac{g^J(x)}{x^3} = \sum_{i=1}^{\infty} \frac{x^i}{i} (4 - 3x - 4x^2 + 4x^3)^i$$

By the function $\ln x$ we obtain the relation

$$-\ln(1 - 4x + 3x^2 + 4x^3 - 4x^4) = -\left[-x(4 - 3x - 4x^2 + 4x^3) - \frac{1}{2}x^2(4 - 3x - 4x^2 + 4x^3)^2 - \dots - \frac{1}{i}x^i(4 - 3x - 4x^2 + 4x^3)^i - \dots \right].$$

A simple calculation shows that

$$\ln \frac{g^J(x)}{x^3} = \sum_{i=1}^{\infty} \frac{x^i}{i} (4 - 3x - 4x^2 + 4x^3)^i$$

Thus we have the conclusion.

Now we consider the sums of the Mersenne-Jacobsthal numbers.

Let

$$T_n = \sum_{i=0}^n M_i^J$$

for $n \geq 0$ and suppose that E^J is the 5×5 matrix such that

$$E^J = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 1 & & & & \\ 0 & C_J^M & & & \\ 0 & & & & \\ 0 & & & & \end{bmatrix}.$$

If we use induction on n then we obtain

$$(E^J)^n = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ T_{n+2} & & & & \\ T_{n+1} & (C_J^M)^n & & & \\ T_n & & & & \\ T_{n-1} & & & & \end{bmatrix}.$$

3. CONCLUSIONS

In this study, we have considered the Mersenne-Jacobsthal numbers. Firstly, we have obtained relationships among the Mersenne-Jacobsthal numbers and the permanents and the determinants of certain matrices which are produced by using the generating matrices of the Mersenne-Jacobsthal numbers. Then, we have given some properties of the Mersenne-Jacobsthal numbers such as the generating function, the exponential representation and the sums of these numbers.

REFERENCES

- Akuzum, Y., & Deveci, O. (is submitted). The Mersenne-Jacobsthal Sequence and its Binet Formulas. *6. Uluslararası Marmara Bilimsel Araştırmalar ve İnovasyon Kongresi*.
- Akuzum, Y., Deveci, O., & Shannon, A. (2017). On The Pell p-Circulant Sequences. *Notes on Number Theory and Discrete Mathematics*, 23(2), 91-103.
- Brualdi, R., & Gibson, P. M. (1977). Convex polyhedra of doubly stochastic matrices I: applications of permanent function. *Journal of Combinatorial Theory*, 2, 194-230.
- Deveci, O. (2016). The Pell-circulant sequences and their applications. *Maejo International Journal of Science and Technology*, 10(03), 284-293.
- Deveci, O. (2016). The Pell-Circulant Sequences and Their Applications. *Maejo International Journal of Science and Technology*, 10, 284-293.
- Frey, D., & Sellers, J. (2000). Jacobsthal numbers and alternating sign matrices. *Journal of Integer Sequences*, 3(2), 1-15.
- Gogin, N., & Myllari, A. (2007). The Fibonacci-Padovan sequence and MacWilliams transform matrices. *Programming and Computer Software*, 33(2), 74-79.
- Gultekin, I., & Deveci, O. (2016). On The Arrowhead-Fibonacci Numbers. *Open Mathematics*, 14(1), 1104-1113.
- Kilic, E. (2009). The generalized Pell (p,i)-numbers and their Binet formulas, combinatorial representations, sums. *Chaos, Solitons & Fractals*, 4, 2047-2063.
- Stakhov, A., & Rozin, B. (2006). Theory of Binet formulas for Fibonacci and Lucas p-numbers. *Chaos, Solitons & Fractals*, 27(5), 1162-1177.
- Tasci, D., & Firengiz, M. (2010). Incomplete Fibonacci and Lucas p-numbers. *Mathematical and Computer Modelling*, 52, 1763-1770.

ON THE STRAIN AND TEMPERATURE DEPENDENCIES OF THE ELECTRIC SUSCEPTIBILITY OF SILICA FIBER CORE

Abdurrahman GÜNDAY

Bursa Uludağ University, Faculty of Engineering, Department of Electrical & Electronics

Engineering, Bursa, Türkiye

ORCID ID: 0000-0002-3262-3494

ABSTRACT

The electrical sensitivity occurs due to the polarization phenomenon that occurs when an electric field is applied to a dielectric material and varies depending on the dielectric coefficient of the fused silica. In other words, electrical susceptibility is a quantitative measure of the extent to which an electric field applied to a dielectric material causes a polarization effect. Numerous publications and experimental investigations on the strain and temperature dependencies of the electric susceptibility of the silica fiber core have been reported in the literature. However, a satisfying theoretical analysis of both strain and temperature dependencies of electric susceptibility of the silica used for producing optical fiber core is still absent. In this study, theoretical analyses regarding the behaviors of electric susceptibility of the silica fiber core under the effects of strain and temperature have been presented and the simulations representing the relationships between electric susceptibility and both strain and temperature have been performed via the Matlab. Using the simulations obtained in this study, the mathematical formulas expressing the numerical relationships between these measurands and the electric susceptibility have been found. In this regard, the strain dependence of electric susceptibility of the silica fiber core has been obtained as $1.075 \times 10^{-6} (\mu\epsilon)^{-1}$ for strain variations in the range of 0 – 1100 $\mu\epsilon$. In this strain range, electric susceptibility has taken the values changing between 1.0788 and 1.0800. Furthermore, the electric susceptibility has changed between 1.0704 and 1.0848 for the temperature variations in the range of 0 °K – 500 °K. Therefore, an increase in temperature of 1 °K causes a linear increase in electric susceptibility of 2.883×10^{-5} . That is, the change of electric susceptibility with temperature has been computed as $2.883 \times 10^{-5} (\text{K}^\circ)^{-1}$. Consequently, this study including the numerical findings and the mathematical equations may be a significant reference for the research of material specifications of the silica core of optical fiber employed in the optical-based sensing systems and communication systems.

Keywords: Electric Susceptibility, Strain Analysis, Temperature Analysis, Silica Fiber Core, Strain and Temperature Dependencies of Fused Silica

SİLİKA FİBER ÇEKİRDEĞİNİN ELEKTRİK DUYARLILIĞININ GERGINLİK VE SICAKLIK BAĞIMLILIKLARI ÜZERİNE

ÖZET

Elektriksel duyarlılık, bir dielektrik malzemeye elektrik alan uygulandığında oluşan ve erimiş silikanın dielektrik katsayısına bağlı olarak değişen polarizasyon olgusu nedeniyle oluşmaktadır. Diğer bir deyişle, elektriksel duyarlılık, bir dielektrik malzemeye uygulanan elektrik alanının polarizasyon etkisine ne ölçüde yol açtığıın niceliksel bir ölçüsüdür. Literatürde, silika fiber çekirdeğinin elektriksel duyarlılığının gerginlik ve sıcaklığa bağımlılığı üzerine çok sayıda yayın ve deneysel araştırma rapor edilmiştir. Bununla birlikte, fiber optik çekirdek üretmek için kullanılan silikanın elektriksel duyarlılığının hem gerginlik hem de sıcaklık bağımlılığının tatmin edici bir teorik analizi hala mevcut değildir. Bu çalışmada, silika fiber çekirdeğinin gerginlik ve sıcaklık etkileri altında elektriksel duyarlılık davranışlarına ilişkin teorik bir analiz sunulmuş ve elektriksel duyarlılık ile hem gerginlik hem de sıcaklık arasındaki ilişkileri gösteren simülasyonlar Matlab üzerinden gerçekleştirilmiştir. Bu çalışmada elde edilen simülasyonlar kullanılarak, bu gerginlik ve sıcaklık ile elektriksel duyarlılık arasındaki sayısal ilişkileri ifade eden matematiksel formüller bulunmuştur. Bu bağlamda, silika fiber çekirdeğinin elektriksel duyarlılığının gerginlik bağımlılığı, 0 – 1100 μe aralığındaki gerginlik değişimleri için $1.075 \times 10^{-6} (\mu\text{e})^{-1}$ olarak elde edilmiştir. Bu gerginlik aralığında elektriksel duyarlılık, 1.0788 ile 1.0800 arasında değişen değerleri almıştır. Ayrıca, 0 °K – 500 °K aralığındaki sıcaklık değişimlerinde elektriksel duyarlılık, 1.0704 ile 1.0848 arasında değişmiştir. Bu nedenle sıcaklıktaki 1 °K'lik artış, elektriksel duyarlılıkta 2.883×10^{-5} değerinde bir artışa neden olmaktadır. Yani, elektriksel duyarlılığın sıcaklıkla değişimi $2.883 \times 10^{-5} (\text{K}^\circ)^{-1}$ olarak hesaplanmıştır. Sonuç olarak, sayısal bulguları ve matematiksel denklemleri içeren bu çalışma, optik tabanlı algılama sistemleri ve haberleşme sistemlerinde kullanılan optik fiberin silika çekirdeğinin malzeme özelliklerinin araştırılması için önemli bir referans olabilir.

Anahtar Kelimeler: Elektriksel Duyarlılık, Gerginlik Analizi, Sıcaklık Analizi, Silika Fiber Çekirdeği, Ergimiş Silikanın Gerginlik ve Sıcaklık Bağımlılıkları

ARDUİNO DESTEKLİ STEM ETKİNLİĞİNİN 6. SINIF FEN BİLİMLERİ DERSİ SOLUNUM SİSTEMİ KONUSUNUN ÖĞRETİMİNDE UYGULANMASI ÜZERİNE BİR ÇALIŞMA

Mustafa YAZICI

Kahramanmaraş Sütçü İmam University, Faculty of Education, Department of Science Education,

Kahramanmaraş

ORCID ID: 0000-0003-1071-0316

Harun AYTAC

Kahramanmaraş Sütçü İmam University, Institute of Science, Department of Science Education,

Kahramanmaraş

ORCID ID: 0000-0002-8400-4417

ÖZET

Son on yılda yaygınlaşan yeni nesil eğitim yaklaşımlarından biri STEM (Science, Technology, Engineering, Math), yaklaşımıdır. Bu eğitim yaklaşımı, Fen(Science), Teknoloji(Technology), Mühendislik(Engineering) ve Matematik(Math) disiplinlerinin entegrasyonu ile gerçek hayat problemlerine çözümler geliştiren etkinlikler içerir. Arduino, açık kaynak kodlu, mikrodenetleyici tabanlı, projeler geliştirmek ve prototipler oluşturmak için kullanılan bir elektronik karttır. Arduino kartı çeşitli sensörlerle bağlanarak ve programlanarak çevreden gelen girdileri işleyerek çıktılar oluşturabilir. Küçük yaş grubundaki çocuklar da mblock programını kullanarak arduinoyu programlayabilirler. Bu çalışmanın amacı 6. Sınıf Fen Bilimleri dersinde Solunum Sistemi konusunun Arduino destekli STEM etkinliğiyle anlatımının öğrencilerin akademik başarı, Fen Bilimlerine karşı tutumlarına ve STEM meslek ilgilerine etkisini araştırmaktır. Araştırmanın çalışma grubunu, bir devlet okulunda eğitim gören 6. sınıfların iki farklı şubesi oluşturmaktadır. Sınıflardan biri deney grubu, diğer sınıf ise kontrol grubu olarak belirlenmiştir. Araştırmada yöntem olarak gömülü deneysel karma araştırma modeli kullanılmıştır. Nicel verilerin toplanmasında “Solunum Sistemi başarı testi”, “STEM meslek ilgileri testi” ve “Fen Bilimlerine karşı tutum ölçeği” kullanılmıştır. Nitel verilerin elde edilmesinde ise öğrenci görüşlerinden yararlanılmıştır. Çalışma öncesinde deney grubundaki öğrencilere STEM eğitim yaklaşımı anlatılarak örnek STEM etkinliği yapılmıştır. Ayrıca Arduino kartı ve sensörler tanıtılmıştır. Bu çalışma için 6. Sınıf Fen Bilimleri dersi sistemler ünitesinde bulunan solunum sisteminin öğretiminde deney grubundaki öğrencilere gerçek hayat problemi verilmiştir. Sınıf içi gruplarda problemin çözümüne yönelik beyin fırtınası yapılarak prototipin yapımında kullanılacak malzemelerini belirlenmesi sağlanmıştır. Prototip oluşturulurken öğrencilerden STEM bileşenlerini, Arduino kartı ve sensörleri de kullanmaları sağlanmıştır. Kontrol grubu olan sınıfta solunum sistemi konusu Milli Eğitim Bakanlığı(MEB) müfredatına göre klasik yöntemle işlenmiştir. Çalışma öncesinde deney grubu

ve kontrol grubuna Solunum sistemi başarı testi, STEM meslek ilgileri testi ve Fen Bilimleri tutum ölçeği ön test olarak uygulanmıştır. Çalışma sonrasında ise her iki gruba aynı test ve ölçekler son test olarak uygulanarak öğrenci görüşleri alınmıştır. Elde edilen veriler analiz edilerek yorumlanmıştır.

Anahtar Kelimeler: STEM, Arduino, Fen Eğitimi, Solunum Sistemi

**A STUDY ON THE APPLICATION OF ARDUINO SUPPORTED STEM ACTIVITY
IN TEACHING THE SUBJECT OF RESPIRATORY SYSTEM IN 6TH GRADE
SCIENCE COURSE**

ABSTRACT

One of the new generation education approaches that has become widespread in the last decade is the STEM (Science, Technology, Engineering, Math) approach. This educational approach includes activities that develop solutions to real-life problems with the integration of Science, Technology, Engineering and Math disciplines. Arduino is an open source, microcontroller-based electronic board used to develop projects and create prototypes. The Arduino board can be connected and programmed with various sensors and generate outputs by processing inputs from the environment. Children in the younger age group can also program Arduino using the mblock program. The aim of this study is to investigate the effect of explaining the Respiratory System topic with an Arduino-supported STEM activity in the 6th Grade Science course on students' academic success, attitudes towards Science and STEM career interests. The study group of the research consists of two different classes of 6th grade students studying in a public school. One of the classes was designated as the experimental group and the other class was designated as the control group. Embedded experimental mixed research model was used as a method in the research. "Respiratory System Achievement Test", "STEM professional interests test" and "Attitude towards Science Scale" were used to collect quantitative data. Student opinions were used to obtain qualitative data. Before the study, the STEM education approach was explained to the students in the experimental group and a sample STEM activity was carried out. Additionally, the Arduino board and sensors were introduced. For this study, a real-life problem was given to the students in the experimental group while teaching the respiratory system in the systems unit of the 6th Grade Science course. Brainstorming was done in classroom groups to solve the problem and the materials to be used in the construction of the prototype were determined. While creating the prototype, students were also allowed to use STEM components, Arduino board and sensors. In the control group classroom, the respiratory system subject was taught using the classical method according to the curriculum of the Ministry of National Education (MEB). Before the study, the Respiratory system achievement

test, STEM career interest test and Science attitude scale were applied to the experimental group and the control group as a pre-test. After the study, the same tests and scales were applied to both groups as a post-test and student opinions were taken. The data obtained was analyzed and interpreted.

Keywords: STEM, Arduino, Science Education, Respiratory System

1. GİRİŞ

İnsanlık tarihi boyunca gelişen bilim ve teknolojiadaki değişimler son yıllarda hız kazanmıştır. Güncel bilimsel bilgi ve teknolojiye sahip olan ülkeler dünyada önemli bir güce sahip olmuşlardır. Geleceğin dünyasında söz sahibi olabilmek ve teknolojiyi elinde tutabilmek isteyen ülkeler fen ve matematik eğitimine önem vermektedirler (Senel ve Gençoğlu 2006). 21. Yüzyıl becerilerini kazandıran, öğrencileri geleceğin mesleklerine yönlendiren eğitim yöntemlerinden birisi de STEM eğitim modelidir (Uz, 2022).

STEM; Fen (Science), Teknoloji (Technology), Mühendislik (Engineering) ve Matematik (Math) disiplinlerinin entegrasyonu ile oluşan ve gerçek hayat problemlerine çözümler geliştiren etkinliklerden oluşur (Altunel, 2018). STEM eğitim modelinde öğrenciler yaparak ve yaşayarak öğrenme ile bilgilerin kalıcılığını sağlayabilirler. Bilimsel süreç becerilerini ve mühendislik tasarım süreçlerini kullanarak 21 yy becerilerini geliştirebilirler (Alıcı, 2018).

Arduino, açık kaynak kodlu, mikrodenetleyici tabanlı, projeler geliştirmek ve prototipler oluşturmak için kullanılan bir elektronik karttır. Arduino kartı çeşitli sensörlerle bağlanarak ve programlanarak çevreden gelen girdileri işleyerek çıktılar oluşturabilir (Banzi ve Shiloh, 2022). Arduino, pek çok sensörden kolayca veri alınabilmesi, maliyetinin düşük olması ve elektronik devrelerde tak çıkar mantığıyla kullanılabilmesi ve programlanmasının basit olmasından dolayı eğitimde kullanılmaktadır (Sinap, 2017).

STEM etkinliklerine Arduino gibi robotik ve kodlama içerikleri dahil edildiğinde öğrencilerin problem çözme becerilerinin geliştiği ve fen okur yazarlığının arttığı ve etkinlikler açısından daha zengin bir ortam oluştuğu görülmüştür (Sullivan ve Heffernan, 2016). Arduino destekli STEM etkinliklerinde öğrenciler hayal güçlerini daha fazla kullanabilmekte ve 21. yy becerilerini geliştirebilmektedir (Meço, 2021).

1.1 AMAÇ

Literatür taramalarından STEM ile ilgili yapılan çalışmaların genelde fizik konularıyla ilgili olduğu, biyoloji alanında yapılan çalışmaların sınırlı kaldığı görülmüştür (Dedetürk, 2020; Buyruk, 2019). Ayrıca Arduino destekli STEM etkinliklerinin fen eğitiminde pek yaygın olmadığı görülmüştür. Yapılan bu çalışma solunum sistemiyle ilgili Arduino destekli bir STEM etkinliğini literatüre kazandıracaktır. Buradan yola çıkarak bu çalışmada 6. Sınıf Fen Bilimleri dersinde Solunum Sistemi konusunun Arduino destekli STEM etkinliğiyle anlatımının öğrencilerin akademik başarı, Fen Bilimlerine karşı tutumlarına ve STEM meslek ilgilerine etkisini araştırmak amaçlanmaktadır.

1.2 PROBLEM CÜMLESİ

‘Arduino Destekli STEM Etkinliğinin 6. Sınıf Fen Bilimleri Dersi Solunum Sistemi Konusunun Öğretiminde Uygulanması’ çalışmamızın problem cümlesini oluşturmaktadır. Problem cümlesi “Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin akademik başarılarına, Fen Bilimleri dersine karşı tutumlarına ve S TEM meslek ilgilerine etkisi var mıdır?” şeklindedir.

1.2.1 Alt problemler:

1.Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin akademik başarılarına etkisi var mıdır?

2. Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin Fen Bilimleri dersine karşı tutumlarına etkisi var mıdır?

3. Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin STEM meslek ilgilerine etkisi var mıdır?

2. YÖNTEM

2.1.Araştırmanın Modeli

Araştırmada yöntem olarak gömülü deneysel karma araştırma modeli kullanılmıştır. Gömülü deneysel karma araştırma modelinde deneysel desen içerisinde nitel veriler gömülü halde bulunur. Elde edilen nitel veriler, nicel verilerin desteklenmesinde kullanılır(Creswell ve Clark, 2002).

2.2.Çalışma Grubu

Araştırmanın çalışma grubunu, bir devlet okulunda eğitim gören 6. sınıfların iki farklı şubesi oluşturmaktadır. Sınıflardan biri deney grubu, diğer sınıf ise kontrol grubu olarak belirlenmiştir. Deney grubu 25 öğrenciden, kontrol grubu da 23 öğrenciden oluşmaktadır.

2.3.Çalışmanın Uygulama Aşamaları

Çalışmanın uygulanması, hazırlık aşamalarıyla beraber toplam 10 ders saati sürmüştür. Uygulama öncesinde öğrencilere STEM eğitim modeli, Arduino kart ve sensörler tanıtılmış ve örnek uygulama yapılmıştır. Çalışma öncesinde deney ve kontrol grubundaki öğrencilere “Solunum Sistemi başarı testi”, “STEM meslek ilgileri testi” ve “Fen Bilimlerine karşı tutum ölçeği” ön test olarak uygulanmıştır. Çalışmanın sonrasında nitel verilerin toplanması için öğrenci görüşleri alınmış ve çalışma öncesi uygulanan testler son test olarak uygulanmıştır. Kontrol grubundaki öğrencilere solunum sistemi konusunun öğretimi Milli Eğitim Bakanlığı(MEB) müfredatına uygun olarak klasik yöntemle yapılırken, deney grubundaki öğrencilere Arduino destekli STEM etkinliğiyle yapılmıştır.

Zaman	Etkinlik
2 ders saati	STEM eğitim modelinin tanıtımı ve örnek etkinlik yapılması
2 ders saati	Arduino'nun tanıtımı ve örnek uygulama yapılması
1 ders saati	Ön testlerin uygulanması
4 ders saati	Uygulamayı gerçekleştirilmesi ve öğrenci görüşlerinin alınması
1 ders saati	Son testlerin uygulanması

Tablo 1: Zaman çizelgesi

Çalışmanın uygulama aşamasında aşağıdaki adımlar izlenmiştir:

- Deney grubundaki öğrencilere solunum sistemini oluşturan yapı ve organların görevleri anlatılarak şema üzerinde gösterilmiştir.
- Deney grubundaki öğrencilere solunum sistemiyle ilgili gerçek hayat problemi verilmiştir.
- Öğrenciler sınıf içi gruplarda problemin çözümü için beyin fırtınası gerçekleştirerek, problemin çözümü için geliştirecekleri prototipi nasıl yapacaklarını tartışmışlardır.
- Her grup yapacakları prototip için gerekli malzeme listesini yapıp ve maliyetini hesaplamışlardır.
- Her grup Öğretmenin sınıfa getirdiği malzemeleri kullanarak prototiplerini oluşturmuşlardır.

- Prototipler yapılırken öğrencilerin STEM bileşenlerini ve Arduinoyu kullanmaları sağlanmıştır.
- Prototiplerin çalışıp çalışmadığı denenmiş, eksik olan prototipler düzeltilmiştir.
- Yapılan prototiplerin avantajları ve dezavantajları sınıfta tartışılmış ve en iyi prototip seçilmiştir.

3.BULGULAR

Arduino destekli STEM etkinliği sonucunda aşağıdaki bulgular tespit edilmiştir:

Araştırmanın ilk alt problemi olan “Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin akademik başarılarına etkisi var mıdır?” sorusuna yönelik deney ve kontrol grubuna uygulanan solunum sistemi başarı testi sonuçları incelendiğinde deney grubunun ve kontrol grubunun akademik başarılarında artış görülmüştür ancak deney grubunun akademik başarısındaki artışın daha fazla olduğu ölçülmüştür.

Araştırmanın ikinci alt problemi olan “Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin Fen Bilimleri dersine karşı tutumlarına etkisi var mıdır?” sorusuna yönelik deney ve kontrol grubuna uygulanan Fen Bilimleri dersine karşı tutum ölçeğine verilen cevaplar değerlendirildiğinde deney grubundaki öğrencilerin Fen Bilimleri dersine karşı tutumlarının kontrol grubuna göre daha fazla arttığı görülmüştür.

Araştırmanın üçüncü alt problemi olan “Solunum sistemi konusunun öğretiminde Arduino destekli STEM etkinliğinin 6. Sınıf öğrencilerinin STEM meslek ilgilerine etkisi var mıdır?” sorusuna yönelik deney ve kontrol grubuna uygulanan STEM meslek ilgileri testine verilen cevaplar incelendiğinde, deney grubundaki öğrencilerin lehine bir artış olduğu görülmüştür.

4.SONUÇ VE ÖNERİLER

Araştırma sonucunda öğrenci görüşleri, uygulanan ön test ve son testler değerlendirildiğinde Arduino destekli STEM etkinliğinin öğrencilerin akademik başarı, fen bilimleri dersine karşı tutumları ve STEM meslek ilgilerine olumlu yönde etki ettiği görülmüştür.

Uygulama sonucunda deney ve kontrol grubundaki öğrencilerin akademik başarılarında anlamlı bir farklılık gözlemlenmiştir. Ancak deney grubu öğrencileri, kontrol grubuna göre akademik başarılarını daha fazla yükseltmişlerdir. Arduino destekli STEM etkinliğinde elde edilen öğrenci görüşlerine göre, öğrencilerin çoğu yapılan etkinliği sevdiklerini, etkinliği eğlenerek yaptıklarını belirtmişlerdir. Bu da öğrencilerin ders motivasyonlarını canlı tutmuştur. Ayrıca yaparak yaşayarak öğrenme, bilginin kalıcılığını sağlayarak akademik başarının artmasına

sebepl olmuř olabılır. Daha önce yapılan alıřmalarda da benzer sonulara ulařılmıřtır (Kurt, 2019; Kurtuluř, 2019).

Öğrencilerin Fen Bilimleri dersine karřı tutumları incelendiğinde; kontrol grubunda anlamlı bir farklılık görölmezken deney grubundaki öğrencilerin Fen bilimleri dersine karřı tutumlarının arttığı görölmüřtür. Yapılan etkinliğin ilgi çekici olması, öğrencilerin etkinlięi keyif alarak yapmaları bu sonucun ortaya ıkmasında etkili olmuřtur. Yamak ve arkadaşları (2014) yaptıkları alıřmada STEM etkinlięinin 5. Sınıf öğrencilerinin Fen Bilimleri dersine karřı tutumlarında artışa sebep olduęu sonucuna ulařmıřtır. Gazibeyoęlu ve Aydın (2020) da benzer sonulara ulařmıřlardır.

Uygulama sonrasında kontrol grubu öğrencilerinin STEM mesleklerine ilgilerinin ok fazla deęiřmedięi, deney grubundaki öğrencilerin ise STEM mesleklerine karřı ilgilerinin arttığı görölmüřtür. Uygulama öncesi öğrencilere gelecekte hangi mesleęi yapmak istedikleri sorulduğunda daha ok polis, öğretmen, uzman avuş cevabı alınırken uygulama sonucu deney grubundaki öğrencilerden mühendis, cerrah, bilim insanı, yazılım mühendisi, doktor gibi cevaplar gelmiřtir. Alıcı (2018)'nın yaptıęı alıřmaya göre STEM etkinlikleri sonucu öğrencilerin mühendislik mesleęine ve tasarım yapmaya ilgilerinin arttığını belirtmiřtir.

Yaptığımız alıřmada ulařılan sonulardan yola ıkılarak ařağıdaki maddeler önerilebilir:

- Arduino destekli STEM etkinlięinin öğrencilerin derse ilgilerini arttırdığı ve daha aktif katılım saęladıkları görölmüřtür. Buradan yola ıkılarak bu uygulamanın dięer fen konularında da kullanılması Fen Eęitiminde başarıyı arttırabilir.
- Öğretmenler, arduino destekli STEM etkinlięi yapabilmeleri için Arduino bileřenleri ve STEM eęitim modeliyle ilgili hizmet ii eęitimler alabilirler.
- Arduino destekli STEM etkinlięinin geleceğin mesleklerine ilgiyi arttırdığı göz önüne alınarak Milli Eęitim Bakanlıęı tarafından okullara Arduino setleri alınabilir, ülke genelinde bu tür uygulamalar yaygınlařtırılabilir.

5.KAYNAKA

Altunel, M. (2018). STEM eęitimi ve Türkiye: fırsatlar ve riskler. *Seta Perspektif*, 207(1), 7.

Alıcı, M. (2018). *Probleme dayalı öğrenme ortamında STEM eęitiminin tutum, kariyer algı ve meslek ilgisine etkisi ve öğrenci görüşleri* (Master's thesis, Kırıkkale Üniversitesi).

Banzi, M., & Shiloh, M. (2022). *Getting started with Arduino*. Maker Media, Inc..

Buyruk, B. (2019). STEM Öğretiminin Öğrenci Başarısına Etkisi ve Bazı Deęiřkenler.

Yayımlanmamıř Yüksek Lisans Tezi, Amasya Üniversitesi, Fen Bilimleri Enstitüsü, Amasya.

Creswell, J. W., & Clark Plano, V. L. (2002). *Designing and Conducting Mixed Methods Research* (second Edit). SAGE Publications.

Dedetürk, A., Saylan-Kırmızıgül A. & Kaya, H. (2020). STEM Aktiviteleri ile "Ses" Öğretiminin Başarıya Etkisi. *Pamukkale Üniversitesi Eęitim Faköltesi Dergisi*, 134-161

- Gazibeyođlu, T., & Aydın, A. (2020). Stem Uygulamalarının 7. Sınıf Öğrencilerinin Fen Bilimleri Dersine Karşı Tutumlarına Etkisinin İncelenmesi. *Eđitim ve Toplum Arařtırmaları Dergisi*, 7(2), 724-752.
- Kurt, M. (2019). STEM uygulamalarının 6. sınıf öğrencilerinin akademik başarılarına, problem çözme becerilerine ve STEM'e karşı tutumlarına etkisi üzerine bir araştırma. *Yayımlanmamış yüksek lisans tezi. Gazi Üniversitesi, Ankara.*
- Kurtuluş, M. A. (2019). *STEM etkinliklerinin öğrencilerin akademik başarılarına, problem çözme becerilerine, bilimsel yaratıcılıklarına, motivasyonlarına ve tutumlarına etkisi* (Master's thesis, Alanya Alaaddin Keykubat Üniversitesi).
- Meço, G. (2021). *Arduino ile desteklenmiş fen, mühendislik, matematik, teknoloji eğitimi: Vücudumuzdaki sistemler* (Doctoral dissertation).
- Sinap, V. (2017). Programlama Eğitiminde Probleme Dayalı Öğrenme İçin Arduino Etkinliklerini Kullanma: Bir Eylem Araştırması (*Yüksek Lisans Tezi*). *Süleyman Demirel Üniversitesi, Eğitim Bilimleri Enstitüsü, Isparta, Türkiye.*
- Sullivan, F. R., & Heffernan, J. (2016). Robotic Construction Kits As Computational Manipulatives For Learning In The STEM Disciplines. *Journal Of Research On Technology In Education*, 48(2), 105-128.
- Şenel, A., & Gençođlu, S. (2003). Küreselleşen dünyada teknoloji eğitimi. *Gazi Üniversitesi Endüstriyel Sanatlar Eğitim Fakültesi Dergisi*, 11(12), 45-65.
- Uz, G. Y. (2022). *Stem Etkinliklerinin Stem Alanlarına Karşı Tutum, Bilgi İşlemsel Düşünme Becerileri, Stem Mesleklerine İlgil ve Farkındalığa Etkisinin İncelenmesi* (Doctoral dissertation, Marmara Üniversitesi (Turkey)).
- Yamak, H., Bulut, N., & Dündar, S. (2014). 5. sınıf öğrencilerinin bilimsel süreç becerileri ile fene karşı tutumlarına FeTeMM etkinliklerinin etkisi. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, 34(2), 249-265.

TÜRKİYE’DE 2020-2023 YILLARI ARASINDA, FEN EĞİTİMİ ALANINDA YAPAY ZEKA TEKNOLOJİSİ KONUSUNDA YAPILAN YÜKSEK LİSANS TEZ ÇALIŞMALARININ BETİMSSEL ANALİZİ

Mustafa YAZICI

Kahramanmaraş Sütçü İmam Üniversitesi, Eğitim Fakültesi, Fen Bilgisi Eğitimi Ana Bilim Dalı,
Kahramanmaraş

ORCID ID: 0000-0003-1071-0316

Tuğçe FISTIK

Kahramanmaraş Sütçü İmam Üniversitesi, Fen Bilimleri Enstitüsü, Fen Bilgisi Eğitimi Ana Bilim
Dalı, Kahramanmaraş

ORCID ID: 0000-0003-1894-4782

ÖZET

Bu çalışmanın amacı, Türkiye’de 2020-2023 yılları arasında fen eğitimi alanında yapay zeka teknolojisini konu alan yüksek lisans tez çalışmalarının analizidir. 21. yüzyılda teknolojinin gelişmesiyle yapay zeka teknolojilerinin kullanımı da artmıştır. Bu nedenle güncel eğilimlerin belirlenmesi için 2020-2023 yılları arası yapılan yüksek lisans tezleri analize dahil edilmiştir. Veri analiz yöntemi olarak betimsel içerik analizi yöntemi kullanılmıştır. Araştırmaya ait veriler Ulusal Tez Merkezinde erişime açık, sadece Türkçe yazılan yüksek lisans tez çalışmalarından elde edilmiştir. Öncelikle tezlere ulaşmak için Ulusal Tez Merkezi veri tabanında "fen bilimleri" anahtar kavramı taratılmıştır. Böylelikle başlangıçta 383 yüksek lisans tezine ulaşılmıştır. Daha sonra bu 383 yüksek lisans tezinden anahtar kavramı “yapay zeka teknolojisi” olan çalışmalar analize dahil edilmiş, 18 yüksek lisans tezine ulaşılmıştır. Literatür tarama sonuçları PRISMA akış diyagramında gösterilmiştir. Veri toplama aracı olarak “Araştırma Sınıflama Formu” kullanılmıştır. Araştırmada kapsamındaki 18 yüksek lisans tezinin; yayın yılı, amacı, araştırma yaklaşım ve yöntemi, örneklem sayısı, örneklem büyüklüğü, sınıf düzeyi, veri toplama araçları ve veri analiz teknikleri incelenmiştir. Analizi yapılan tezlerden elde edilen bulgulara göre yapılan çalışmalarında yapay zeka teknolojilerinin genel olarak akademik başarıya etkilerinin incelendiği görülmektedir. Yine araştırmacıların ağırlıklı olarak nitel araştırma yöntemini tercih ettikleri, çalışmaların en fazla 2022 yılı içerisinde yapıldığı sonuçlarına ulaşılmıştır. İncelenen çalışmaların çoğunda örneklem olarak öğretmenlerin tercih edildiği, örneklem büyüklüğünde ise dağılımın en fazla 0-50 aralığında olduğu bulgusuna ulaşılmıştır. Çalışmada yapay zeka teknolojisinin kullanılmasının sağlayacağı avantajlara ve diğer derslere entegre edilmesine ilişkin öneriler sunulmuştur.

Anahtar Kelimeler: Yapay zeka teknolojisi, içerik analizi, fen eğitimi

DESCRIPTIVE ANALYSIS OF MASTER THESIS STUDIES ON ARTIFICIAL INTELLIGENCE TECHNOLOGY IN SCIENCE EDUCATION IN TURKEY BETWEEN 2020-2023

ABSTRACT

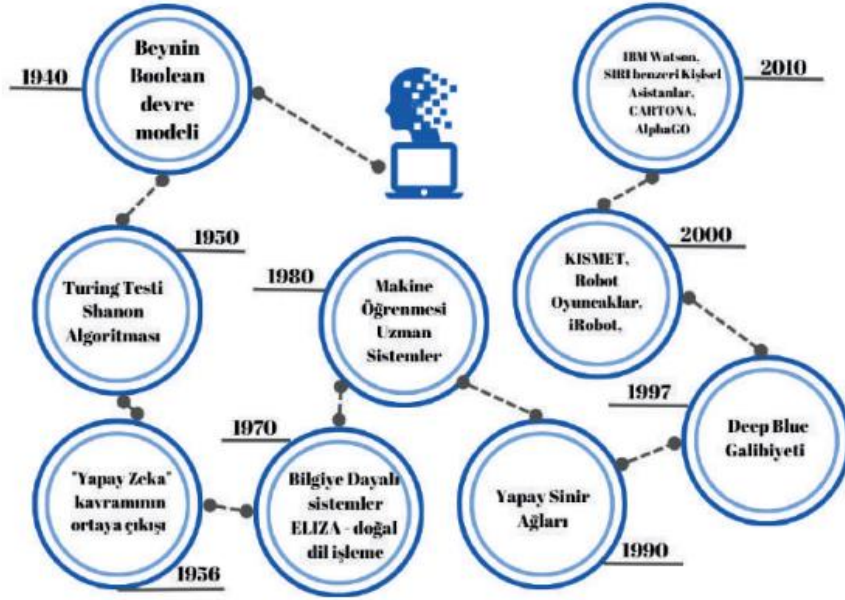
The purpose of this study is to analyse master's thesis studies on artificial intelligence technology in the field of science education in Turkey between 2020-2023. With the development of technology in the 21st century, the use of artificial intelligence technologies has also increased. For this reason, master's theses written between 2020 and 2023 were included in the analysis to determine current trends. Descriptive content analysis method was used as the data analysis method. The data for the research were obtained from master's thesis studies written only in Turkish and accessible at the National Thesis Center. First of all, the key concept of "science" was scanned in the National Thesis Center database to access the theses. Thus, initially 383 master's theses were reached. Then, out of these 383 master's theses, studies with the key concept "artificial intelligence technology" were included in the analysis, and 18 master's theses were reached. The literature search results are shown in the PRISMA flow diagram. "Research Classification Form" was used as a data collection tool. Of the 18 master's theses within the scope of the research; Publication year, purpose, research approach and method, number of samples, sample size, grade level, data collection tools and data analysis techniques were examined. According to the findings obtained from the analysed theses, it is seen that the effects of artificial intelligence technologies on academic success in general are examined in the studies conducted. Again, it was concluded that researchers mainly preferred the qualitative research method and the studies were conducted mostly in 2022. It was found that in most of the studies examined, teachers were preferred as samples, and the distribution in sample size was in the range of 0-50 at most. In the study, suggestions are presented regarding the advantages of using artificial intelligence technology and its integration into other courses.

Keywords: Artificial intelligence technology, content analysis, science education

1. GİRİŞ

Teknolojide yaşanan gelişim hızı beraberinde birçok alanda yenilik ve değişimleri de getirmiştir. Yaşanan değişikliklerin etkisini gösterdiği alanlardan birisi de eğitimidir (Erden ve Uslu pehlivan, 2020: s.109). Bireyler değişen ve hızla gelişen teknolojik bir dünyada yeni teknolojilere uyum sağlamaya çalışmaktadır. Teknoloji, eğitimi etkileyerek bireylerin öğrenme ortamlarından daha fazla faydalanabilmesine imkân tanımaktadır (Korkmaz, 2022). Ayrıca

teknolojide yaşanan hızlı gelişim ve değişime uyum sağlayabilmek için öğretim ortamları her dönemde çağın teknolojisi ile donatıldığını söyleyebiliriz. Kara tahtayla başlayan bu değişim ve gelişim serüveni zamanla bilgisayar, akıllı tahta, tablet bilgisayar ve elektronik cihazlara doğru evrilmiştir (Kolburan ve Bakar, 2020: s.24).



Şekil 1. Yapay Zekanın Tarihsel Süreci

Düşünme, problem çözmeye, iletişim kurma, akıl yürütme, algılarla hareket etme, çıkarım ve değerlendirme yapma vb. ileri seviye bilişsel fonksiyonlara sahip olan, insan gibi hareket eden yani akıllı davranışlar sergileyebilen yazılımlar ya da donanımlar oluşturma arayışı yapay zekâ ifade edilmektedir (Özdemir ve Kılınç, 2019). Yapay zekanın kullanılmasıyla hızlı ve kaliteli sonuçlar ortaya çıktığı da söylenebilir. Yapay zeka teknolojisi, bireyin üretkenlik yönünü ortaya çıkaran ve işgücü verimliliğini arttıran temel araçlardan biri olarak değerlendirilmektedir (Sümer, 2020: s.16). Şekil 1'de görüldüğü üzere yapay zeka geçmişten günümüze gelişerek devam etmektedir.

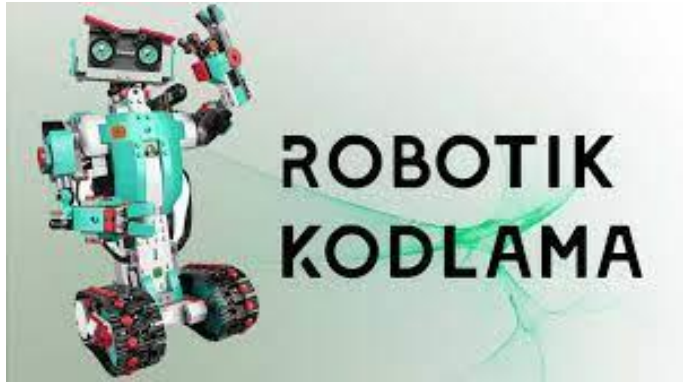
21. Yüzyılda gelişen bilgi ve iletişim teknolojileriyle birlikte yapay zekanın kullanımı da geniş alana yayılmasının önünü açmıştır (Bağır, 2022). Yapay zeka teknolojisi sağladığı imkânlarla içerisinde bulunduğumuz yüzyılda her alanı etkileyerek yaşamın vazgeçilmez bir parçasına dönüşmüştür (Kaya, 2019: s.151). Eğitimden tıpa, ekonomiden bankacılığa kadar ve hatta cep telefonlarımızda ve birçok alanda yapay zekanın izleri görülmektedir.

Teknolojik gelişmeler ile birlikte bilgisayarlar, projeksiyon cihazı, akıllı tahtalar, televizyon, akıllı telefonlar, tabletler, veya Google Glass gibi cihazlardan eğitim amacıyla

yararlanılmaktadır (Öncel, 2022). Fen eğitiminde kullanılan yapay zeka uygulamalarına örnek olarak; artırılmış gerçeklik, robotik kodlama, Teachable Machine verilebilir.



a)



b)

Şekil 2. Fen Eğitiminde Kullanılan Yapay Zeka Örnekleri a) Artırılmış Gerçeklik b) Robotik Kodlama

1.1 AMAÇ

Fen bilimlerinde yapay zeka teknolojisini temel alan yüksek lisans tez araştırmalarının inceleme konusu ile birlikte içerik analizi yöntemi yapılması amaçlanmıştır.

1.2 PROBLEM CÜMLESİ

Türkiye’de 2020-2023 Yılları Arasında, Fen Eğitimi Alanında Yapay Zeka Teknolojisi Konusunda Yapılan Yüksek Lisans Tez Çalışmalarının Betimsel Analizi çalışmamızın problem cümlesini oluşturmaktadır.

1.2.1 ALT PROBLEMLER

2020-2023 yılları arasında yayımlanan yüksek lisans tezlerinin;

- Yıllara göre dağılımı nasıldır?
- Amacına göre dağılımı nasıldır?
- Araştırma yaklaşımlarına göre dağılımı nasıldır?
- Araştırma yöntemlerine göre dağılımı nasıldır?
- Örneklem sayısına göre dağılımı nasıldır?
- Sınıf düzeyine göre dağılımı nasıldır?
- Veri toplama araçlarına göre dağılımı nasıldır?
- Veri analiz tekniklerine göre dağılımı nasıldır?

2. YÖNTEM

Belirli bir konu üzerinde yapılan çalışmaların ele alınıp eğilimlerinin ve araştırma sonuçlarının tanımlayıcı bir boyutta değerlendirilmesini içeren sistematik çalışmalara betimsel içerik analizi denilmektedir (Çalık & Sözbilir, 2014, p.34). Betimsel içerik analiz aynı konu üzerinde hem nitel hem de nicel araştırma yöntemlerinin kullanıldığı araştırmalarda genel eğilimin ne olduğunu tespit etmede kullanılmaktadır (Cohen vd., 2007; Selçuk vd., 2014).

Bu çalışma kapsamında 2020-2023 yılları arasında fen bilimlerinde yapay zeka teknolojisi alanında yapılan çalışmaların genel eğilimini belirlemek için betimsel içerik analiz yöntemi kullanılmıştır. Arama sürecindeki önemli rol anahtar kelimelere düşmektedir (Çınar, 2021). Araştırmamızı yaparken kullandığımız anahtar kelimeler; fen bilimleri, yapay zeka teknolojisi olmuştur.

Veri Kaynağı

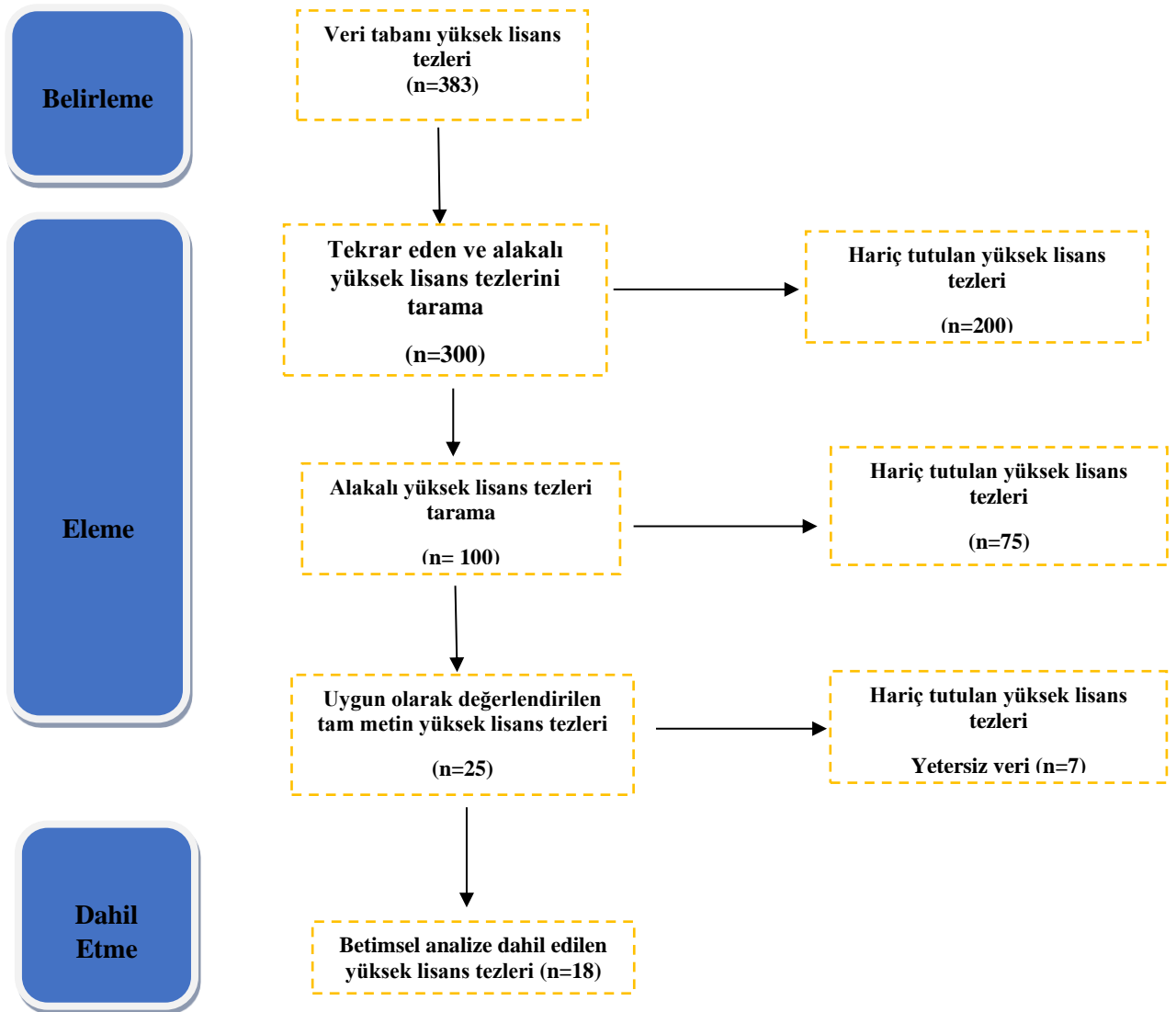
Bu çalışmanın evrenini 2020-2023 yılları arasında fen bilimlerinde yapay zeka teknolojisini temel alan yüksek lisans tezleri oluşturmaktadır. Araştırmanın kaynağı seçilirken; yürütülen çalışmaların Türkiye’den seçilmesi, YÖK Tez veri tabanında yer alan yüksek lisans tezlerinin tam metin olarak ulaşılması ve fen bilimlerinde yapay zeka ve teknoloji alanında olması gibi kriterler dikkate alınmıştır. Güncel eğilimlerin belirlenmesi için 2020-2023 yılları arası yapılan yüksek lisans tezleri analize dâhil edilmiştir. Bu kriterler dikkate alınarak yapılan araştırmamızın örneklemini toplam 18 makale oluşturmaktadır. Bu araştırmaların yanında Araştırma kapsamında incelenen bu çalışmalarla ilgili bilgiler Ek- 1’ de sunulmuştur.

Verilerin Toplanma Süreci ve Sınıflandırılması

Çalışma kapsamında veriler 2020-2023 yılları arasında fen bilimlerinde yapay zeka teknolojileri alanında yayımlanan yüksek lisans tezlerinden elde edilmiştir. Bunun için araştırmacıların belirlediği kriterlere uygun olan 18 yüksek lisans tezi incelemeye alınmıştır. Bu tezleri incelerken alanyazında yapılan diğer betimsel analiz çalışmalarında, tezleri incelerken hangi nitelikleri göz önünde bulundurdıklarına yönelik araştırmalar yapılmıştır. Yapılan incelemeler doğrultusunda inceleme yapılacak yüksek lisans tezlerinin özelliklerini belirli kategori altında toplayabilmek için araştırmacı tarafından hazırlanan “Araştırma Sınıflama Formu” geliştirilmiş ve kullanılmıştır. Araştırma sınıflandırma formu geliştirilirken alan yazında daha önce betimsel içerik analizi kullanılarak yürütülen çalışmalar irdelenmiş (Çiltaş vd., 2012; Selçuk vd., 2014; Sözbilir vd., 2012) ve bilimsel bir yüksek lisans tezinde

bulunması gereken özellikler incelenmiştir (Cohen vd., 2007; Büyüköztürk vd., 2011; Çepni, 2014).

Literatür tarama sonuçları PRISMA akış diyagramında gösterilmiştir. Araştırmanın ilk aşamasında literatür tarama stratejisine uygun 383 adet çalışma belirlenmiştir. Yapılan inceleme sonucunda bu araştırmaların 83'ünün tekrar olduğu görülerek dışlanmıştır. Kalan 300 yüksek lisans tezlerinin özeti, dışlama ve kabul edilme kriterlerine uygun olarak değerlendirilmiş ve belirlenen stratejiye uygun olmayan 200 çalışma araştırma kapsamına alınmamıştır. Son aşamada uygun olarak değerlendirilen tam metin yüksek lisans tezlerinin 25 tanesinden 7'si yetersiz veri nedeniyle çalışmaya alınmamış olup, toplam 18 çalışma PRISMA akış diyagramına alınmıştır. Literatür tarama stratejisine ilişkin sonuçlar Şekil 3'te PRISMA (Preferred Reporting Items for Systematic Reviews and MetaAnalyses) akış diyagramında sunulmuştur.



Şekil 3. PRISMA Akış Diyagram

3. BULGULAR

Fen bilimlerinde yapay zeka teknolojileri alanında 2020-2023 yılları arasında yayımlanan ve ulaşılabilen 18 yüksek lisans tezleri analiz edilerek belirlenen kategoriler kapsamında ifade edilmiştir. Elde edilen bulgulara göre; fen bilimlerinde yapay zeka teknolojisi alanında yapılan çalışmaların yıllara göre dağılımı incelendiğinde, 2022 yılında 15, 2020 yılında 3 yüksek lisans tezinin yayınlandığı görülmektedir. 2021 ve 2023 yılında ise çalışmaların olmadığı görülmektedir.

İncelenen çalışmaların amacına göre dağılımı Tablo 1’de verilmiştir.

Tablo 1. İncelenen çalışmaların araştırmanın amacına göre dağılımı

ÇALIŞMALARIN AMACI	FREKANS	KOD
Akademik Başarılarına Etkisi	7	M3-M7-M10-M11-M12-M14-M16
Motivasyon Düzeylerine Etkisi	5	M7-M10-M11-M12-M16
Öğretmen Görüşlerini İnceleme	4	M1-M2-M9-M17
Ders Tutumlarına Etkisi	3	M3-M5-M7
İçerik Analizi	2	M4-M8
Öğrenci Görüşleri	2	M6-M10
Bilgi Düzeyleri Etkisi	1	M5
Öğrenme Düzeyine Etkisi	1	M13
Kaygı Düzeylerine Etkisi İnceleme	1	M14
Değişken Yönelimlerin Etkisi	1	M15
Öğrenci Deneyimleri İncelemesi	1	M18

Tablo 1 incelendiğinde, fen bilimlerinde yapay zeka teknolojisi alanında yapılan çalışmaların 7 tanesinin akademik başarılarına etkisine yönelik olduğu ve 5’inin ise motivasyon düzeylerine etkisini belirlemek amacıyla yapıldığı görülmektedir.

Yaptığımız çalışmada tezlerde kullanılan araştırma yaklaşım ve yöntemleri dağılımı Tablo 2’de sunulmuştur.

Tablo 2. İncelenen çalışmalarda kullanılan araştırma yaklaşım ve yöntemleri

Araştırma Yaklaşımları	Araştırma Yöntemleri	Frekans	Kod
Nitel	Fenomenoloji	3	M2-M6 –M17
	Belirtilmemiş	2	M1-M9
	Doküman İnceleme	1	M4
	Durum Çalışması	1	M8
Nicel	Yarı Deneysel	4	M12-M13-M14-M16
	Kesitsel Tarama	1	M3
	Betimsel İlişkisel Tarama	1	M15
Karma	Açıklayıcı Ardışık Desen	3	M5-M7-M11
	Keşfedici Ardışık Desen	1	M18
	Belirtilmemiş	1	M10

Tablo 2 incelendiğinde, fen bilimlerinde yapay zeka teknolojisi alanında yapılan çalışmalarda en fazla (7) nitel yaklaşım kullanıldığı belirlenmiştir. Nicel yaklaşımlardan en çok fenomenolojik yöntemin benimsendiği görülmektedir. Nicel yaklaşımlardan 6 ve karma yaklaşımlardan 5 adet faydalanılması araştırmancının bulgularındandır.

Çalışmaların yapıldığı örneklem grubunda yer alan katılımcı sayısına göre; Katılımcı sayısının 0-50 aralığında olduğu 11 araştırma yapılmışken, katılımcı sayısının 151-200 olduğu 3 çalışma yapılmıştır.

Çalışmaların yapıldığı örneklem grubunda yer alan katılımcı sınıf düzeylerine göre; Öğretmenler düzeyinde 6 çalışmaya rastlanırken; 7. Sınıf düzeyinde 5 çalışmaya rastlandığı gözlenmiştir. Ayrıca 5. Sınıf düzeyine dair bir çalışma yapılmadığı da gözlenmektedir.

İncelenen çalışmalarda kullanılan veri toplama araçlarının dağılımına göre elde edilen bulgulara göre; bazı çalışmalarında birden fazla veri toplama aracı kullanıldığı için veri toplama araçları sayısının incelenen çalışma sayısından daha fazla olduğu görülmektedir. Çalışmalarda en fazla kullanılan veri toplama araçlarının yarı yapılandırılmış görüşme formu (10 adet) ve başarı testi (6 adet) olduğu görülmektedir. Araştırmalarda en az tercih edilen veri toplama araçlarının ise bilgi ölçeği, girişimcilik ölçeği, gözlem formu, kaygı ölçeği, öğrenme ölçeği, kişisel bilgi formu, ilgi ölçeği, sınıflama formu olduğu belirlenmiştir.

Araştırmada ele alınan çalışmalarda kullanılan veri analiz yöntemleri dağılımı Tablo 3'te gösterilmiştir.

Tablo 3. İncelenen çalışmalarda kullanılan veri analiz yöntemleri dağılımı

	VERİ ANALİZ TEKNİKLERİ	FREKANS	KOD
Nicel	Bağımsız örneklem t-testi	6	M3-M6-M7-M10-M12-M14
	Mann-Whitney U testi	4	M10-M12-M15-M18
	Shapiro-Wilks testi	3	M12-M14-M15
	ANOVA	2	M3-M5
	Kruskal Wallis H testi	2	M15-M18
	Wilcoxon Testi	1	M12
	Kolmogorov-Smirnov	1	M15
	ANCOVA	1	M14
	İki Yönlü Varyans Analizi	1	M16
	Korelasyon Analizi	1	M18
Nitel	İçerik Analizi	6	M1-M4-M7-M8-M17-M18
	Betimsel Analiz	5	M1-M6-M8-M9-M11
	Odak Grup Görüşmesi	1	M2

Tablo 3 incelendiğinde, fen bilimlerinde yapay zeka teknolojisi alanında kullanılan veri analiz tekniklerinin bazı çalışmalarında birden fazla veri analiz teknikleri kullanıldığı için veri analiz teknikleri sayısının incelenen çalışma sayısından daha fazla olduğu görülmektedir. Çalışmalarda en fazla kullanılan veri analiz tekniklerinin nicelde, bağımsız örneklem t-testi (6 adet), Mann-Whitney U testi (4 adet) olduğu, nitelde ise, içerik analizi (6 adet) olduğu görülmektedir.

4. SONUÇ VE ÖNERİLER

Araştırmada yer alan çalışmalarda en çok nitel araştırma yaklaşımları kullanılarak fen bilimlerinde yapay zeka teknolojilerinin konu alanı incelenmiş; sonuç ve öneriler sunulmuştur.

En fazla çalışılan örneklem grubunun 7. Sınıflar olduğu bununla birlikte 6 ve 8. sınıflarda da çalışmanın yer aldığı görülmesine rağmen 5. sınıflarda çalışma yapılmadığı görülmektedir. Bu durum 7. ve 8. sınıflarda çalışma sayısının, 5. ve 6. sınıflardan fazla olmasının sebebi, üst düzey düşünme becerilerinin gelişmiş olmasından kaynaklandığı söylenebilmektedir.

Araştırmadan elde edilen verilere bakıldığında, 0-50 aralığında örneklem büyüklüğüne sahip çalışmaların en fazla olduğu görülmektedir. Bu durum çalışmada çoğunlukla yarı deneysel desenin tercih edilmesinden kaynaklı olabileceğini söyleyebiliriz. Yarı deneysel desende bir deney bir kontrol olmak üzere iki grup ile çalışılmaktadır. Bu gruplarda analiz yapılabilmesi için her grupta en az 20-25 birey bulunması gerekliliğinden örneklem aralığının 0-50 olmasına sebep olabilir.

Araştırmaya dahil edilen çalışmalarda nicel ve nitel analizlerin yapıldığı görülmektedir. Araştırmaların büyük bir kısmı nitel yaklaşımlarla oluşturulmuştur. Fakat kullanılan veri analiz yöntemlerinin çoğunun nicel olduğunu görebiliriz. Nicel analiz tekniklerinden en çok bağımsız örneklem t-testi ve Mann-Whitney U testi kullanıldığı görülmektedir. Bunun nedeni, örneklem sayılarının parametrik testleri uygulamaya yeterli düzeyde olması ve kullanılan test varsayımlarının sağlanmış olması olarak düşünülmektedir. Araştırmada fen bilimlerinde yapay zeka ve teknoloji alanında literatüre genel bir bakış açısı sağlamak ve analiz etmek için nitel veri analizi yöntemlerinden içerik analizi ve betimsel analizin kullanımının tercih edildiği söylenebilir.

Bu çalışma fen bilimlerinde yapay zeka teknolojisi konusuyla ilgili Türkiye’de yürütülen çalışmaların genel eğilimlerini belirlemeye yönelik yapılmıştır. Uluslararası düzeyde fen bilimlerindeki yapay zeka ve teknoloji alanındaki çalışmalardaki genel eğilimleri belirlemeye yönelik araştırmaların yürütülmesi tavsiye edilebilir. Ayrıca fen bilimlerinde yapay zeka ve

teknoloji alanında ölçek geliştirme, başarı testi geliştirme ve teknolojik imkanların kullanıldığı uygulamaların etkilerini belirlemeye yönelik sınırlı sayıda çalışmanın yürütüldüğünü göstermektedir. Fen bilimlerinde yapay zeka ve teknoloji alanında araştırma yapacak araştırmacılara bu konularda çalışmaların yapılması önerilebilir.

Yapay zeka teknolojisinin eğitime olumlu yansımalarını görebilmek için öncelikle öğretmen ve yöneticilerin bu konudaki farkındalık düzeyleri belirlenerek gerekli hizmet içi eğitim ya da kurslar verilerek eksiklikler giderilebilir.

En fazla çalışma örneklem grubunun 7. Sınıflar olduğu, bununla birlikte 6 ve 8. Sınıflarda da çalışmanın yer aldığı görülmesine rağmen 5. Sınıflarda çalışma yapılmadığı görülmektedir. Bu durum gelecek çalışmalara fen bilimlerinde yapay zeka ve teknoloji konusundan hangi sınıf düzeyinde çalışmalar yapılmadığını gösterip ışık tutacaktır.

Ders kitaplarının öğrencilerin teknolojiyi kullanma becerilerine katkı sağlayacak, düzeylerine uygun yöntem ve tekniklerin eklenmesi şekilde hazırlanması ve düzenlenmesi sağlanabilir. Öğrencinin yaparak yaşayarak öğrenebileceği öğretim ortamlarının oluşması ve çeşitli öğretim yöntem ve teknikleri kullanılabilmesi için fen bilimleri ders saatleri artırılabilir. Ayrıca öğretmenler çoklu zeka kuramına ya da öğrencilerin öğrenme stillerine göre öğrencilerinin baskın olan zeka alanlarını belirleyip bu zeka alanına hitap edecek etkinlikler yapabilirler. Bu şekilde yapılacak olan öğrenmeler çok daha kısa sürede anlaşılır ve daha kalıcı olması sağlanabilir.

5. KAYNAKÇA

- Bağır, M. (2022). *Fen Bilimleri Öğretmenlerinin Eğitimde Yapay Zekâ Kullanımı ile İlgili Görüşleri*. Fırat Üniversitesi Eğitim Bilimleri Enstitüsü, Elazığ.
- Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, O.E., Karadeniz, Ş., & Demirel, F. (2011). *Bilimsel araştırma yöntemleri* (8.baskı). Pegem Akademi.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in Education (6th ed.)* New York, NY: Routledge.
- Çalık, M. & Sözbilir, M. (2014). *İçerik analizinin parametreleri [Parameters of content analysis]*. Eğitim ve Bilim [Education and Science], 39(174), 33-38.
- Çepni, S. (2014). *Araştırma ve Proje Çalışmalarına Giriş*. Celepler Matbaacılık. Trabzon.
- Çınar, N. (2021). İyi Bir Sistemik Derleme Nasıl Yazılmalı?. *Online Türk Sağlık Bilimleri Dergisi*, 6(2), 310-314.
- Çiltaş, A., Güler, G., & Sözbilir, M. (2012). *Türkiye’de matematik eğitimi araştırmaları: Bir içerik analizi çalışması*. Kuram ve Uygulamada Eğitim Bilimleri, 12(1), 565-580.
- Erden, Meltem ve Uslupehlivan Eda (2020). “Eğitimde Teknoloji Kullanımının Bugünü ve Geleceğine İlişkin Öğretmen Adaylarının Düşüncelerinin İncelenmesi.” *Uşak Üniversitesi Sosyal Bilimler Dergisi*, 13(1), 109-126.
- Kaya, Mehmet, Fatih (2019). “İlkokul Öğretim Programlarının Teknoloji Entegrasyonu Bakımından İncelenmesi.” *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, 20, 1063-1091.

- Kolburan, Aynur ve Bakar, Ayşegül (2020). “Ortaöğretim Öğretmenlerinin BİT Kaynaklarından Yararlanma Durumları ve Yaşadıkları Sorunlar: Kocaeli Örneği.” Eğitim Teknolojisi Kuram ve Uygulama, 10(1), 1-24.
- Korkmaz, S. (2022). Öğretmen Görüşlerine Göre Ortaokul Fen Bilimleri Dersinde Sanal Gerçeklik Teknolojilerinin Öğretimde Kullanım İlkeleri ve Olası Etkileri. Kocaeli Üniversitesi Sosyal Bilimler Enstitüsü, Kocaeli.
- Öncel, Z. (2022). Fen Bilimleri Eğitimi Alanında Sanal Gerçeklik Uygulamaları Üzerine Yapılan Çalışmaların İçerik Analizi. Adıyaman Üniversitesi Lisansüstü Eğitim Enstitüsü, Adıyaman.
- Özdemir, Ş. ve Kılınc, D. (2019). Geleceğin meslekleri dijital dönüşüm, veri bilimi, yapay zekâ. İstanbul: Abaküs Yayınları.
- Selçuk, Z., Palancı, M., Kandemir, M., & Dündar, H. (2014). Eğitim ve bilim dergisinde yayınlanan araştırmaların eğilimleri: İçerik analizi. Eğitim ve Bilim, 39(173), 430453.
- Sözbilir, M., Kutu, H., & Yaşar, M. D. (2012). Science education research in Turkey: A content analysis of selected features of papers published. In J. Dillon & D. Jorde (Eds). The World of Science Education: Handbook of Research in Europe (pp.341-374). Rotterdam: Sense Publishers.
- Sümer, S. (2020). “Mobil Uygulama Teknolojisi Destekli Beden Eğitimi ve Spor Dersinin 7. ve 8. Sınıf Öğrencilerinin Hentbol Performansları Üzerine Etkisinin İncelenmesi.” Yüksek Lisans Tezi, Eğitim Bilimleri Enstitüsü, Marmara Üniversitesi, İstanbul.

Ek-1 Araştırma Kapsamında İncelenen Yüksek Lisans Tezlerinin Kod Listesi

- M1)** Sanca, M. (2022). Fen Öğretiminde Yapay Zeka Destekli Teknolojilerin Kullanımına İlişkin Fen Bilimleri Öğretmenlerinin Görüşlerinin İncelenmesi. Van Yüzüncü Yıl Üniversitesi Eğitim Bilimleri Enstitüsü, Van.
- M2)** Bağır, M. (2022). Fen Bilimleri Öğretmenlerinin Eğitimde Yapay Zekâ Kullanımı ile İlgili Görüşleri. Fırat Üniversitesi Eğitim Bilimleri Enstitüsü, Elazığ.
- M3)** Bostancı, Ç. Ş. (2022). Fen Bilimleri Öğretmen Adaylarının Nanoteknolojiye Yönelik Tutumlarının Çeşitli Değişkenlere Göre İncelenmesi. Necmettin Erbakan Üniversitesi, Eğitim Bilimleri Enstitüsü, Konya.
- M4)** Boyraz, A. (2022). Fen Bilimleri Eğitiminde Nanobilim ve Nanoteknoloji Üzerine Yapılmış Tez ve Makalelerin İçerik Analizi. Necmettin Erbakan Üniversitesi, Eğitim Bilimleri Enstitüsü, Konya.
- M5)** Göçmen, A. (2022). Fen Bilimleri Öğretmen Adaylarının Nanoteknolojiye Yönelik Bilgi ve Tutum Düzeyleri ile Görüşlerinin Belirlenmesi. Erciyes Üniversitesi Eğitim Bilimleri Enstitüsü, Kayseri.
- M6)** Kaya, M. (2022). Fen Bilimleri Eğitiminde Arduino Uygulama Süreçlerine Yönelik Öğretmen Adaylarının Görüşlerinin İncelenmesi. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü, Adana.
- M7)** Akgün, U. (2022). 3 Boyutlu Yazıcının Kullanıldığı STEM Eğitim Uygulamalarının 7. Sınıf Fen Bilimleri Dersinde Akademik Başarı, Tutum ve Motivasyona Etkisi. Atatürk Üniversitesi Eğitim Bilimleri Enstitüsü, Erzurum.
- M8)** Öncel, Z. (2022). Fen Bilimleri Eğitimi Alanında Sanal Gerçeklik Uygulamaları Üzerine Yapılan Çalışmaların İçerik Analizi. Adıyaman Üniversitesi Lisansüstü Eğitim Enstitüsü, Adıyaman.
- M9)** Korkmaz, S. (2022). Öğretmen Görüşlerine Göre Ortaokul Fen Bilimleri Dersinde Sanal Gerçeklik Teknolojilerinin Öğretimde Kullanım İlkeleri ve Olası Etkileri. Kocaeli Üniversitesi Sosyal Bilimler Enstitüsü, Kocaeli.
- M10)** Demir, İ. (2022). Eğitsel Dijital Oyunun Fen Bilimleri Dersinde Öğrenci Başarısına ve Motivasyona Etkisi: Saf Maddeler Örneği. Ondokuz Mayıs Üniversitesi Lisansüstü Eğitim Enstitüsü, Samsun.
- M11)** İlkay, D. (2022). Fen Bilimleri Dersinde Eğitsel Dijital Oyun Kullanımının 6. Sınıf Öğrencilerinin Motivasyonlarına ve Akademik Başarılarına Etkisi. Kilis 7 Aralık Üniversitesi, Lisansüstü Eğitim Enstitüsü, Kilis.
- M12)** Akkan, D. (2022). Eğitsel Dijital Oyun Destekli Fen Bilimleri Dersinin Öğrenci Başarı ve Motivasyonuna Etkisi: Elektriğin İletimi. Ondokuz Mayıs Üniversitesi Lisansüstü Eğitim Enstitüsü, Samsun.
- M13)** Bozkurt, M. (2022). Ortaokul Fen Bilimleri Dersinde Sanal Müze Kullanımının Öğrencilerin Laboratuvar Malzemelerini Öğrenmeleri Üzerine Etkisi. Necmettin Erbakan Üniversitesi, Eğitim Bilimleri Enstitüsü, Konya.

- M14)** Alagöz, Z. B. P. (2020). *Mobil Artırılmış Gerçeklik Uygulamalarının Ortaokul 7. Sınıf Öğrencilerinin Fen Bilimlerine Yönelik Kaygılarına ve Akademik Başarılarına Etkisi*. Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.
- M15)** Doğan, T. (2022). *Fen Bilimleri Öğretmenlerinin Dijital Okuryazarlık Düzeyleri ile Eğitim Bilişim Ağı (EBA)'na Yönelik Tutumları Arasındaki İlişki*. Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.
- M16)** Laçın, Ö. (2021). *Fen Bilimleri Dersinde Classdojo ile Destekli E-Öğrenme Süreçlerinin 7. Sınıf Öğrencilerinin Akademik Başarılarına, Fene Yönelik Motivasyonlarına, Dijital Okuryazarlıklarına ve Teknolojiyle Kendi Kendine Öğrenmelerine Etkisinin İncelenmesi*. Kocaeli Üniversitesi Fen Bilimleri Enstitüsü, Kocaeli.
- M17)** Yavuz, C. (2022). *Fen Bilimleri Öğretmenlerinin Fen Bilimleri Dersinde Sanal Laboratuvar Kullanımına Yönelik Görüşlerinin İncelenmesi*. Van Yüzüncü Yıl Üniversitesi Eğitim Bilimleri Enstitüsü, Van.
- M18)** Keskin, Z. (2022). *Fen Bilimleri Öğretmenleri ve 7. Sınıf Öğrencilerinin Etkileşimli Simülasyon Deneyimlerinin İncelenmesi*. Kırşehir Ahi Evran Üniversitesi Fen Bilimleri Enstitüsü, Kırşehir.

CULTIVATING TRANQUILITY: STOICISM'S APPROACH TO OVERCOMING ENVY

Zidan KAFABIH

Faculty of Economics and Islamic Business, State Islamic University K.H Abdurrahman Wahid
Pekalongan, Indonesia

ORCID ID: 0009-0007-3603-5423

Muhammad Sultan MUBAROK

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid
Pekalongan Indonesia

ORCID ID: 0000-0002-6168-0439

Muhammad Taufiq ABADI

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid
Pekalongan Indonesia

ORCID ID: 0000-0001-9705-7756

Muhammad SHULTHONI

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid
Pekalongan Indonesia

ORCID ID: 0000-0002-3470-4335

ABSTRACT

The abstract of this research endeavors to delve into the application of Stoicism philosophy as a potent tool to mitigate and manage feelings of envy experienced when witnessing the achievements or acquisition of new possessions by one's neighbors. Stoicism, an ancient philosophical school of thought, lays significant emphasis on self-control, wisdom, and inner tranquility as fundamental principles in attaining happiness and serenity in one's life. In the specific context of this study, we embark on an exploration of how the core tenets of Stoicism, such as the focus on controlling only what is within one's sphere of influence and the realization that genuine happiness stems from one's internal state, can be effectively utilized to navigate the complex and often challenging emotion of envy. Envy, often triggered by the success or material wealth of others, can disrupt one's emotional equilibrium and general well-being. The findings of this research uncover that by applying Stoic principles, individuals can develop a heightened sense of emotional intelligence and resilience when confronted with situations that evoke envy. By cultivating these Stoic virtues, individuals can redirect their attention away from external comparisons and toward their own inner growth and contentment. As a result, the quality of life and psychological well-being of individuals can be significantly enhanced. In conclusion, Stoicism emerges as a valuable and practical framework for individuals seeking to effectively manage envy, fostering inner peace, and ultimately enriching their daily lives with a deeper sense of purpose and contentment. This study sheds light on the potential of Stoicism philosophy to offer guidance and solace in the face of one of the most pervasive and complex human emotions.

Keywords: Envy, Cultivate, Stoicism, self-control, wisdom.

ELEKTRİKLİ ARAÇLARDA TÜKETİCİ TERCİHLERİ: ÇOK KRİTERLİ KARAR VERME YÖNTEMLERİNİN UYGULANDIĞI BİR KARŞILAŞTIRMA ÇALIŞMASI

Prof. Dr. Metin CANCI

Yalova University, Faculty of Economics and Administrative Sciences, Department of International Trade and Finance, Yalova-Türkiye
ORCID ID: 0000-0002-2152-0975

Gizem ALKAN KABAKCI

Yalova University, Faculty of Economics and Administrative Sciences, Department of International Trade and Finance, Yalova-Türkiye Industrial Engineer, Stellantis N.V., Bursa-Türkiye
ORCID ID: 0000-0002-3676-0760

ÖZET

Günümüzde, son 10 yıl ile karşılaştırıldığında elektrikli araçların günden güne daha popülerleştiği ve tüm dünyada otomotiv sektöründe artık daha yaygın kullanılan önemli bir teknoloji olduğu açıktır. Tüketici tercihleri göz önünde bulundurularak, bu çalışma çok kriterli karar verme yöntemlerinden Vikor ve Topsis yöntemleri kullanılarak tüketicilerin elektrikli araç seçiminin arkasındaki itici sebepleri incelemiştir. Çalışmanın başlangıç noktası olarak, ulusal ve uluslararası literatür taraması yapılmış ve elektrikli araç seçimleri ve eğilimleri detaylı olarak araştırılmıştır. Bu literatür taramasına göre, çok kriterli karar verme çalışmasını yapılandırabilmek için yirmi farklı kriter belirlenmiştir. Seçeneklerin belirlenmesi için birçok seçenek arasından Vietnam, Japonya, Çin, Güney Kore ve Türkiye menşeli 5 farklı elektrikli araç markası seçilmiştir ve anket çalışması için tüm kriterler her bir seçenek bazında değerlendirilmiştir. En iyi seçenek sırasıyla Vikor ve Topsis yöntemleri uygulanarak belirlenmiştir. Çalışma boyunca, çalışmanın sayısal güvenilirliğini ve sonuç uyumunu etkileyen en önemli etmenin kriterlerin ağırlıklandırılması olduğu vurgulanmış ve kriter ağırlıkları ile çalışma arasında köprü oluşturulmuştur. Sonuç olarak, bu çalışma pazar koşullarında faaliyet gösteren 5 farklı modelin müşteri tercihlerine göre sıralanması ve karşılaştırılması bakımından oldukça önemli katkı ortaya koymaktadır. Ayrıca Topsis ve Vikor yöntemlerinin uygulaması otomotiv sektörünün büyüyen ve gelişen alanı olarak elektrikli araçlar için güzel bir örnek olarak literatüre katkı sağlamaktadır. Değerli bilgileriniz ve desteğiniz için, bu çalışmayı konferansa online katılım sağlayarak sunmak isteriz.

Anahtar Kelimeler: Tüketici Tercihleri, Elektrikli Araçlar, Topsis, Vikor

CONSUMER PREFERENCES ON ELECTRIC VEHICLES: A COMPARISON STUDY APPLYING MULTI CRITERIA DECISION ANALYSES

ABSTRACT

Nowadays, it is obvious that electric vehicles become more popular comparing to recent 10 years and all around the world electric vehicles will be the one most important widespread technology in automotive industry. Referring to consumer behaviours, this study provides insight into motivational reasons of consumers' preferences for electrical vehicles applying Vikor and Topsis methods as multi criteria decision analyse. As a starting point of this study, thanks to the international literature review, the main intentions by choosing and compensating the electric vehicles were deeply investigated. Related to literature review, twenty various criteria was arranged in order to establish a multi criteria decision analyse. In terms of defining alternatives, five different electrical vehicle models from Japan, Vietnam, South Korea, China and Turkey were allocated entire the several options and they were respectively evaluated per each criteria by surveys. Best alternatives according to Topsis and Vikor methods were calculated as an exact result of the study. During the study, defined weights of the each criteria was the most important bridge between numerical consistency of study and results reliability of calculations. As a conclusion, this study contributes to an important comparison of five different electric vehicle model according to consumer preferences and behaviours while this will provide the one of important example for Topsis and Vikor methods applications in electric vehicle as an advancing and growing area of automotive industry. For your kind information, we kindly ask online participation to isarconferance to present our study.

Keywords: Consumer Preference, Electric Vehicles, Topsis, Vikor

1. GİRİŞ

Son 10 yılda geçmiş yıllara oranla elektrikli araçların hem üretimi hem de kullanımı oldukça artmıştır. 20. yüzyılın başında elektrikli araçlar piyasada fosil yakıtlı araçlardan daha fazla kullanıma ve üretime sahipti fakat petrol kullanımının giderek artması, petrolün ucuzlaması ve fosil yakıtlı araçların elektrikli araçlara göre daha verimli olması tezinin desteklenmesi ile piyasadaki elektrikli araç sayısı giderek azalmıştır. Son yıllarda ise petrol fiyatlarının gün geçtikçe artması ve 21. yüzyılda etkisini göstermeye başlayan küresel ısınma gibi çevresel problemler sebebiyle alternatif yakıtlı araçlara özellikle elektrikli araçlara piyasada yeniden talep artmaya başlamıştır. Sadece ekonomik veya da karbondioksit seviyesinden kaynaklı çevresel sebeplerden değil ayrıca verimlilik anlamında da elektrikli araçlarda son yıllarda

yaşanan olumlu gelişmeler bu bağlamda destekleyici olmuştur. Elektrikli araçların gelişim süreçleri incelendiğinde, 2000’li yılların başlarında çok düşük olan elektrikli araç satışlarının 2020’li yıllara gelindiğinde 10 milyon civarında olduğu görülmüştür. Pazardaki bu önemli ve ivmeli büyümenin yanı sıra tüketicilerin alternatif yakıtlı araçlar konusundaki bilgi birikimi ve kullanım hassasiyetleri beklenen seviyede değildir. Şarj istasyonlarının yeterliliği, batarya ömrü ve menzil gibi konularda tüketicilerin sahip olduğu teknik ve psikolojik endişeler elektrikli araç satışlarına olumsuz bir etki yaratmaktadır. Türkiye’nin de içinde bulunduğu ülkelerde bu tip endişeler halen aşılabilmiş değildir. Bu nedenle, Türkiye’deki elektrikli araç satışları bahsi geçen endişeler ve bu endişeleri ortadan kaldırmada karşılaşılan zorluklar sebebiyle halen istenen seviyeye ulaşamamıştır.

Bu çalışma, yapılan literatür taramaları sonucu, tüketicilerin elektrikli araç tercihlerini ve satış eğilimlerini incelemek amacıyla tasarlanmıştır. Elektrikli araç kullanımını piyasaya hâkim kılmak adına belli kriterler ortaya koymaya çalışmıştır. Belirlenen kriterler çerçevesinde Asya ülkeleri piyasasında lider konumdaki 5 farklı markayı kriterler bazında karşılaştırmıştır. Bu karşılaştırma ilk adımda Vikor yöntemi ile yapılmış olup doğası gereği Vikor yönteminin seçim unsurunu göz önünde bulundurarak 5 farklı seçenek arasından en iyinin seçimini gerçekleştirmiştir. Çalışmanın ikinci ve devam adımıda Topsis yöntemi kullanılmış olup doğası gereği Topsis yönteminin sıralama unsurunu göz önünde bulundurarak 5 farklı seçenek arasında en iyiden başlayarak bir sıralama ortaya koymuştur.

2. ARAŞTIRMA VE BULGULAR

2.1. Uygulama

Çalışmanın ilk adımıda literatür taraması sonucunda tüketicilerin elektrikli araç satın alma kararlarında etkili olan 20 farklı kriter belirlenmiştir. Bu kriterler sırasıyla, elektrikli aracın satış fiyatı, elektrikli aracın km başına maliyeti, ses problemleri, titreşim problemleri, sürüş konforu, kullanım kolaylığı, elektrikli aracın bakım maliyeti, elektrikli aracın batarya ömrü, şarjı olma hızı, menzili, şarj istasyonlarına ulaşım kolaylığı, çevreci olması, devlet tarafında teşvik oranı, algılanan marka değeri, yenilikçi teknoloji, daha önce marka veya model ile ilgili edinilmiş kişisel tecrübeler, kullanıcı deneyimleri, yaratıcı tasarımı, sürdürülebilirliği ve satış sonrası hizmet kalitesidir. Bu kriterler alanında uzman kişilerce kriterler bazında ağırlıklandırılmıştır ve birbirlerine göre önem dereceleri belirlenmiştir. Ayrıca her bir seçenek özelinde kriterler tekrar değerlendirilmiş ve her bir seçenek için her bir kriter ayrı ayrı puanlanmıştır. Seçenekler belirlenirken özellikle Asya pazarında lider konumda olan ve lider olması muhtemel olan 5 farklı ülke ve elektrikli araç markası dikkate alınmıştır. Özellikle Asya pazarının seçilmiş olmasının

nedeni, elektrikli araç taleplerinin ivmelenmesinin oldukça yüksek seyretmesi ve dünya nüfus yoğunluğunun talep bazlı değerlendirildiğinde oldukça yüksek olmasıdır.

Çalışmanın birinci bölümünde Vikor yöntemi uygulaması yapılmıştır. Vikor yönteminin ilk adımında karar matrisi oluşturulmuştur. Karar matris Tablo 2.1’de verilmiştir.

Tablo 2.1. Karar matrisi

Ağırlık	Kriterler	Çin Menşei EA	Türkiye Menşei EA	Vietnam Menşei EA	Japonya Menşei EA	G.Kore Menşei EA
10%	Satış Fiyatı	3	7	4	10	4
3%	Km Başına Maliyet	8	7	5	9	6
3%	Ses	6	5	3	7	5
3%	Titreşim	6	5	5	8	6
5%	Sürüş Konforu	8	8	4	9	7
4%	Kullanım Kolaylığı	7	7	5	10	7
3%	Bakım Maliyeti	8	9	6	6	6
8%	Batarya Ömrü	9	8	6	9	8
7%	Şarj Hızı	8	8	8	9	8
5%	Menzil	9	9	7	8	7
5%	Şarj İst. Erişimi	10	9	6	7	7
2%	Çevre Dostu	5	8	7	10	7
4%	Devlet Teşviği	7	10	5	6	6
7%	Marka Değeri Algısı	8	8	6	6	7
6%	Yenilikçi Teknoloji	9	8	7	9	7
8%	Kişisel Tecrübeler	7	8	6	9	8
3%	Kullanıcı Deneyimi	8	7	6	8	7
5%	Yaratıcı Tasarım	9	8	7	5	6
3%	Sürdürülebilirlik	6	7	5	8	7
6%	Satış Sonrası	7	9	6	9	8

Vikor yönteminin ikinci adımı olarak en iyi (f^*) ve en kötü (f^-) değeri belirlenmiştir ve Tablo 2.2’de verilmiştir.

Üçüncü adım olarak normalizasyon işlemine başlanmıştır ve karar matrisinin her bir kriter ve her bir seçenek hücresine karşılık gelen değerler normalleştirilmiştir. Normalizasyon işlemleri için aşağıdaki formüller kullanılmıştır ve normalize matris oluşturulmuştur. Kriter maksimizasyonu temsil ediyorsa 1.’ci, kriter minimizasyonu temsil ediyorsa 2.’ci formül kullanılacaktır.

Tablo 2.2. En iyi ve en kötü değerler

Ağırlık	Kriterler	f^* En iyi	f^- En kötü
10%	Satış Fiyatı	3	10
3%	Km Başına Maliyet	5	9
3%	Ses	3	7
3%	Titreşim	5	8
5%	Sürüş Konforu	9	4
4%	Kullanım Kolaylığı	10	5
3%	Bakım Maliyeti	6	9
8%	Batarya Ömrü	9	6
7%	Şarj Hızı	9	8
5%	Menzil	9	7
5%	Şarj İst. Erişimi	10	6
2%	Çevre Dostu	10	5
4%	Devlet Teşviği	10	5
7%	Marka Değeri Algısı	8	6
6%	Yenilikçi Teknoloji	9	7
8%	Kişisel Tecrübeler	9	6
3%	Kullanıcı Deneyimi	8	6
5%	Yaratıcı Tasarım	9	5
3%	Sürdürülebilirlik	8	5
6%	Satış Sonrası	9	6

$$r_{ij} = (x_{ij} - x_j^-) / (x_j^* - x_j^-) \quad (1)$$

$$r_{ij} = (x_j^* - x_{ij}) / (x_j^* - x_j^-) \quad (2)$$

Dördüncü adım olarak normalizasyon matrisinin ağırlıklandırılması işlemine başlanmıştır ve normalize matrisin her bir kriter ve her bir seçenek hücresine karşılık gelen değerler daha önce belirlenen ağırlıklar ile çarpılmıştır. Ağırlıklandırma işlemi için aşağıdaki formül kullanılmıştır ve Tablo 2.3'te ağırlıklandırılmış normalize matris oluşturulmuştur.

$$V_{ij} = r_{ij} \times W_{ki} \quad (3)$$

Beşinci adım olarak seçeneklere ait S_i ve R_i değerleri hesaplanmıştır. Bu değerler hesaplanırken aşağıdaki formüllerden yararlanılmıştır.

$$S_i = \sum_j^n w_j * (f_j^* - x_{ij}) / (f_j^* - f_j^-) \quad (4)$$

$$R_i = \max (W_j * (f_j^* - x_{ij}) / (f_j^* - f_j^-)) \quad (5)$$

Daha sonrasında S_i ve R_i değerlerinin her biri için en iyi değer olan S_i^* ve R_i^* değerleri ve en kötü değer olan S_i^- ve R_i^- değerleri belirlenmiştir.

Tablo 2.3. Ağırlıklandırılmış normalize matris

Ağırlık	Kriterler	Çin Menşei EA	Türkiye Menşei EA	Vietnam Menşei EA	Japonya Menşei EA	G.Kore Menşei EA
10%	Satış Fiyatı	0.10	0.06	0.01	0.00	0.01
3%	Km Başına Maliyet	0.02	0.02	0.00	0.03	0.01
3%	Ses	0.02	0.02	0.00	0.03	0.02
3%	Titreşim	0.01	0.00	0.00	0.03	0.01
5%	Sürüş Konforu	0.04	0.04	0.00	0.05	0.03
4%	Kullanım Kolaylığı	0.02	0.02	0.00	0.04	0.02
3%	Bakım Maliyeti	0.02	0.03	0.00	0.00	0.00
8%	Batarya Ömrü	0.08	0.05	0.00	0.08	0.05
7%	Şarj Hızı	0.00	0.00	0.00	0.07	0.00
5%	Menzil	0.05	0.05	0.00	0.03	0.00
5%	Şarj İst. Erişimi	0.05	0.04	0.00	0.01	0.01
2%	Çevre Dostu	0.00	0.01	0.01	0.02	0.01
4%	Devlet Teşviği	0.02	0.04	0.00	0.01	0.01
7%	Marka Değeri Algısı	0.07	0.07	0.00	0.00	0.04
6%	Yenilikçi Teknoloji	0.06	0.03	0.00	0.06	0.00
8%	Kişisel Tecrübeler	0.03	0.05	0.00	0.08	0.05
3%	Kullanıcı Deneyimi	0.03	0.02	0.00	0.03	0.02
5%	Yaratıcı Tasarım	0.05	0.04	0.03	0.00	0.01
3%	Sürdürülebilirlik	0.01	0.02	0.00	0.03	0.02
6%	Satış Sonrası	0.02	0.06	0.00	0.06	0.04

Çin menşei EA, Türkiye menşei EA, Vietnam menşei EA, Japonya menşei EA ve Güney Kore menşei EA için hesaplanmış S_i değerleri 0,69 - 0,65 - 0,05 - 0,66 ve 0,35 olarak hesaplanmıştır. Aynı şekilde, Çin menşei EA, Türkiye menşei EA, Vietnam menşei EA, Japonya menşei EA ve Güney Kore menşei EA için hesaplanmış R_i değerleri 0,10 - 0,07 - 0,03 - 0,08 ve 0,05 olarak hesaplanmıştır. Bu değerler arasında en iyi S_i^* değeri 0,69 ve R_i^* değerleri 0,10 olarak görülmektedir. Aynı şekilde en kötü olan S_i^- değeri 0,05 ve R_i^- değerleri 0,03 olarak görülmektedir. Son olarak, Q_i değeri farklı olasılıklarda her bir seçenek için hesaplanmıştır.

$$Q_i = (q * (S_i - S^*) / (S^- - S^*)) + ((1 - q) * (R_i - R^*) / (R^- - R^*)) \quad (6)$$

Altıncı adımda seçeneklerin sıralaması Q_i değeri dikkate alınarak yapılacaktır ve Tablo 2.4'te gösterilmiştir. Koşulların denetlenmesi işlemi ile en iyi seçeneğe karar verilecektir ve Tablo 2.5'te gösterilmiştir.

Tablo 2.4. Sıralama yapılmış seçenekler

	0.00		0.25		0.50		0.75		1.00			
	Qi	Sıra	Qi	Sıra	Qi	Sıra	Qi	Sıra	Qi	Sıra	Si	Ri
Çin EA	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.69	0.10
Türkiye EA	0.40	3	0.32	3	0.23	3	0.15	3	0.06	2	0.65	0.07
Vietnam EA	1.00	5	1.00	5	1.00	5	1.00	5	1.00	5	0.05	0.03
Japonya EA	0.27	2	0.21	2	0.16	2	0.11	2	0.06	3	0.66	0.08
G Kore EA	0.62	4	0.60	4	0.58	4	0.55	4	0.53	4	0.35	0.05

Tablo 2.5. Koşulların denetlenmesi ve karar

	Çin Menşei EA	Türkiye Menşei EA	Vietnam Menşei EA	Japonya Menşei EA	G Kore Menşei EA
Q(A2)	0.27	0.21	0.16	0.11	0.06
Q(A1)	0.00	0.00	0.00	0.00	0.00
Q(A2)-Q(A1)	0.27	0.21	0.16	0.11	0.06
DQ	0.25	0.25	0.25	0.25	0.25
Kabul	Evet	Hayır	Hayır	Hayır	Hayır

Çalışmanın ikinci bölümünde Topsis yöntemi uygulaması yapılmıştır. Topsis yöntemi uygulamasının ilk adımı olarak, karar matrisinin hazırlanmasıdır. Çalışmanın birinci bölümünde uygulana Vikor yönteminde kullanılan Tablo 2.1 karar matrisi olarak Topsis yönteminde de kullanılmıştır.

İkinci adım olarak karar matrisinin normalize işlemi yapılmıştır. Normalize işlemi için aşağıdaki 7 numaralı formül kullanılmıştır. Her bir kriterin her bir seçenek için R_{ij} değeri hesaplanmıştır.

$$R_{ij} = a_{ij} / \sqrt{\sum_{i=1}^m a_{ij}^2} \quad (7)$$

Ardından üçüncü adım olarak normalize edilmiş matris ağırlıklandırılmış matrise dönüştürülmelidir. Bunun için 8 numaralı formül kullanılmıştır.

$$V_{ij} = r_{ij} \times W_{Ki} \quad (8)$$

Dördüncü adımda, S^* gibi pozitif ideal çözüm ve S^- gibi negatif ideal çözüm değerleri belirlenmiştir. Ağırlıklandırılmış normalize matris değerleri ve S^*, S^- gibi pozitif ideal ve negatif ideal değerleri Tablo 2.6’da verilmiştir.

Tablo 2.6. Ağırlıklandırılmış normalize matris

Ağırlık	Kriterler	Çin Menşei EA	Türkiye Menşei EA	Vietnam Menşei EA	Japonya Menşei EA	G Kore Menşei EA	S^*	S^-
10%	Satış Fiyatı	0.073	0.051	0.029	0.022	0.029	0.07	0.02
3%	Km Başına Maliyet	0.015	0.013	0.009	0.017	0.011	0.02	0.01
3%	Ses	0.015	0.013	0.008	0.018	0.013	0.02	0.01
3%	Titreşim	0.013	0.011	0.011	0.018	0.013	0.02	0.01
5%	Sürüş Konforu	0.024	0.024	0.012	0.027	0.021	0.03	0.01
4%	Kullanım Kolaylığı	0.017	0.017	0.012	0.024	0.017	0.02	0.01
3%	Bakım Maliyeti	0.015	0.017	0.011	0.011	0.011	0.02	0.01
8%	Batarya Ömrü	0.040	0.035	0.027	0.040	0.035	0.04	0.03
7%	Şarj Hızı	0.031	0.031	0.031	0.034	0.031	0.03	0.03
5%	Menzil	0.025	0.025	0.019	0.022	0.019	0.03	0.02
5%	Şarj İst. Erişimi	0.028	0.025	0.017	0.020	0.020	0.03	0.02
2%	Çevre Dostu	0.006	0.009	0.008	0.012	0.008	0.01	0.01
4%	Devlet Teşviği	0.018	0.026	0.013	0.015	0.015	0.03	0.01
7%	Marka Değeri Algısı	0.035	0.035	0.027	0.027	0.031	0.04	0.03
6%	Yenilikçi Teknoloji	0.030	0.027	0.023	0.030	0.023	0.03	0.02
8%	Kişisel Tecrübeler	0.033	0.037	0.028	0.042	0.037	0.04	0.03
3%	Kullanıcı Deneyimi	0.015	0.013	0.011	0.015	0.013	0.01	0.01
5%	Yaratıcı Tasarım	0.028	0.025	0.022	0.016	0.019	0.03	0.02
3%	Sürdürülebilirlik	0.012	0.014	0.010	0.016	0.014	0.02	0.01
6%	Satış Sonrası	0.024	0.031	0.020	0.031	0.027	0.03	0.02

Beşinci adım olarak seçeneklerin pozitif ideal ve negatif ideal noktalarına olan uzaklıkları hesaplanmıştır, Bunun için aşağıdaki 9 numaralı ve 10 numaralı formüllerden yararlanılmıştır. En iyi alternatife karar verilmesi için C_i^* değeri hesaplanmıştır ve sıralama büyükten küçüğe olacak şekilde yapılmıştır. Tablo 2.7’de karar için sıralama yapılmıştır.

Tablo 2.7. Sıralama tablosu

Seçenekler	S_i^*	S_i^-	C_i^*	Sıralama
Çin Menşei EA	0.019	0.060	0.760	1
Türkiye Menşei EA	0.027	0.043	0.615	2
Vietnam Menşei EA	0.059	0.010	0.142	5
Japonya Menşei EA	0.055	0.035	0.388	3
G Kore Menşei EA	0.050	0.022	0.301	4

$$S_i^* = \sqrt{\sum_{j=1}^n (V_{ij} - V_j^*)^2} \quad (9)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (V_{ij} - V_j^-)^2} \quad (10)$$

$$C_i^* = S_i^- / (S_i^- + S_i^*) \quad (11)$$

2.2. Uygulama Sonuçları

Çalışmanın ilk bölümünde uygulanan Vikor yöntemine göre çalışmayı konu alan 5 farklı seçenek arasında en iyi seçeneğin Çin üretimi elektrikli araç olduğu gözlemlenmiştir. Kullanıcı tercihlerine göre Vikor yöntemi ile yapılacak bir seçim, Çin üretimi elektrikli araç ile en iyi sonucu verecektir. Çalışmanın ikinci bölümünde uygulanan Topsis yöntemine göre çalışmayı konu alan 5 farklı seçenek arasında en iyi seçeneğin yine Çin üretimi elektrikli araç olduğu gözlemlenmiştir. Topsis yöntemine göre, ikinci en iyi seçenek Türkiye’de üretilen elektrikli araç olarak hesaplanmaktadır. Kullanıcı tercihlerine göre yapılacak bir sıralamada üçüncü sırada Japonya’da üretilen elektrikli araç, dördüncü sırada Güney Kore’de üretilen elektrikli araç ve beşinci sırada ise Vietnam’da üretilen elektrikli araç bulunmaktadır.

3. SONUÇ

- İklim değişikliğini tetikleyen, verimliliği düşüren ve sürekli artan fiyatlarda piyasaya sunulan petrol ile kullanım maliyeti önemli ölçüde olumsuz yönde etkilenen fosil yakıtlı araçlara bir alternatif olarak son yıllarda yaygınlığı artan elektrikli araç üretimi ve elektrikli araç satın alma eğilimleri bu çalışmada detaylı olarak incelenmiştir.
- Çalışmada, kullanıcıların elektrikli araçları tercih etmelerindeki itici gücü saptayabilmek adına literatürde belirlenmiş kriter arasında 20 tanesi ile ve Asya pazarında faaliyet gösteren 5 farklı elektrikli araç üreticisi marka ile çok kriterli karar verme uygulamaları yapılandırılmıştır.

- En iyi seçeneğin seçimi için Vikor yöntemi ve en iyi seçeneklerin sıralanması için Topsis yöntemi kullanılmıştır.
- Sayısal veriler, konusunda uzman otomotiv profesyonellerinden karar verici pozisyonunda temin edilmiştir.
- Sayısal uygulamaların sonucunda hem Vikor hem de Topsis yöntemine göre en iyi seçeneğin Çin menşeli elektrikli araç olduğu gözlemlenmiştir. Bu sonucun en önemli etmenlerinden bir tanesi, karar vericiler tarafından %10 gibi bir değer olarak belirlenmiş en yüksek kriter ağırlığına sahip satış fiyatı rekabetçiliğidir. Çin’de üretilen elektrikli araç maliyet ve satış fiyatı bakımından diğer markalarda üstün konumdadır. Ayrıca satış fiyatı rekabetçiliğini %8 gibi bir ağırlık ile takip eden batarya ömrü uzunluğunda da Çin menşeli elektrikli araç rekabetçilerinden daha üstün konumdadır.
- Ülkemizde üretimi gerçekleştirilen elektrikli aracın Topsis yöntemine göre yapılan hesaplamalarda Çin üretimi araçtan sonra en iyi seçenek olması çalışmanın bir diğer dikkat çekici özelliğidir. Gelişmeye açık yönlerinin yanında Japonya, Güney Kore gibi ülkelerde uzun yıllardır elektrikli araç üretimi gerçekleştiren markalardan daha iyi bir seçenek ile karşımıza çıkması önemli bir detaydır.

KAYNAKÇA

- Barbarossa, C., Beckmann, S. C., De Pelsmacker, P., Moons, I., & Gwozdz, W. 2015. A self-identity based model of electric car adoption intention: Across cultural comparative study. *Journal of Environmental Psychology*, 42, 149–160. <https://doi.org/10.1016/j.jenvp.2015.04.001>
- Carley, S., Krause, R. M., Lane, B. W., & Graham, J. D. 2013. Intent to purchase a plug-in electric vehicle: A survey of early impressions in large US cities. *Transportation Research Part D: Transport and Environment*, 18(1), 39–45. <https://doi.org/10.1016/j.trd.2012.09.007>
- Erdem, C., Şentürk, I., & Şimşek, T. 2010. Identifying the factors affecting the willingness to pay for fuel-efficient vehicles in Turkey: A case of hybrids. *Energy Policy*. <https://doi.org/10.1016/j.enpol.2010.01.043>
- Kerem, A. 2014. Elektrikli Araç Teknolojisinin Gelişimi ve Gelecek Beklentileri. *Mehmet Akif Ersoy Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 5(1), 1–13.
- KPMG 2015 Türkiye Otomotiv Sektöründe Yeni Stratejik Yatırım Hedefleri.
- KPMG 2016 Türkiye Otomotiv Yöneticileri Araştırması.
- Lamba, N. ve Thareja, P. 2020. Developing the structural model based on analyzing the relationship between the barriers of Green supply chain management using TOPSIS approach. *Materials Today: Proceedings*.
- Skippon, S., & Garwood, M. 2011. Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. *Transportation Research Part D: (40) 260 Transport and Environment*, 16(7), 525–531.
- Smith, B., Olaru, D., Jabeen, F., & Greaves, S. 2017. Electric vehicles adoption: Environmental enthusiast bias in discrete choice models. *Transportation Research Part D: Transport and Environment*. <https://doi.org/10.1016/j.trd.2017.01.008>

- Tunçel, N., Belbağ, S. ve Çimen, M. 2017. Satın alma kriterleri açısından marka sıralama kararının verilmesinde bulanık Electre I yöntemi: Otomobil sektöründe bir uygulama. Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi, 31 (5), 1069-1085.
- Uzel, E. 2015. Araç Kullanıcıların Temel Güdülerinin Elektrikli Araç Satın Alma Niyetine Etkisi: İstanbul'da Araç Kullanıcılar Üzerine Kantitatif Bir Çalışma. 20. Ulusal Pazarlama Kongresi (ss. 365–376). Eskişehir: Anadolu University.
- Zeger D., Eva, L. ve Filip, R. 1999. An evaluation of vendor selection models from a total cost of ownership perspective, *European Journal of Operational Research*, 125, 34-58.
- Zhang, Y., Yu, Y., & Zou, B. 2011. Analyzing public awareness and acceptance of alternative fuel vehicles in China: The case of EV. *Energy Policy*, 39(11), 7015–7024. <https://doi.org/10.1016/j.enpol.2011.07.055>

NARRATIVE OF INDIGENOUS COMMUNITY IN CANADA**Ananda MAJUMDAR**Connecting Research and Researchers

The University of Alberta (Bachelor of Education after Degree Elementary, Faculty of Education, Community Service-Learning Certificate and Certificate in International Learning, CIL) *
Harvard Graduate School of Education (Professional Education as a Child Development Educator, Certificate in Early Education Leadership (CEEL-Series 2), online) *
Book Pecker Fellow, Peace X, India (April 2021- September 2021, Online) *
Intern, Digital Museum and Diaspora, Migration, GRFDT, New Delhi, India (April 2021-Present, Online) Workshop in Babeş-Bolyai University (UBB), Faculty of Letters, Romania, Early Crisis of Christianity, 2022*
Certificate in Migration Studies, GRFDT, New Delhi, India (September 2020-March 2021, Online)
Grant MacEwan University (Diploma in HR Management)
Jadavpur University (Master of Arts in International Relations)
Sikkim Manipal University (Master of Business Administration in HR and Marketing Management)
MBB College, Tripura University (Bachelor of Arts in Political Science)
Antarctic Institute of Canada (Researcher and Writer), Servicing Community Internship Program (SCiP) Funded by the Government of Alberta
Member of Student Panel, Cambridge University Press,
Member of the Association of Political Theory (ATP) University of Massachusetts
Student Member of ESA (European Studies Association), Columbia University, U.S.
General Coordinator, Let's Talk Science, University of Alberta
Early Childhood Educator, Brander Garden After School Parents Association
ORCID ID: 0000-0003-3045-0056

ABSTRACT

The reading of the topic is about First Nations, their lifestyles, community culture, educational systems, the tale of grief and grieving, which has been discussed from its historical viewpoints to the modern day's scenarios. The scenarios of colonialism, racism, unfair practices, deprivation, unethical images, deletion of identities, many slurs' words (savage) and offensive attitudes, exploitations are the features of the topic that had been historically performed by a colonial power to the original communities of their land. "Suppress the native culture as rapidly as possible and fashion a new generation of Indian children raised in isolation from their parents, in the image of white men" (p.47). The quote reflects racial and colonial supremacy through a sophisticated educational system by the European colonial power. Historically through the world views and values of dealings and agreements, the European settled their jurisdictions and thus set up their own identities through the formation of the schooling system. This is how they diverted a traditional, innocent community into a new European system. Modern days scenarios are similar through the government-led policy objective of infusing Aboriginal knowledge and perspectives into mainstream school programs and curriculum. The objective of the topic is to explore Canadian Indigenous People and their colonial history through various colonial narratives such as the 'schooling system.' The methodology has been done through documentary analysis. The

outcome of the paper is about the understanding of Canadian Indigenous culture and norms through collective land ownership, schooling system and its annihilation by Indian act., residential school, school of missionaries etc. The feature question is how European Canadians settled their supremacy over the Indigenous Community of Canada and turned into a mainstream community.

Keywords: Residential School, School of Missionaries, Collective Land Ownership, Mother Nature, Healing, Indigenous Norms, First Nations, Indian Act. Proclamation, Traditional Education, Land Ownership, Colonization, Integration, Settlement.

Introduction: "Indian education in Canada is a very complex and intriguing subject" (Diamond, 1989, p. 86). It has been a subject for discussion since the Europeans came on the shores of Turtle Island. Several practices have been implemented by early settlers' societies, then by the Canadian government for the assimilation of the Indigenous people into the mainstream of Canadian society. It has been implemented to make Aboriginals civilized from a savage culture, according to the settlers. However, the First Nations Community of Canada had a very rich tradition to live in with nature, living by sharing each other. They thought collectively instead of individually. The land was their root to know them. The European Canadian government did not realize that glimpse of the tradition and traditional education. They implemented educational systems for the reformation of the Indigenous system. But it worked the opposite. It created First Nations Community mentally, physically, and emotionally sick. They could not be able to accept a new European system for their livelihood. Their educational and other practices were based on nature that lives in animals, trees, and landscapes. They are attached to anything that has sustainability. They govern the weather, hunt, the corps for life sustain. They are more than religion by representing them on behalf of heaven, on earth. They answer questions of death, life, nature, and medicine. They thus represent their culture, language, and many other narratives for an amalgamation throughout their life cycle (Indigenous Traditions, URI, n.d.). They are communities that are attached with their space and place as well. There is something to be said about the relationship between space and place. Often, where we are located geographically and the site in which we operate contribute greatly to the cultural goods, environmental glimpses we produce. both space and place are about the where of things, and their relative invocation has usually signalled different understandings of what were means, in this way we can amalgamate both. Understanding of land ownership as "similar to one owning air, nobody can own the air that we breathe" (Steinhauer, 2007). This is how space and place are connected to realize Indigenous environment and knowledge through universal-collective ownership.

Literature Review: This paper has described traditional activities by the Indigenous communities of North America. Healing is one of their best rituals through which they call their people for a gathering and meet. The paper also describes the traditional livelihood of Aboriginal communities, their educational system. The description of the paper shows its nobility about the Aboriginal Communities of Canada. They have been forcefully removed from their land, and thus European colonization started in North America. Europeans' activities have been reflected through racism everywhere in their world during their colonization. Racism in Canada originated throughout the starting exploitation of First Nations by European Settlers. Ideologies of race were an excuse by the colonizers over Indigenous people to make them civilized from a savage nature, as well as control over them for a sophisticated pathway. As a result, they have been forced to leave their land, they have been detached from their communities, families and they lost their culture through language lost. According to McCallum and Perry, "Indigenous people in such renderings of history have a very little role—removed or erased from the land to facilitate settlement and resource extraction" (McCallum & Perry 2018, p. 5-6). The 1876 Indian Act was created for the control of the First Nations People and to assimilate them into the mainstream Canadian culture. It was a way to destroy their ownership and to become followers of the new world created by the European settlers (Fonseca, 2020).

Methodology: The methodology to write the paper has been taken by the description of sources, by reading, gathering in-depth insights on topics, focuses on exploring ideas, summarising, and interpreting and mainly expressed in words (documentary analysis through qualitative approach). This paper has discussed traditional lives, educational system, history of their life cycle, life circle and their cultural and linguistic identities. The paper has tried to focus on them through various aspects they can be known.

Result and Discussion: Aboriginal people lived in Canada for thousands of years before European settlers arrived, though they are only a small percentage of Canadians today. Native Canadian culture varies from nation to nation but tends to center around hunter-gather lifestyles, respect for nature, and rich mythologies to explain the natural world. They have sharing circle, which is helping each other. Throughout the circle, many terms have been explored for divine and collective togetherness among communities and with nature. The world is their mother nature. Sharing, spiritual, praying, smudge, listening, taking care, sharing, informative, confidential, development, growth, youth empowerment, mental strength, collectivity, holistic, balance, harmony are terms in the indigenous circling process in North America. Indigenous communities have been called as.

Métis: - Métis peoples are of mixed European and Indigenous ancestry and live mostly in the Prairie provinces and Ontario, but also in other parts of the country (Branch, 2009).

Inuit: -The Inuit primarily inhabit the northern regions of Canada (Branch, 2009).

First Nations: - First Nations peoples were the original inhabitants of the land that is now Canada, often occupying territories south of the Arctic (Branch, 2009).

Historical: Helping each other through circling and sharing is a historical aspect of an indigenous community that had been conducted through many ways such as spiritual ceremonies, wedding ceremonies, storytelling, etc.; this is how a greater understating, mutuality had been built within a community through a collective process. This is how the universality had been built for long-term growth and healing (Hart, 2002).

Physical: Circling process had many areas in the context of its structuring, such as unlimited people gathering(sometimes limited with restrictions such as women circling as indigenous women time for women importance and spirituality), many places for the gathering through unbroke circling in many layers(1st, 2nd, 3rd circling), sitting without a gap, processes like a smudge, then pray, then start sharing, ending prayers, strong presence, voluntary participation, speaking etc. no time limit for sharing, using stone while sharing stories, happiness, emotion and expressing through crying, laughing etc. No question or argument, respectful, listen, patient etc. (Hart, 2002).

Sharing Circle Process: Seated Towards the center; then wash bodies(smudge) for open mind or mind freshness to become positive and then start praying for the promise of belongingness, truth, reality, contact each other, listen respectfully, looking insides etc. this is how to make a co-operative environment (Hart, 2002).

Circle as emotional, mental, and spiritual reflection: Conducts through 4 levels. 3 out of 4 levels are to become healthy(therapeutic), which is healing. Start talking through level 1 to know the real hurt, then expressing emotion where trust is informed, working through painful memories through level 3rd and thus developing trust through the receiving of spiritual message. This is how an opportunity creates to become an extrovert through the expression of pain and joy (Hart, 2002).

Learning Process by Cree Community: Cree community uses this sharing circle for a greater understanding of community development which is a learning process. According to them,

everyone is a learner and a teacher and mutually shares their ideas to learn and teach (Hart, 2002).

An Aboriginal Worldview: One of the most important aspects through spirituality through which inclusion of prayer with many symbols (stones, feather) occurs, such as smudging ceremony for a sacred agreement with wilderness (Hart, 2002).

First Nations: They are the people whose ancestors lived in this land (the United States and Canada) before the arrival of Europeans. First Nations is a political term for the identification of Aboriginal people, as identity is one of the main features of ethnicity. They have many names such as Aboriginal, Indigenous, Indian, Cree etc. There are an estimated 600 First Nations in Canada, among them an estimated 46 from Alberta (Steinhauer, 2008, p 29).

Indian: Indigenous people of Canada are also called Indian under the Indian act. Which is a treaty. Indian act mentioned that who is a registered indigenous is called Indian. Indianness is a self-identification of Indigenous people in Canada. It separates them from the rest of Canadian communities for a unique status (Steinhauer, 2008, p.29).

Treaties: Legal texts between the Government of Canada and the Indigenous People of Canada through which rights have been preserved for the protection of Indigeneity. Western Treaty was made by the Crown of Great Britain and the First Nations Canada. The treaty was protected their rights on land, hunting, fishing, and trapping. To the Indigenous people, the treaty was a commitment (Steinhauer, 2008, p. 30).

Reserve: A territory that is only for Indigenous Communities. The reserve land had been vested by the Queen of England through which the Indigenous Community receives benefits (Steinhauer, 2008, p. 30).

History of the First Nations: Indigenous people lived in North America both in the United States and in Canada as a sovereign nation prior to the European agreement. They were self-sufficient, obtained everything from the environment, which is their mother nature. They were living in harmony and naturally sustained. Their lifestyle was nomadic. They move from place to place to live and enjoy the land. Nobody was the owner of the land. They love and respect other tribes, spend their livelihood through fishing, trapping, hunting and would share, among others.

⁶“There were literally millions of buffalo roaming the plains along the foothills and even into the Rocky Mountains themselves. There were game animals of all kinds—moose, elk, deer, wild sheep, and goats, readily available for hunting animals, but the hunt was never for the sake of killing them. . . . When we were in need of meat, when we were hungry, the medicine men of the tribe performed sacred ceremonies before the hunters went out” (Snow, 1977).

Their living lifestyle changed after the arrival of Europeans. Mutual respect, relations, interdependence, ideologies, traditionalism slowly changed. They have been controlled by the Europeans, and colonization started by the Europeans over First Nations People of North America. A newly Euro-Canadian Government launched in Canada where European education, laws, economy, and the power of church established. Oppression through racism, sexism, ableism started over the Indigenous Communities. The process of immigration from Europe started with the encouragement of the European ruler to capture all reserve lands and for the establishment of European settlement. The destruction of Indigeneity was their primary objective from Canada. Europeans were structured, well educated. Once they arrived in America, they started to apply their societal structure for the ownership of those lands. On the other side, Aboriginal people had no idea of private ownership of the land and resources. They have a collective relationship with nature, sky. According to the Aboriginal community owning land is like owning the sky, and nobody owns it. According to the Indigenous view, mother nature provides them foods, escapes them, which is a mutual relationship between nature and the Indigenous community. Therefore, it was impossible even to think about private ownership over land and resources. Europeans, on the other hand, we're thinking of the implementation of land ownership through trade, purchase or treaty for the land.

Royal Proclamation: In 1763 (Steinhauer, 2008, p. 34) British Monarch issued a Royal Proclamation for a permanent and stable relationship with the Aboriginal Communities. It opened the way to implement European trade, settlement, and purchase land on the Western Frontier; Canada was known as Western Frontier then. According to the Proclamation, it will protect Indian lands from the settlers, but it did not happen in reality. It had been said that due to this law, everyone was benefitted, but the Indigenous Community.

⁶ Parental School Choice in First Nations Communities: Is There Really a Choice? History of First Nations in Canada. Paragraph 1st. p. 33

Indian Act. ⁷“The Indian Act was unilaterally designed to abolish First Nations status as independent, self-governing peoples, legislating the rules for band membership, abolishing traditional political systems, imposing federally controlled election systems, banning spiritual activities, and creating residential schools” (Steinhauer, 2004, p. 16). It was the legal document or law through which the federal government of Canada and indirectly provincial government were controlling First Nations People of Canada.

First Nations Education in Canada: After the creation of the treaty, it was the responsibility of the federal government to educate native children. First Nations Communities asked for the inclusion of education rights for their children. Because they realized that they must be educated for the continuation of their livelihood under a new ruler and its law. The government made educational approaches in the context of political gain. The government wanted to make the Indigenous children a labour force (Steinhauer, 2008, p.38).

Traditional Education: ⁸“For thousands of years Aboriginal peoples had a very effective education. We knew how to prepare our children to handle the challenges they would face when living on the land. The harshness of our environment imposed a discipline that produced resilient, proud, and self-reliant people. Then things changed” (Watt-Cloutier, 2000, p. 114). First Nations People had a highly developed educational system. Their classrooms were natural environments and communities. Adults were responsible for teaching their children how to live a good life (Steinhauer, 2008, p.38). “Learning was for living—for survival. Boys and girls were taught at an early age to observe and to utilize, to cope with and respect their environment” (Kirkness & Bowman, 1992, p. 6). Through observation and active participation, children “learned the nature of sources of their food, community, life relationships. They learned that everything in life was a matter of kinship with all nature” (Cajete, 2000b, p. 101). The education was based on environment, guidance, kinship, diversity, special status, ethical models, clear roles, customs and practices, recognition, unique ways of learning, community work, spirit (Steinhauer, 2008, p. 41).

Missionaries Education: Traditions seem right and natural to those who follow them, and seeing that we did not have schools, people from the south concluded that we needed them.

⁷ Parental School Choice in First Nations Communities: Is There Really a Choice? Indian Act. Paragraph 1st. p.35

⁸ Parental School Choice in First Nations Communities: Is There Really a Choice? Traditional Education. Paragraph 1st. P. 38

(Watt-Cloutier, 2000, p. 114). Building schools on the reserve lands was the first implementation of a formal treaty between the Aboriginal tribes and Canada on behalf of England. Churches were given authority to run those schools in the context of religion. The government and the church decided to remove children from their parents and train them into missionary school. The decision was due to their suspicion over the Indigenous traditional education (Steinhauer, 2008, p. 42-43).

Residential School: ⁹Rather than make us stronger, they tended to undermine our confidence and identity. (Watt-Cloutier, 2000, p. 115). ¹⁰“It was a policy designed to move communities, and eventually all Aboriginal peoples, from their helpless ‘savage’ state to one of self-reliant ‘civilization’ and thus to make Canada but one community—a non-Aboriginal, Christian one” (RCAP, 1996, p. 2). With the help of the missionary’s government started to recruit children from the aboriginal communities from their homes to the residential school. Parents had no idea about the residential school system, and they were initially encouraged to send their children. It was the government whose intention was “to prepare the children for a new way of life, make them give up accustomed beliefs, take white people as their models, and aspire to live as much like them as possible” (Buckley 1992, p. 48). Indian act. Law in the 1920s made it mandatory to attend residential school. From ages 3 to 16, children from the First Nations tribes were removed from their houses for the residential school. During the ten (10) months annual periods, they all were isolated from their parents and the rest of Canada. They were not permitted to speak their native language. They had to speak English or French. Students were punished if they spoke their own language. It was a policy by the government to integrate Indigenous children into mainstream Canadian society from their Indigenous status (Steinhauer, 2008, p. 45).

Integrated Education: Integrated Education was for the assimilation of mainstream Canadian society. The Residential School system was not that successful for the integration. Therefore, the government launched a new educational system called integrational pedagogy. According to Titley, "What the policy of integration meant in practice was that wherever possible Indian children would be enrolled in the predominantly white public schools operated by the provincial governments. Provincial education authorities concurred with this new departure and over the

⁹ Parental School Choice in First Nations Communities: Is There Really a Choice? Residential School. Paragraph 1st. p.43

¹⁰ Parental School Choice in First Nations Communities: Is There Really a Choice? Residential School. Paragraph 1st. p.43

following two decades the gradual transfer of large numbers of native children from all-Indian schools to integrated ones took place. By March 1968, the Minister of Indian Affairs was able to announce that over 50 per cent of Indian children of school age were attending schools operated by the provinces. The first major assessment of integrated education was carried out between 1964 and 1967 by a research group under Dr. H. Hawthorn of the University of British Columbia. . . . The report documented the alarmingly high drop-out rate of Indian students in school and showed that this rate intensified when Indians transferred to public schools” (Titley, 1980). In 1969 then Prime Minister of Canada Pierre Trudeau presented the White Paper on Indian Affairs to the parliament for the integration of the Indigenous community into mainstream Canada. On the other side, Indian Association issued a Red Paper for sovereignty. The Trudeau government withdrew the bill finally (Steinhauer, 2008, p. 47).

Indian Control of Indian Education: In 1972 federal government accepted the document for the recognition of First Nations control over their school. The federal government agreed that the Indigenous people must take control of their own education. However, recognition was not enough for the changes in Indigenous schooling in Canada. According to Brady, "Whereas the federal government may have agreed with the principle of Native control of Native education, it has done little to transfer legislative control over education to First Nations Government. . . . The result is that the term 'band controlled' somewhat misrepresents reality. As long as legislative and legal authority continues to reside in non-Native legislative bodies, Native people's ability to control their children's education will be, to all intents and purposes, severely restricted” (Brady, 1995). In Alberta, Canada, First Nations, Metis, and Inuit Policy Framework (Alberta Learning, 2002) and the Alberta Commission on Learning offered potentialities on Aboriginal-led education. The provincial government funded the expansion of Aboriginal-led education. But whatever processes and methods are used for the implementation strategies does not show the complete autonomy of Aboriginal people (Steinhauer, 2008, p. 49).

Conclusion: The feature question is how European Canadians settled their supremacy over the Indigenous Community of Canada and turned into a mainstream community. Indian act. It was a law through which European settlers settled their supremacy over innocent First Nations Canadians who had no idea about settlement, private land ownership and about many things. The agreement they settled between the First Nations and the European rulers was false. It was a paper to control the Indigenous communities, and through the educational system, government tried to integrate children of the Aboriginal Community into mainstream Canadian society. The

learning of English and French language was one of the mediums through government tried to detach them from their own language. As a result, they would also lose their identity and culture. The Indigenous peoples have been changed with severe destruction of their culture and identities. They have been faced cultural disturbances through which their well-being reduced and created confusion on identity loss (Aboriginal Canadians and European Settlers - PHDessay.com, 2017). Another question raises on the theme of residential schools, such as, what should the present generation of children know about the residential school system? Children need to know about residential schools. They have a responsibility because they are learning and growing up with the truth. It is crucial to understand the plight of indigenous peoples in our society today. Every Child Matters, as they grow older, they will realize that was shameful, horrific holocaust of the innocent, (just like the holocaust by Nazi) taking from their families just to be killed. They will know and understand that churches are not what they're supposed to do. The older they get, they will be asking more serious questions and demand more transparency with why. Representation of residential school has the idea of resilience, which is so powerful, and it's something that kids can identify with. It is also essential to deal with the tough stuff in age-appropriate ways. Therefore, the age (7-10) according to this discussion is appropriate for the students to talk more in-depth about the devastating ripple effect that the abuse and loss of culture have on indigenous communities, though the lesson should be started from an early age. By making stories about residential schools relatable, kids can understand in their hearts, as well as their brains. It's overwhelming when you hear those kids were taken from their families, so it is important to educate and connect the students with one child and create resonance in students' minds. Therefore, it is a recognition of indigenous culture and adaptation by reading, learning, and listening. There shouldn't be a timetable for education, realization, and multi-ethnic adjustment.

References:

- 1) Aboriginal Canadians and European Settlers - PHDessay.com. (2017, February 1). Free Essays - PhDessay.com. <https://phdessay.com/aboriginal-canadians-and-european-settlers/>
- 2) Defence, N. (2018, April 12). The Arrival of the Europeans: 17th Century Wars. Aem. <https://www.canada.ca/en/department-national-defence/services/military-history/history-heritage/popular-books/aboriginal-people-canadian-military/arrival-europeans-17th-century-wars.html>
- 3) Steinhauer, E. (2008). Parental school choice in First Nations communities: is there really a choice. VDEM Verlag Dr. Müller Aktiengesellschaft & Co. KG.
- 4) Hart, M. (2002). Seeking mino-pimatisiwin: an aboriginal approach to helping. Fernwood.
- 5) Fonseca, S. (2020, May 15). Institutional Racism in Canada: Indigenous Lived Realities [Review of Institutional Racism in Canada: Indigenous Lived Realities]. The University of Toronto. <https://jps.library.utoronto.ca/index.php/society/article/view/34003/26078>

- 6) Branch, G. of C. I. and N. A. C. C. (2009, January 12). Indigenous peoples and communities. Www.rcaanc-Cirnac.gc.ca. <https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303>
- 7) Indigenous Traditions | URI. (n.d.). Www.uri.org. Retrieved December 1, 2021, from <https://www.uri.org/kids/world-religions/indigenous#:~:text=Indigenous%20Traditions%20Some%20spiritual%20practices%20are%20so%20much>

BİR OTONOM TARIMSAL İNSANSIZ KARA ARACI İÇİN GÖVDE TASARIMI VE YAPISAL ANALİZİ

Mustafa AYDIN

Pamukkale University, Faculty of Technology, Automotive Engineering Department, Kınıklı Campus
ORCID ID: 0000-0002-6187-6722

Adil Can KAYA

Pamukkale University, Faculty of Technology, Automotive Engineering Department, Kınıklı Campus

ÖZET

Son yıllarda tarımsal üreticiler; tarımsal işçi erişiminin belirsizliği, güvenli, erişilebilir ve yüksek kaliteli tarımsal ürünler konusunda artarak devam eden müşteri talebi, uluslararası üreticilerle olan rekabet ve karbon ayak izinin azaltılması ihtiyacı nedeniyle önemli zorluklarla karşı karşıyadır. Üreticilerin rekabetçi ve karlı üretimi devam ettirebilmeleri teknolojiye yatırım yaparak işçi maliyetlerini düşürüp, verimi arttırmalarından geçmektedir. Otonom tarımsal araçlar tarımsal arazideki proseslerin otonom hale getirilmesi, verimliliğin artırılması, bahçe yönetimi konusunda alınan kararlar için gerekli verilerin toplanması, işletme giderlerinin ve karbon ayak izinin azaltılması konularında önemlidir. Ülkemizde tarımsal üretimde yabancı otlar nedeniyle %20-30 oranında verim kaybı meydana gelmektedir. Yabancı otların yaygınlık ve yoğunlukları ile zarar oranları ve mücadelelerine yönelik çalışmalar önem kazanmıştır. Tarım ürünlerinin arzu edilen miktar ve kalitede üretilebilmesi, bu ürünlerin hastalık, zararlı ve yabancı otlardan korunabilmesi için çeşitli mücadele yöntemleri geliştirilmiştir. Bu mücadele yöntemleri ve teknikleri içinde en başta geleni en kolay uygulanan ve en ekonomik olan kimyasal mücadeledir. Bu çalışmada tarımsal arazilerde değişken düzeyli ilaçlama sistemini taşımak için otonom tarımsal insansız kara aracı (TIKA) için araç gövde tasarımı ve yapısal analizi yapılmıştır. Otonom tarımsal kara aracının görevini yerine getirebilmesi için gereken elektronik ve mekanik ekipmanların gövde üzerindeki konumları, gövde üzerindeki bağlantı noktalarında ve taşıyıcı elemanlar üzerinde oluşacak kuvvet ve gerilmeler sonlu elemanlar yöntemi ile analiz edilmiştir. Değişik arazi koşullarında otonom ilaçlama görevini yapabilecek araç için Al6063 malzeme ile 25x25x1.5 mm kare profiller kullanılarak gerçekleştirilen gövde tasarımının analiz sonuçlarına göre, 1750 N yük altında araç şasisinde oluşan maksimum Von-Mises gerilmesi 115.4MPa ve 2.09 mm yer değiştirme değerleri elde edilmiştir. Bu yer değiştirme miktarı uygulanan gerilmeler ve kuvvetler göz önüne alındığında kabul edilebilir seviyede olduğu ve herhangi bir deformasyona sebep olmadan kendi ekipmanlarını ve yararlı yükleri rahatlıkla taşıyabileceği tespit edilmiştir.

Anahtar Kelimeler: Otonom TIKA, Sonlu elemanlar, Statik analiz

HULL DESIGN AND STRUCTURAL ANALYSIS FOR AN AUTONOMOUS AGRICULTURAL UNMANNED GROUND VEHICLE

ABSTRACT

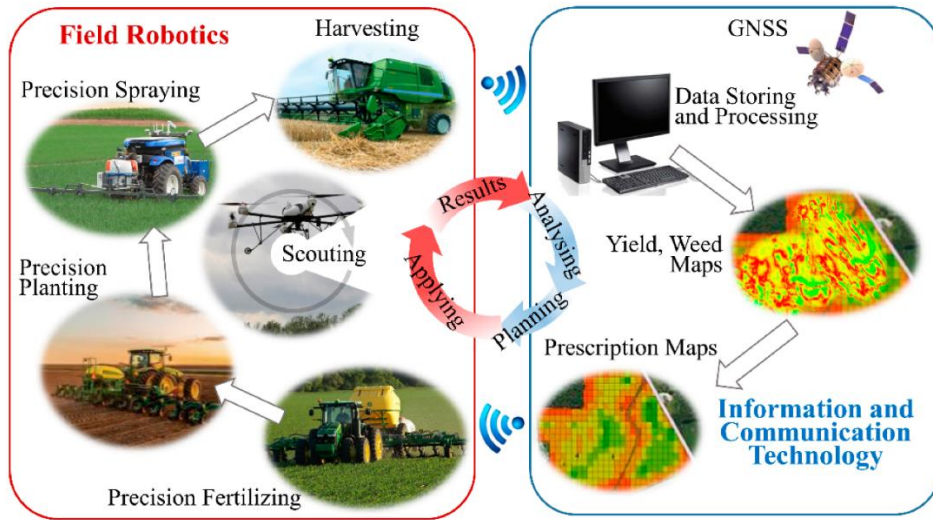
In recent years, agricultural producers; It faces significant challenges due to uncertainty of access to agricultural workers, increasing customer demand for safe, accessible and high-quality agricultural products, competition with international producers and the need to reduce carbon footprint. In order for manufacturers to maintain competitive and profitable production, they need to reduce labor costs and increase efficiency by investing in technology. Autonomous agricultural vehicles are important in making agricultural processes autonomous, increasing efficiency, collecting the necessary data for decisions about garden management, and reducing operating expenses and carbon footprint. In our country, 20-30% productivity loss occurs in agricultural production due to weeds. Studies on the prevalence and density of weeds, their damage rates and their control have gained importance. Various control methods have been developed to produce agricultural products in the desired quantity and quality and to protect these products from diseases, pests and weeds. Among these control methods and techniques, the most important one is chemical control, which is the easiest to apply and the most economical. In this study, vehicle body design and structural analysis were carried out for the autonomous agricultural unmanned ground vehicle (UGV) to carry the variable level spraying system in agricultural lands. The positions of the electronic and mechanical equipment on the body required for the autonomous agricultural land vehicle to fulfill its mission, the forces and stresses that will occur at the connection points on the body and on the carrier elements were analyzed using the finite element method. According to the analysis results of the body design, which was made using aluminum 6063 material and 25x25x1.5 mm square box profiles for the vehicle that can perform autonomous spraying in different terrain conditions, the maximum Von-Mises stress on the vehicle chassis under a load of 1750 N was 115.4MPa and displacement values of 2.09 mm were obtained. This amount of displacement is at an acceptable level considering the applied stresses and forces, and it has been determined that it can easily carry its own equipment and useful loads without causing any deformation.

Keywords: Autonomous UGV, Finite elements, Static analysis

1. GİRİŞ

Çoğunlukla otonom veya robotik tarım araçları olarak adlandırılan insansız tarım araçları, tarım sektöründe insan müdahalesi olmadan çeşitli görevleri yerine getirebilen gelişmiş tarım ekipmanlarıdır. Şekil1'de tarımsal alanda farklı amaçlar için kullanılan tarımsal robot

teknolojileri görülmektedir. Ülkemizde ve dünyada yaşanan iklim değişikliği ve kuraklık gibi olumsuz etkiler nedeniyle tarımsal üretimin daha verimli yapılabilmesi, zararlı böcek ve bitkilerle mücadele, verimli sulama, akıllı hasat gibi tarımsal faaliyetlerin otonom bir şekilde yürütülmesine yönelik akademik ve endüstriyel birçok çalışma vardır. Otonom tarımın avantajları, literatüre bakıldığında şu şekilde sıralanabilir: tarlada hassas konum takibi yaparak işleme esnasında yakıt, tohum, gübre ve ilaç verimliliğini artırma (Türker ve ark.2015), (Bechar ve Vigneault,2017), sürücü üzerindeki yükü azaltma, tarım için gereken işçi sayısını azaltma (Sneha vd,2015)(Gölbol, 2020), günün 24 saatinde çalışabilme (Bechar ve Vigneault, 2017) tarım alanı hakkında tutulan kayıtlar ile alana uygun tarımsal faaliyet yürütme ve tarımsal uygulamaları optimize etme (Weiss ve Biber 2011)(Heege, 2013).(Biber vd, 2012).



Şekil 9. Tarımsal robot teknolojileri (Gonzalez-De-Santos et al., 2020)

Otonom tarım araçları tarımsal üretim faaliyetlerinden, tohumlama, bitki yetiştirme, sulama, gübreleme, ilaçlama ve hasat gibi birçok farklı görevi yerine getirebilecek cihazlardır (Hülako ve Kapıcı, 2019) (Uz, 2019) (Şahin ve Kadioğlu 2021). Tarımsal faaliyet alanında yürütülecek görevlerin doğru zaman ve konumda hassas bir şekilde yürütülebilmesi için tarımsal robotların sensörler, radar, lidar, kameralar ve GPS donanımları ile desteklenmesi gereklidir (Keicher ve Seufert, 2000). Xue ve diğ. (2012) tarımsal robotun mısır tarlasında mısır sıraları arasında otonom şekilde gezinebilmesi için yeni bir değişken görüntü alanı kullanan yapay görme metodu geliştirmişlerdir. Kullanılan robot dört tekerlekli ve iki motorlu bir iskelete sahiptir. Biber ve diğ. (2012) lidar, imu ve gps sensörlerinden aldığı veriler ile tarla içinde sıraları

belirleme, sıralar içinde hareket ve haritalama gibi işlemler yapabilen Bonirob robotunu geliştirmişlerdir.

Otonom tarım araçları toprak analizi ve veri toplama gibi görevlerde de kullanılabilir ve böylelikle tarımsal üretim alanında yabancı ot temizleme, pestisit ilaçlama, mahsul sağlığının izlenmesi gibi çok çeşitli görevleri yerine getirebilirler. Amos ve Ruckelshausen (2014) geliştirdikleri tarımsal robot ile bitki sağlık durumu kontrolü, toprak analizi, hassas ilaçlama, yabancı ot kontrolü ve seçici hasat olmak üzere beş farklı görevin otonom şekilde yapılabilmesini sağlamışlardır.

Sonlu Elemanlar Yöntemi (Finite Element Method - FEM), karmaşık yapıların ve parçaların mühendislik analizlerini yapmak için yaygın olarak kullanılan bir sayısal analiz yöntemidir. Bu yöntem, karmaşık bir yapıyı daha küçük ve daha basit elemanlara böler ve her bir elemanın davranışını matematiksel olarak modellemek için denklem sistemlerini kullanır. Bu yöntem, taşıt gövdesi yapısal analizi gibi çeşitli uygulamalarda kullanılabilir. Otomotiv endüstrisinde, özellikle araç gövdelerinin yapısal bütünlüğünün, güvenliğinin ve performansının değerlendirilmesinde geniş bir uygulama yelpazesine sahiptir. Sonlu elemanlar yöntemi, taşıt gövdesinin mukavemetini ve dayanıklılığını optimize etmek, tasarım hatalarını tespit etmek ve ürün geliştirme sürecini hızlandırmak için kullanılan güçlü bir araçtır. Bu yöntem, taşıt gövdesinin karmaşıklığını, dayanıklılığını, mukavemetini, titreşim özelliklerini modellemek ve performansını artırmak için tasarım sürecini iyileştirmeyi amaçlar.

Tasarımın başlangıç aşamasında, fiziksel araçlar veya parçalar henüz mevcut olmadığı için gerçek dünyada fiziksel denemeler yapma imkânı yoktur. Sadece araca ait parçaların bilgisayar ortamında oluşturulmuş geometrik verileri bulunur. Bu noktada bilgisayar destekli tasarım ve sonlu elemanlar yöntemi büyük önem taşır. Tasarım esnasında; araç dayanım, çarpışma güvenliği ve gürültü titreşim özellikleri arasında çok sayıda optimizasyon yapılır (Çınar, 2015, Çınar 1986, Zhong, 1993).

Nefske ve diğ. (1982), duvar panellerinin yapısal titreşimleri tarafından üretilen düşük frekanslı gürültüye özellikle vurgu yaparak, otomobil yolcu bölmelerinin akustiğini analiz etmek ve anlamak için sonlu elemanlar yöntemini kullanmışlardır.

Farrafı ve diğ. (2020), standartlaştırılmış sürüş manevralarının neden olduğu dinamik yükler altında araç gövdesi dayanıklılığının ve nokta kaynak arızalarının analizini sonlu elemanlar yöntemiyle yaparak, analizde doğru modellemenin ve külçe çapının önemini vurgulamışlardır.

Arı ve Esen (2022) dört araçlı bir metro sisteminin tasarımını ve sonlu elemanlar yöntemi kullanılarak araç gövdesinin yapısal analizini yapmışlardır. Analiz sonuçlarına göre tampon bölgesinde gerekli gerilme koşullarının karşılanmasını sağlayacak tasarım revizyonları önermişlerdir.

2. ARAŞTIRMA VE BULGULAR

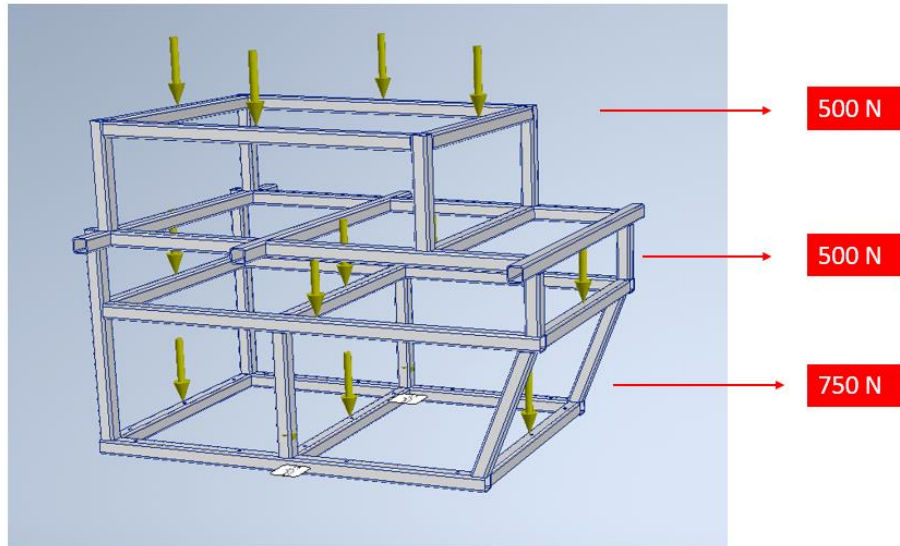
2.1. TİKA Gövde Tasarımı

Bu çalışmada tarımsal arazilerde değişken düzeyli ilaçlama sistemini taşımak için otonom tarımsal insansız kara aracı (TIKA) için araç gövde tasarımı ve yapısal analizi yapılmıştır. Otonom tarımsal kara aracının görevini yerine getirebilmesi için gereken elektronik ve mekanik ekipmanların gövde üzerindeki konumları, gövde üzerindeki bağlantı noktalarında ve taşıyıcı elemanlar üzerinde oluşacak kuvvet ve gerilmeler sonlu elemanlar yöntemi ile analiz edilmiştir. TİKA otonom görev yapabilme kabiliyeti için ihtiyaç duyduğu GPS, lidar, kamera, ultrasonik mesafe sensörü, ana kontrol ünitesi gibi elektronik ekipmanların yanında yabancı otlarla mücadele için kullanılacak olan ilaç deposu ve püskürtme sistemi gibi ilaçlama sistemi ekipmanları ve elektriksel besleme güç ihtiyacı için kullanılan batarya, güneş paneli ve gerilim dönüştürücü devreler ile birlikte toplam ağırlık değeri hesaplanmıştır. Elde edilen ağırlık değeri 26.7 kg olup tasarlanacak araç gövdesinin bu ağırlığı herhangi bir deformasyona maruz kalmadan taşıyabilmesi, nemli ortamlar gibi değişik çalışma koşullarında paslanma ve korozyona maruz kalmaması amacıyla gövde malzemesi olarak hafif ve dayanıklı bir malzeme olana AL6063 malzeme seçilmiştir. Tasarlanan araç şasisinin kütlesi 6,1 kilogramdır. Şasi ağırlığının düşük olması motor performansını artırıp, bataryanın sağlayabileceği enerji süresini uzatmıştır. Ayrıca aracın taşıyabileceği faydalı yük miktarı da artmıştır. Şasiyi tasarımında tercih edilen alüminyum 6063 malzemenin mekanik özellikleri Tablo 1’de verilmiştir.

Tablo 3. Alüminyum 6063 Mekanik Özellikleri (İnt. 1)

Temper	Akma Mukavemeti (MPa)	Çekme Mukavemeti (MPa)	Uzama (%50)	Sertlik (brinel)
-	min-max	min-max	min-max	min-max
0	50	100	26	25
T1	90	150	24	45
T4	90	160	21	50
T5	110-175	150-215	12	60
T6	170-210	205-245	12	75
T8	240	260	9	80

TIKA gövdesi için oluşturulan gövde tasarımı ve analiz için uygulanan kuvvetler Şekil 2’de verilmiştir.

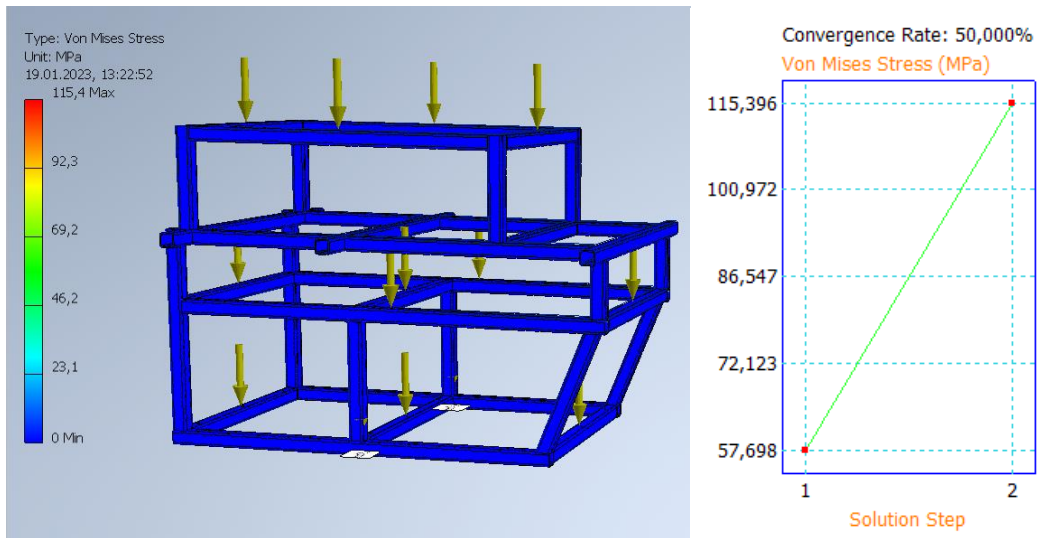


Şekil 2. TİKA gövde tasarımı ve uygulanan kuvvetler.

TIKA üzerinde bulunan bileşenlerin ilaçlama deposu ve ilaçlama sıvısı dahil olmak üzere toplam kütlesi 26.7 kilogramdır elimizde bulunan bu veriye göre aracın maruz kalacağı maksimum yükte statik analiz yapılmıştır. Verilen görsele göre; 1. Kompartıman: 76,5 kg, 2. Kompartıman: 51 kg, 3. Kompartıman: 51 Kg olmak üzere; araca toplam 178,5 kütle etki etmiştir. (yerçekimi ivmesi $9,8 \text{ m/s}^2$ alınmıştır.)

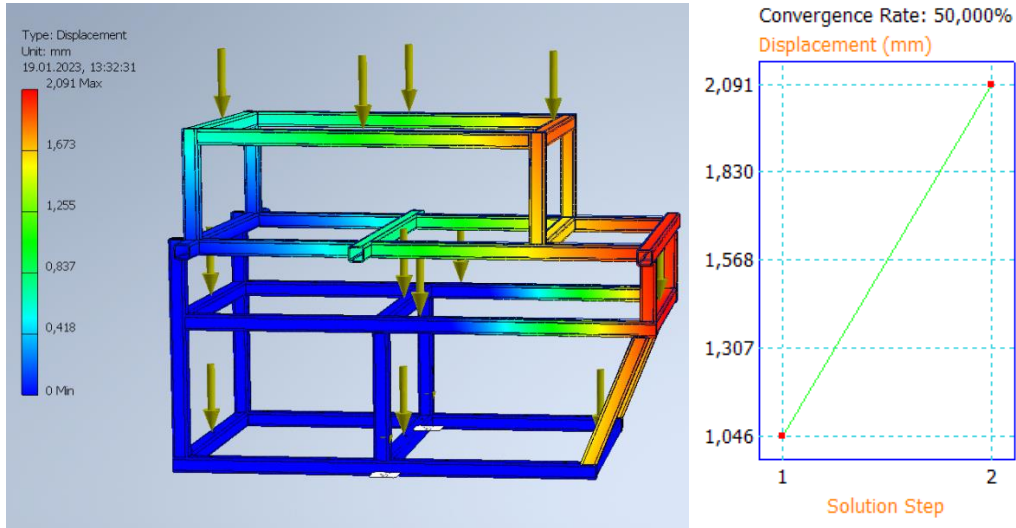
2.2. Deneysel Sonuçlar

2.2.1. Yapısal Analiz Sonuçları



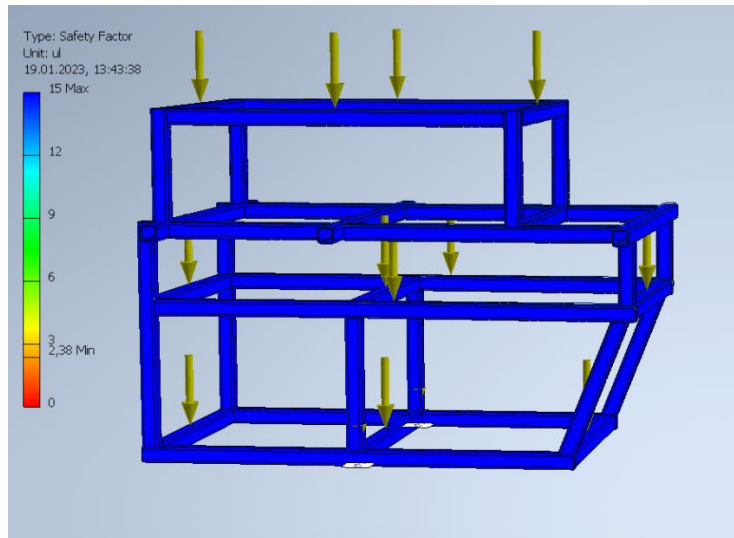
Şekil 3. Şasi Von Mises Gerilmesi

Statik analizde 1750 N uygulanan araç şasisinde oluşan maksimum Von Mises gerilmesinin 115.4 MPa olduğu Şekil 3'te görülmektedir. Şekil 4'te ise gövde üzerinde oluşan yer değiştirme miktarı görülmektedir.



Şekil 4. Şasi Yer değıştirme Miktarı

Oluşan maksimum yer değıştirme 2,09 mm'dir. Araç şasisinde meydana gelen bu yer değıştirme aracın ön bölgesinde meydana gelmiştir.



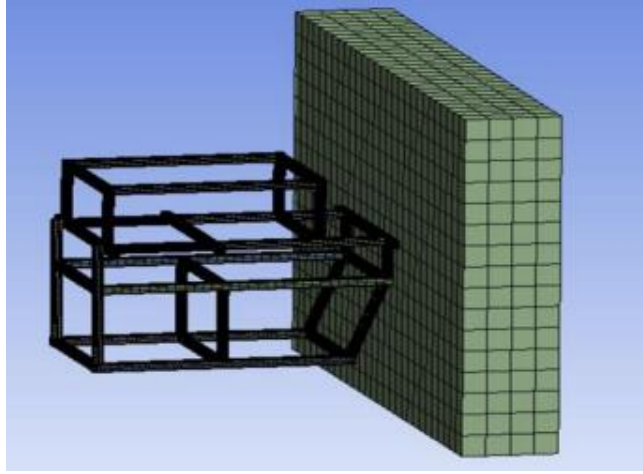
Şekil 5. Şasi Güvenlik Faktörü

Analiz sonuçlarına göre güvenlik faktörü minimum 2,38 ul çıkmıştır. Araç şasisinin maruz kaldığı maksimum yüke göre oluşan gerilme 115,4 Mpa dır. Alüminyum malzemenin çekme dayanımı ise 275 Mpa dır. Araç şasisinin güvenlik faktörü: $275 \text{ MPa} / 115,4 \text{ MPa} = 2,38$ olarak da hesaplanarak doğrulanmıştır.

2.2.2. Çarpışma Analizi Sonuçları

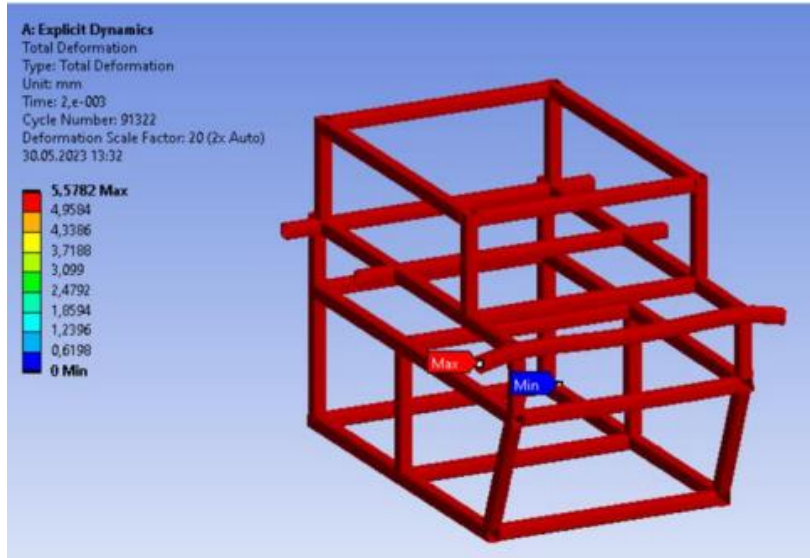
Araç şasisi ve çarpışma nesnesine ait datanın ANSYS programına aktarılmasıyla birlikte uygun mesh yapısı tanımlanmıştır. Meshleme sonucu 66444 düğüm sayısı ,61272 Eleman sayısı elde edilmiştir. Uygun mesh yapısı kriterlerine baktığımız zaman; her bir elemandaki b/a oranı en fazla 1/10 kabul edilir.0,85/12,32 Analizde bulunan a/b oranıdır. 6,1 kg olan araç şasisi sabit

duran çarpışma nesnesine doğru 20 km/h hız ile çarpılmaktadır Oluşan momentum; $P= 6,1\text{kg} \times 5,555 \text{ m/s} = 33,885 \text{ kg} \times \text{m/s}$ 'dir.



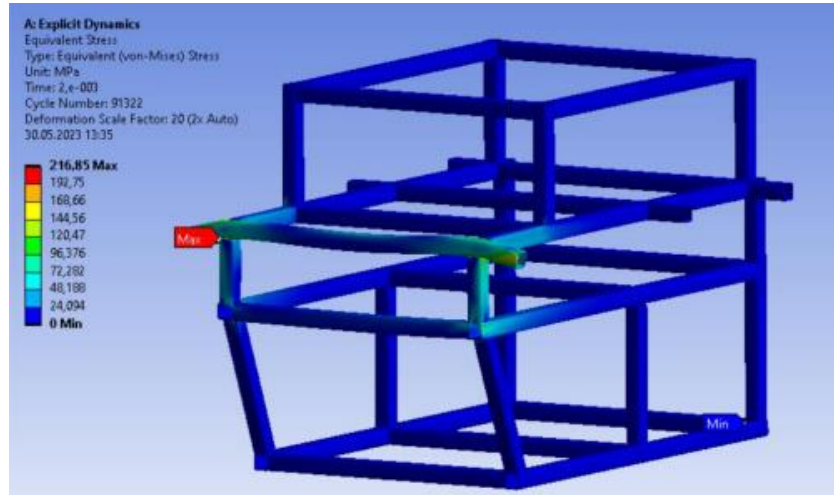
Şekil 6. Çarpışma Analizi Mesh Görünümü

Şekil 7'de verilen çarpışma analizi sonucu şaside oluşan toplam yer değiştirme maksimum 5,578 mm'dir. Oluşan deformasyon makinenin çalışmasını engelleyecek düzeyde değildir.



Şekil 7. Çarpışma Analizi Sonucu Oluşan Toplam Yer Değiştirme Sonuçları

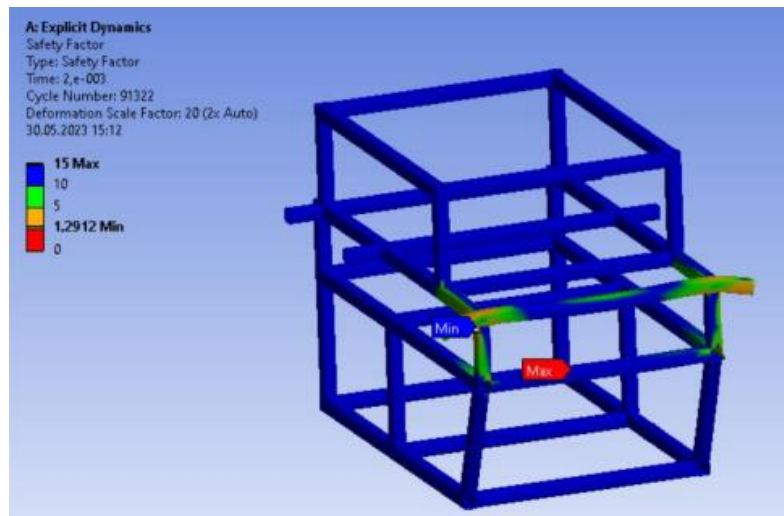
Çarpışma analizi sonucu şaside oluşan Maksimum Von Mises Gerilmesi 216,8 MPa'dır ısıtılmış işlem görmemiş alüminyumun maksimum çekme mukavemeti 275 MPa olduğu dikkate alınır bu oluşacak maksimum gerilme araç şasisinde mekanik olarak deformasyona neden olmaz. Bu sayede araç içinde bulunan kontrol sistemleri ve elektronik aksam zarar görmez. Detayları Şekil 8'de gösterilmiştir.



Şekil 8. Maksimum Von Mises Gerilmeleri

Çarpışma analizi sonucu şasi oluşan Güvenlik Kat Sayısı 1,29'dur. Detayları Şekil 9'da gösterilmiştir. Araç şasisi kompakt bir prototip şasi olduğu için; analiz sonucuna göre elde edilen değer (1,29 ul > 1 ul) alt sınır olan 1 'den büyük olduğu için güvenli kabul edilmiştir.

Bu değerler aracın statik (durağan bir cisme çarpması sonucunda meydana gelen değerlerdir. Ters yönde hareketli bir cisme çarptığında ise değerler farklılık görüleceği ön görülmektedir. Bu durumda maksimum gerilme ve yer değiştirme miktarı artıp, güvenlik faktör azalacaktır.



Şekil 9. Çarpışma Analizi Sonucu Şaside Oluşan Güvenlik Kat Sayısı

2. SONUÇ

TIKA gövdesi yapısal analiz sonuçlarına göre 1750 N yük altında araç şasisinde oluşan maksimum Von-Mises gerilmesi 115.4MPa ve 2.09 mm yer değiştirme olarak gerçekleşmiştir. Bu yer değiştirme miktarı uygulanan gerilmeler ve kuvvetler göz önüne alındığında kabul edilebilir seviyede olduğu ve herhangi bir deformasyona sebep olmadan kendi ekipmanlarını ve yararlı yükleri rahatlıkla taşıyabileceği tespit edilmiştir.

Teşekkür: Yazarlar, mali destek için Pamukkale Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü'ne (PAÜ, BAP, Proje Numarası: 2022LÖKAP012) teşekkür eder.

3. KAYNAKLAR

- Arı, M. E., & Esen, İ. (2022). Design of a metro train and structural analysis of the metro vehicle body by finite element method. *Demiryolu Mühendisliği*, (15), 30-45.
- Beaune, FR Bechar, A. and Vigneault, C., Agricultural robots for field operations. part 2: Operations and systems, *Biosystems engineering*, vol. 153, pp. 110–128, 2017.
- Biber, P., Weiss, U., Dorna, M., & Albert, A. (2012). Navigation System of the Autonomous Agricultural Robot “BoniRob”. *Proceeding IROS Workshop on Agricultural Robotics*
- A.Çınar and G.B.Sinclair, Quasi-Static Normal Indentation of and Elasto-Plastic Half Space by a Rigid Circular Cylinder of Infinite Length, *Int. J. Solids and Structures*, vol. 8, p919-934 , 1986.
- Çınar, A. (2015), Sonlu Elemanlar Yönteminin Araç Dayanım Ve Ömür Hedeflerinin Doğrulanmasındaki Önemi Ve Buna Ait Bazı Özel Uygulama Sonuçları, *XIX. Ulusal Mekanik Kongresi*, 24-28 Ağustos 2015, Karadeniz Teknik Üniversitesi, Trabzon
- Gonzalez-de-Santos, P., Fernández, R., Sepúlveda, D., Navas, E., Emmi, L., & Armada, M. (2020). Field robots for intelligent farms—*Inhering features from industry. Agronomy*, 10(11), 1638.
- Gölbol, F., Ölmez, H., Hacineciipoğlu, A., & Ankaralı, M. M. (2020, October). Developing a motion controller for autonomous agricultural robot. *In 2020 28th Signal Processing and Communications Applications Conference (SIU)* (pp. 1-4). IEEE.
- Güncan, A., 2010, Yabancı Ot Mücadelesi (genişletilmiş ve ilaveli ikinci baskı). *Selçuk Üniversitesi Ziraat Fakültesi*, Konya. 278 s.
- Heege, H. J., Precision in crop farming: site specific concepts and sensing methods: applications and results. *Springer Science & Business Media*, 2013.
- Hülako, H. & Kapucu, S. (2018). Düşük Maliyetli GPS Tabanlı Otonom Bir İnsansız Kara Aracının Tasarımı ve Yapılması. *Gazi University Journal of Science Part C: Design and Technology*, 6 (4) , 834-850 . DOI: 10.29109/gujsc.421665
- İnt1: Seykoç Alüminyum, alaşımlar AL6063, <https://seykoc.com.tr/icerik/6063?dil=tr>, (15.10.2023)
- Keicher, R. and Seufert H., “Automatic guidance for agricultural vehicles in europe,” *Computers and electronics in agriculture*, vol. 25, no. 1-2, pp. 169–194, 2000.
- Nefske, D. J., Wolf Jr, J. A., & Howell, L. J. (1982). Structural-acoustic finite element analysis of the automobile passenger compartment: a review of current practice. *Journal of sound and vibration*, 80(2), 247-266.
- Ö. C. Kıvanç, T. E. Mungan, B. Atila ve G. Tosun, İnsansız kara aracı geliştirmeye bütünleşik bir yaklaşım: tasarım, analiz, uygulama ve öneriler, *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, c. 34, sayı. 4, ss. 1957-1974, Haz. 2019 57
- Ruckelshausen, A., Biber, P., Dorna, M., Gremmes, H., Klose, R., Linz, A., ... & Weiss, U. (2009). BoniRob—an autonomous field robot platform for individual plant phenotyping. *Precision agriculture*, 9(841), 1.
- Sneha, A.A., Abirami, E., Ankita, A., Praveena, R., & Srimeena, R. (2015). Agricultural Robot for automatic ploughing and seeding. *In Innovations in ICT for Agr. and Rural Dev.* (pp. 17- 23).
- Şahin, B. U., & Kadioğlu, İ. (2021). Bazı Herbisitlerin Mısır ve Yabancı Otlar ile Kültür Bitkileri Üzerindeki Etkilerinin Belirlenmesi. *Journal of the Institute of Science and Technology*, 11(3), 1817-1830.
- Türker, U., Akdemir, B., Topakcı, M., Tekin, B., Aydın, İ. Ü. A., Özoğul, G., & Evrenosoğlu, M. (2015). Hassas tarım teknolojilerindeki gelişmeler. *Türkiye Ziraat Mühendisliği VIII. Teknik Kongresi Bildiriler Kitabı-1*, 295.
- Uz, Umut. Hexacopter Yapısında Bir İnsansız Hava Aracı İle Elektronik İlaçlama/Sulama Sisteminin Oluşturulması, Yüksek Lisans Tezi, *İstanbul Gelişim Üniversitesi*, 2019
- Z.H. Zhong, Finite Element Procedures For Contact-Impact Problems, *Oxford University Press*, 1993.

HİBRİT VE ELEKTRİKLİ BİR ARAÇ İÇİN LİTYUM-İYON BATARYA MODÜLÜNÜN KARAKTERİSTİĞİNİN ÇIKARTILMASI

Mustafa AYDIN

Pamukkale University, Faculty of Technology, Automotive Engineering Department, Kınıklı Campus

ORCID ID: 0000-0002-6187-6722

İsmail GÜRBÜZ

Pamukkale University, Faculty of Technology, Automotive Engineering Department, Kınıklı Campus

ORCID ID: 0000-0002-1762-9388

ÖZET

Elektrikli ve hibrit araçların pazardaki yerini sağlamlaştırılmaları için batarya ömür sürelerinin bilinmesi önemli bir gerekliliktir. Günümüzde elektrikli ve hibrit araçların batarya paketinin kullanım ömrü, kapasite ve sağlık durumunun doğru bir şekilde takip edilebilmesi kullanıcıların bu araçlarla ilgili en büyük çekincelerinden olmuştur. Batarya yönetim sistemi ile elektrikli ve hibrit araç bataryasının sağlıklı ve uzun bir süre kullanılabilmesi, batarya karakteristiğinin doğru bir şekilde elde edilmesi ile doğrudan ilgilidir. Bu çalışmada, günümüzde kullanımları hızla artan elektrikli ve hibrit araçların Li-iyon bataryaları için batarya paketinde yer alan bir batarya modülüne ait karakteristik verilerin elde edilmesi üzerine çalışılmıştır. Kesit bir Li-iyon batarya modülünün oluşturulması için NCR18650PF 3300 mAh 3,7 V Li-iyon bataryalar ile 6S batarya grubu oluşturulmuştur. Batarya paketinin akım, gerilim ve yüzey sıcaklığı verileri karakteristik belirleme sürecinde 500 çevrim boyunca her şarj-deşarj çevrimi için toplanmıştır. Batarya karakteristik çıkarım sürecinde elde edilen şarj-deşarj profili ve tutulabilir kapasite değişim verilerine bağlı olarak batarya karakteristik parametreleri elde edilmiştir. 500 çevrim boyunca elde edilen batarya modülü karakteristik verileri filtrelenmiş ve bataryanın sağlık ve şarj durumu hesaplamaları gerçekleştirilmiştir. Sensörlerden alınan şarj-deşarj akımı, gerilimi ve yüzey sıcaklığı verilerine bağlı olarak gerçekleştirilen hesaplamalar ile batarya modülünün anlık sağlık durumu, anlık şarj durumu ve anlık sağlık durumu verileri belirlenmiştir. Toplanan veriler incelendiğinde şarj-deşarj profillerinde literatürde olduğu gibi beklenen düşüş gözlemlenmiştir. 500 şarj-deşarj çevrimine ulaşıldığında batarya modülünün tutulabilir kapasitesinin başlangıç kapasitesine kıyasla %70'in altına düşerek kullanılabilir ömür sonuna ulaştığı görülmüştür.

Anahtar Kelimeler: Elektrikli ve hibrit araç, Li-iyon batarya, batarya karakteristiği, batarya sağlık durumu

CHARACTERISTICS OF A LITHIUM-ION BATTERY MODULE FOR A HYBRID AND ELECTRIC VEHICLE

ABSTRACT

It is an important requirement to know the battery life of electric and hybrid vehicles in order to consolidate their place in the market. Today, the ability to accurately monitor the lifespan, capacity and health status of the battery pack of electric and hybrid vehicles has been one of the biggest concerns of users about these vehicles. With the battery management system, the ability to use the electric and hybrid vehicle battery for a healthy and long time is directly related to the obtaining of the battery characteristics correctly. In this study, it was studied to obtain characteristic data of a battery module in the battery pack for Li-ion batteries of electric and hybrid vehicles, the use of which is increasing rapidly today. In order to create a sectional Li-ion battery module, NCR18650PF 3300 mAh 3.7 V Li-ion batteries and a 6S battery pack were formed. The charge-discharge current, voltage and surface temperature data of the battery pack were collected for each charge-discharge cycle for 500 cycles during the characteristic determination process. Battery characteristic parameters were obtained based on the charge-discharge profile and retainable capacity change data obtained during the battery characteristic extraction process. The battery module characteristic data obtained during 500 cycles were filtered and battery health and charge status calculations of the battery were performed. Instant health status, instant charge status and instant health status data of the battery module were determined with the calculations carried out depending on the charge-discharge current, voltage and surface temperature data received from the sensors. When the collected data were examined, the expected decrease in the charge-discharge profiles was observed, as in the literature. It was observed that when 500 charge-discharge cycles were reached, the retainable capacity of the battery module decreases to less than 70% compared to the initial capacity and reaches the end of its usable life.

Keywords: Electric and hybrid vehicle, Li-ion battery, battery characteristics, battery health status.

1. GİRİŞ

Geçen yıllar boyunca akaryakıtlı araçların kullanımı gezegendeki hava kirliliğinin artmasında büyük bir etkidir. Akaryakıtlı araçların salgıladığı emisyonlar sera gazları oluşumunu arttırdığı için ozon tabakasındaki deliğin genişlemesine sebep olmaktadır. Tabakadaki deliğin genişlemesi dolayısıyla gezegendeki iklim değişiklikleri günümüzde görülen bariz

sonuçlardandır (Haidar ve diğ. 2014). Araçlar günlük yaşantımızda ulaşım, nakliye ve konfor anlamında hayatımızın büyük bölümünde yer alırlar ve kullanımları bir gerekliliktir. Dizel ve benzin çevrimli araçların kullanımının çevre kirliliği ve petrol rezervlerini azaltma gibi büyük bir dezavantajı olduğu için elektrikli araç fikri sektörde yeniden gün yüzüne çıkmıştır.

Elektrikli araçlar fosil yakıtlı araçlara kıyasla daha az karbon emisyonuna sahip olmaları nedeniyle çevre dostudur. Ayrıca elektrikli araçlar, enerji verimliliği ve düşük işletme maliyetleri nedeniyle sürdürülebilir bir seçenektir (Haidar ve diğ. 2014). Elektrikli araçlarda DC motor, batarya paketinden DC motorun ihtiyacı olan depolanmış elektriği kullanarak tahriki dört tekere iletir. Çalışma esnasında sıfır emisyon değerleriyle doğaya zarar vermezler, bununla birlikte sessiz ve konforlu bir sürüş imkânı sağlarlar. Fakat elektrikli araç pazarının gelişimi ve kullanımının artması için kullanıcıların menzil, şarj edilebilirlik ve batarya ömrü hakkındaki endişeleri ortadan kaldırılmalıdır (Gelmanova ve diğ. 2018, Özbay ve diğ. 2020). Elektrikli aracın ihtiyacı olan elektrik enerjisini depolama görevi için ise günümüzde en uygun batarya çeşidi Li-iyon bataryalardır. Li-iyon bataryalar en verimli bataryalar olsa da iyileştirmeye ihtiyaçları vardır. Li-iyon pillerin kullanımı için maliyeti düşmeli ve batarya ömürlerinin kestirimlerinin yapılabilmesi büyük önem taşımaktadır (Deng 2015, Wang ve diğ. 2020). Pil ömürlerinin tahmin edilebilmesi bu süreçte zordur çünkü Li-iyon pillerin ömrü araç sürücüsünün sürüşüne, şarj-deşarj döngülerine ve sürücünün şarj etme alışkanlıklarına göre değişebilmektedir (Gerssen-Gondelach ve Faaij 2012, Wang 2019).

Bataryaların kalan sağlıklı ömrüne dair yorum yapılabilmesi adına anlık sağlık durumu (SoH) verisinin bilinmesi gerekmektedir. Batarya SoH tahminleri için batarya paketi üzerinde veri ölçümleri yapılmaktadır (Saqli ve diğ. 2019). Gerçek zamanlı ölçüm yapılan uygulamalar literatürde doğrudan ölçüm teknikleri olarak bilinmektedir. Doğrudan ölçüm teknikleri, Ah sayma, kapasite testi, iç direnç ölçümü ve elektrokimyasal empedans spektroskopisi gibi spesifik ölçüm tekniklerini kapsamaktadır (Yang ve diğ. 2015, Schweiger ve diğ. 2010, Pradhan ve Chakraborty 2022). Ah sayma yöntemi bazı kaynaklarda Coulomb sayma yöntemi olarak da görülebilmektedir. Bir batarya veya bataryanın sağlık durumu deneysel olarak tahmin edilmek istendiğinde günümüzde en çok başvurulan deneysel tekniklerden biridir. Ah sayma yönteminde şarj esnasında bataryaya verilen akım,deşarj esnasında ise bataryadan çekilen akımlar kontrol edilir (Yang ve diğ. 2015). Böylece bataryanın anlık kapasitesi tahmin edilebilir. Ah sayma yönteminde bataryanın oda sıcaklığına yakın bir ortamda şarj-deşarj döngüsüne girmesi ve çok değişken olmayan akımlar ile şarj vedeşarj edilmesi yöntem tutarlılığı açısından önemlidir. Elektrikli araç batarya sistemlerde gerçekleştirilen ölçümler ve

toplanan veriler, genel olarak sistem işleyişinin kontrolü için kullanılmaktadır. Gerçekleştirilen ölçümler ile birlikte bataryaların SoH ve anlık şarj durumu (SoC) hesaplamaları yapılmaktadır (Saqli ve diğ. 2019). Elde edilen bu bilgiler, belli bir zaman dilimi içerisinde sistem verimliliğinin incelenmesi ve sistemin gelecekteki performansının artırılması için de kullanılabilir. Gerçek zamanlı ölçüm ve analiz yapılması, elektrikli araç sistemlerinde yaşanabilecek arızalara zamanında müdahale edilebilmesi açısından önem kazanmaktadır. Ayrıca birden fazla kaynağın bulunduğu hibrit araç sistemlerinde de gerçek zamanlı ölçüm ve izleme sistemlerine ihtiyaç olduğu açıktır (Attidekou ve diğ. 2017, Asaad ve diğ. 2018, Abd Wahab ve diğ. 2018).

Literatürde elektrikli araç batarya sisteminin performansının denetlenmesi ve değerlendirilmesi (Gerssen-Gondelach ve Faaij 2012, Omariba ve diğ. 2019), akü doluluk oranlarının takibi (Sarrafan ve diğ. 2018, Sarrafan ve diğ. 2017, Li ve diğ. 2015) ve plug-in hibrit ve elektrikli araç gibi sistemlerinde elektriksel ve çevresel parametrelerin ölçülmesi (Wang ve diğ. 2019, Hua ve diğ. 2000) için oluşturulmuş veri toplama sistemleri olduğu bilinmektedir. Bu çalışmaların ortak özellikleri ölçüm verilerinin elde edilmesi için veri kaydedicilerin kullanılması ve belli periyotlarla bu verilerin bilgisayara iletilerek analiz edilmesidir. Gerçekleştirilen bu çalışmada, literatürde bulunan çalışmaların çoğunluğundan farklı olarak batarya karakteristik verileri ah sayma yöntemi ile elde edilmiş ve 500 çevrimlik gerçek zamanlı şarj-deşarj döngüsü boyunca akım sayımı gerçekleştirilmiştir. Batarya akımı, batarya gerilimi, batarya sıcaklığı ve ortam sıcaklığına ait veriler ilgili sensörler ile ölçülmüştür. Çalışmada gerçekleştirilen ölçüm düzeneği ile elektriksel arıza tespiti, batarya verimi, sağlık ve şarj durumu parametreleri ile batarya karakteristiği elde edilmiş, ömür tahmini hesaplamalarında kullanılabilir bir alt yapı oluşturulmuştur.

2. ARAŞTIRMA VE BULGULAR

2.1. Deneysel Çalışmalar

2.1.1. Batarya karakteristik belirleyici devrenin kurulumu

Batarya karakteristiğinin analizi için batarya paketinin oluşturulması aşamasında Panasonic markasının 18650 NCR 3300 mAh 3,7 V Li-iyon pil hücreleri ve Li-iyon pil hücrelerinden 6 serilik bir batarya paketi oluşturulabilmesi adına 2 adet 3 yuvalı plastik Li-iyon pil yatağı kullanılmıştır. Oluşturulan batarya modelinin kapasitesi 3300 mAh, çalışma gerilimi ise 19,2-25,2 V'tur. Batarya paketinin korunması ve hücreler arası dengelemenin sağlanması için HX-6S-12A marka batarya yönetim sistemi (BYS) kullanılmıştır. Panasonic tarafından üretilen

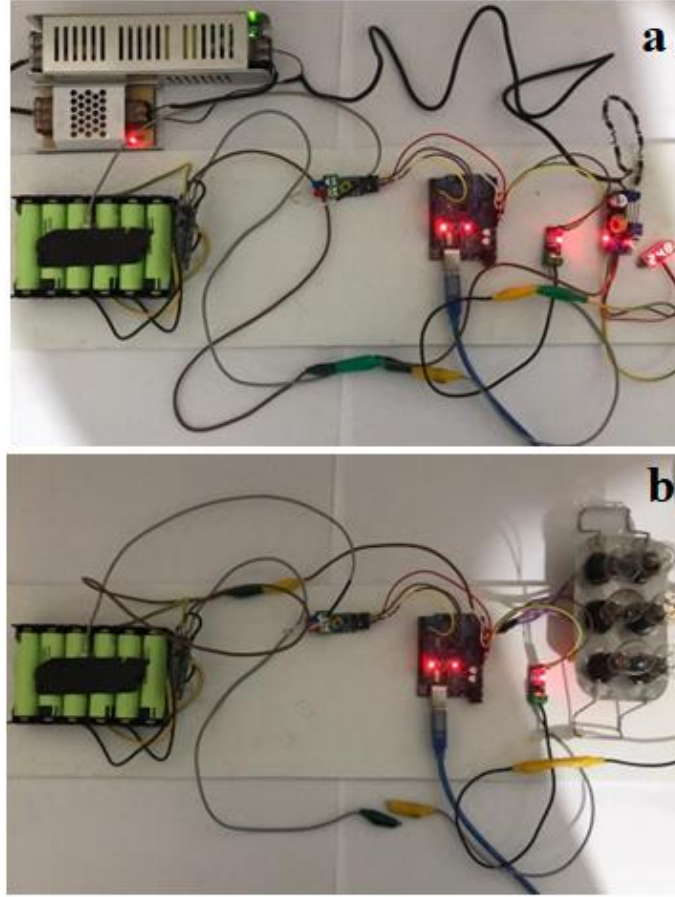
NCR18650PF tipindeki bu pil tipik olarak 500 şarj-deşarj döngüsü boyunca verim sağlayabilmektedir. Panasonic NCR18650PF, Li-iyon pil teknolojisine dayanan bir silindirik pildir. Bu Li-iyon piller, nominal gerilim olarak genellikle 3,7 V gerilimde bulunmaktadır. Pilin maksimum gerilimi 4,2 V ikendeşarj sürecindeki cut-off voltajı ise 2,5 V'tur. Bunların yanı sıra pilindeşarj akımı 10 A seviyesindedir (Actec 2016). Şarj-deşarj akım sayma ve sıcaklık ölçümü veri okuma devrelerinden şarj devresinin kurulumunda 36 V DC 5 A'lık güç kaynağı, bir adet XL4015 akım ayarlı voltaj düşürücü, bir adet 30 V DC dijital voltmetre, bir adet ACS712 akım sensörü, bir adet MAX6675 sıcaklık sensörü, bir adet Arduino Uno ve MATLAB kullanılmıştır. Deşarj 6 adet 12 V 21 W ampullerden oluşturulmuş bir yük bankası kullanılmıştır. Batarya paketinin 4 A iledeşarj olabilmesi adına 6 adet 12 V 21 W'lık ampul ile bir yük bankası oluşturulmuştur. Yük bankası oluşturulurken 24 V gerilimi elde edebilmek adına 2 seri ampul bağlantıları ile 3 paralel devre kurulmuştur.

2.1.2. Batarya karakteristik devresinin kurulumu ve işletilmesi

Şarj akım sayma devresinin kurulumunda ise XL4015 voltaj düşürücü devresinin çıkışından 25,2 batarya şarj voltajını elde edebilmek için 36 V DC güç kaynağı kullanılmıştır. Elde edilen 36 V DC gerilim XL4015 akım ayarlı voltaj devresi girişine güç kaynakları çıkışından alınan kablo bağlantıları ile aktarılmıştır. Oluşturulan batarya paketinin 0,5 C oranı ile şarj edilebilmesi için XL4015 üzerinde maksimum akım 1,65 A olarak ayarlanmıştır. Batarya paketinin şarj gerilimi olan 25,2 V'a yükseltilebilmesi için XL4015 modülünün çıkış gerilimi de 25,2 V'a sabitlenmiştir. Batarya paketi şarj döngüsünde tam dolu şarj gerilimi olan 25,2 V gerilime kadar şarj edilmiştir. Sıcaklık sensörünün probu batarya paketinin yüzeyine sabitlenmiş ve sıcaklık sensörü Arduino kartına bağlanmıştır. Akım verilerinin okunabilmesi için akım sensörü Arduino kartına bağlanmıştır. Sıcaklık sensöründen alınan batarya yüzey sıcaklık verileri ve ACS712 akım sensöründen saniyede bir kez alınan veriler Arduino sanal ortamına aktarılmış ve bu veriler MATLAB ortamında txt dosyası haline getirilmiştir.

Deşarj akım sayma devresi kurulurken akım ve sıcaklık verilerini okumak ve kaydetmek adına şarj devresinde bulunan Max 6675 sıcaklık sensörü, ACS712 akım sensörü ve Arduino Uno komponentleri kullanılmıştır. Batarya paketinin 4 A iledeşarj olabilmesi adına 6 adet 12 V 21 W'lık ampul ile bir yük bankası oluşturulmuştur. Yük bankası oluşturulurken 24 V gerilimi elde edebilmek adına 2 seri ampul bağlantıları ile 3 paralel devre kurulmuş ve oluşturulan yük bankası bataryadan 6/5 Cdeşarj oranına karşılık gelen 4 A akım çektiği görülmüştür. Deşarj döngüsünde batarya paketi 19,2 V cut-off gerilimine dekdeşarj edilmiş ve cut-off gerilimine ulaşıldığındadeşarj döngüsü batarya yönetim sistemi (BYS) tarafından sonlandırılmıştır.

Deşarj esnasında da bataryanın yüzey sıcaklığı ve çekilen akım saniyede bir alınmış ve MATLAB ortamına aktarılmıştır. Şarj-deşarj akım sayma devreleri Şekil 1'de verilmiştir. MATLAB ortamında şarj-deşarj akımı ve yüzey sıcaklık verilerinin kaydedildiği txt dosyası Şekil 2'de verilmiştir.

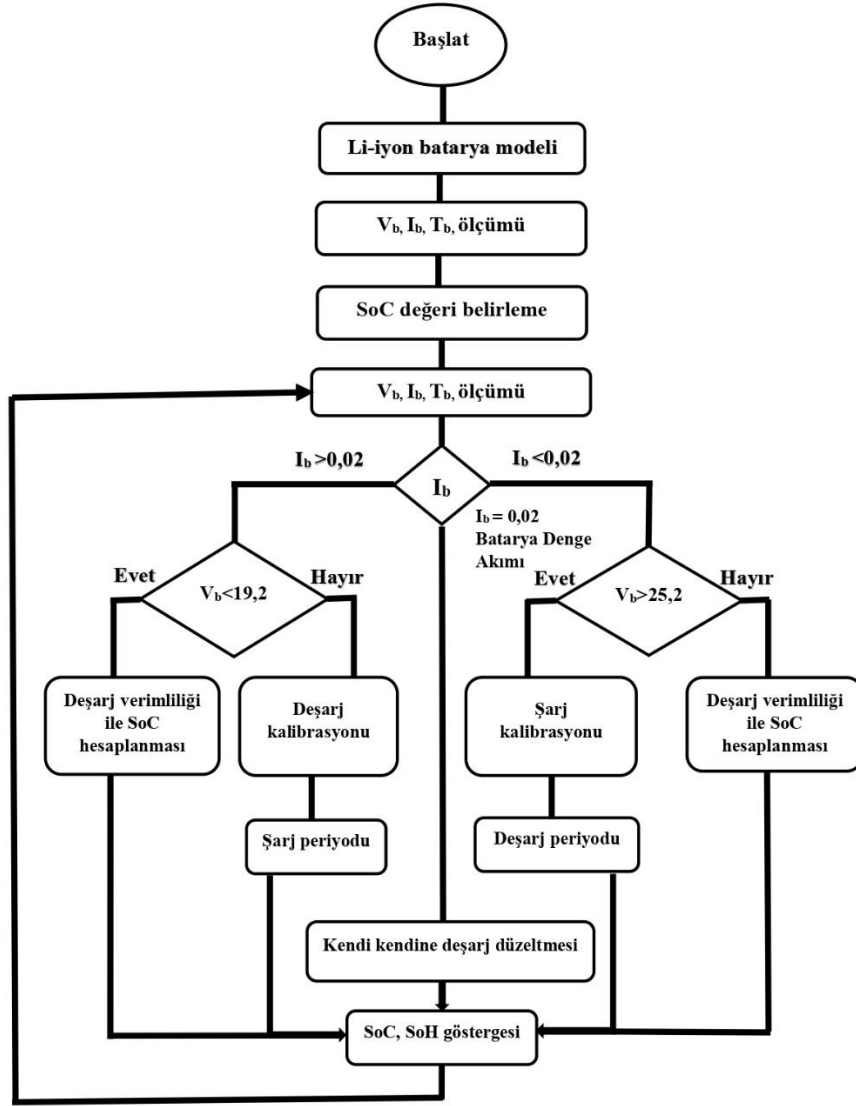


Şekil 1. (a) Şarj, (b)deşarj akım sayma devresi

Deşarj5.txt - Not Defteri					Şarj 5.txt - Not Defteri				
Dosya	Düzen	Biçim	Görünüm	Yardım	Dosya	Düzen	Biçim	Görünüm	Yardım
21.00	,	-4.17	,		20.00	,	1.53	,	
20.25	,	-4.09	,		20.00	,	1.50	,	
20.50	,	-4.01	,		19.75	,	1.48	,	
20.75	,	-4.17	,		19.25	,	1.45	,	
20.75	,	-4.20	,		19.50	,	1.50	,	
20.75	,	-4.09	,		20.00	,	1.45	,	
20.75	,	-4.12	,		20.00	,	1.43	,	
20.75	,	-4.12	,		19.50	,	1.45	,	
20.25	,	-4.17	,		20.00	,	1.53	,	
20.75	,	-4.14	,		19.75	,	1.43	,	
20.50	,	-4.12	,		20.00	,	1.45	,	
20.75	,	-4.17	,		20.00	,	1.50	,	
20.75	,	-4.12	,		20.00	,	1.50	,	
20.75	,	-3.93	,		20.00	,	1.45	,	
21.00	,	-4.06	,		20.00	,	1.43	,	

Şekil 2. Matlab ortamında alınan (a) deşarj akımı, (b) şarj akımı ve yüzey sıcaklığı verilerininin txt dosyası

Başlangıç SoC değeri tespit edildikten sonra batarya birbirini takip eden şarj ve deşarj döngülerine tabi tutulmuş ve bu döngülerdeki ölçülen akım, gerilim ve sıcaklık değerlerine göre anlık SoC durumu takibi yapılarak bataryanın her bir şarj-deşarj döngü sonundaki kapasite değeri hesaplanmıştır. Şarj-deşarj döngü ömrüne ait algoritma Şekil 3'te verilmiştir.



Şekil 3. Şarj döngü ömrü belirleme algoritması

2.1.1.1 Kapasite değişim verilerinin elde edilmesi

500 şarj-deşarj çevrimi sonucunda her çevrim için elde edilen veriler Excel'e aktarılarak çevrim başına kapasite hesaplamaları yapılmıştır. Hesaplanan kapasite verileri ile şarj vedeşarj için iki ayrı kapasite değişim grafiği elde edilmiş olup elde edilen grafikler MATLAB ortamında filtrelenmiştir. Filtrelenmiş veri grafiklerinden alınan kapasite verileri Eşitlik 1 ile birlikte hesaplanmış ve kapasite değişimi yüzdeler cinsinden elde edilmiştir.

$$SoH(\%) = \frac{\text{Tutulabilir Kapasite}}{\text{Başlangıç Kapasitesi}} \times 100 \quad (1)$$

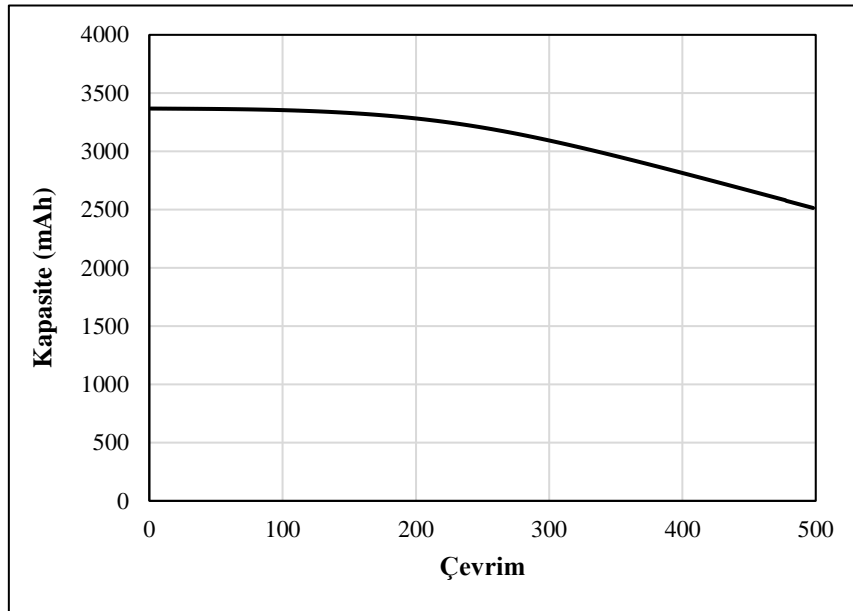
500 çevrim boyunca akım verilerinin yanı sıra batarya yüzey sıcaklıklarındaki değişimlerin elde edilebilmesi için MAX 6675 sıcaklık sensörü ile sürekli olarak sıcaklık ölçümü yapılmıştır.

Ölçülen sıcaklık verileri, akım verilerinin aktarıldığı gibi Excel ortamına aktarılarak her çevrim için sıcaklık değişim verileri elde edilmiştir.

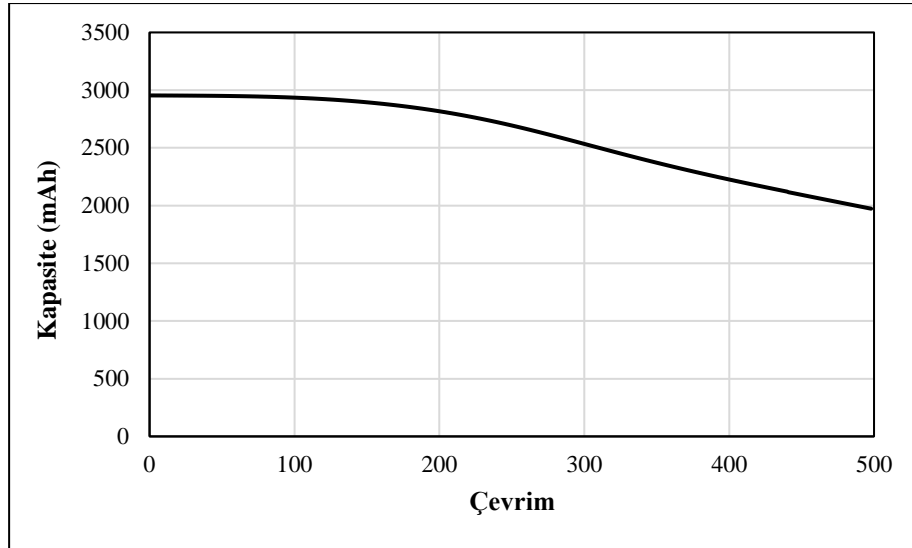
2.2. Deneysel Sonuçlar

2.2.1 Batarya Kapasitesinin Değişimi

Gerçekleştirilen 500 çevrim sonunda bataryanın şarj ve deşarj kapasitesinde tahmin edilen düşüş gerçekleşmiştir. 3367,21 mAh olan başlangıç şarj kapasitesi 500. çevrime ulaşıldığında 2513,94 mAh seviyesine gerilediği gözlemlenmiştir. Öte yandan 2954,05 mAh'lik başlangıç deşarj seviyesine sahip bu batarya modelinin son çevrime ulaşıldığında 1972,93 mAh seviyesine düştüğü görülmüştür. Şarj ve deşarj kapasitelerinin 150. çevrimden sonra düşüş eğilimine geçtiği görülmüştür. Şekil 4'te şarj kapasitesinin değişim grafiği, Şekil 5'te ise deşarj kapasitesinin değişim grafikleri filtrelenmiş olarak verilmiştir.



Şekil 4. Şarj kapasitesinin çevrime bağlı değişim grafiği



Şekil 5. Deşarj kapasitesinin çevrime bağlı değişim grafiği

Tüm çevrimlerin sonucunda şarj edilebilir kapasite %74,66 seviyesine inerken deşarj kapasitesinin %66,70 seviyesine düştüğü yapılan hesaplamalar sonucunda görülmüştür. Literatürde verilen bilgilere göre batarya paketi %70 sağlanabilir kapasite yani deşarj kapasitesinin altına düştüğünde EoL'a (ömür sonuna) ulaşmış olarak değerlendirilmiştir (Lee ve diğ. 2018) ve çalışmada kullanılan batarya modelinin 500 çevrim sonucunda %66,70 seviyesiyle bu sınırın altına düştüğü gözlemlenmiştir. Tablo 1'de belirli çevrimlere göre şarj ve deşarj kapasitelerinin yüzdelik değişimleri verilmiştir.

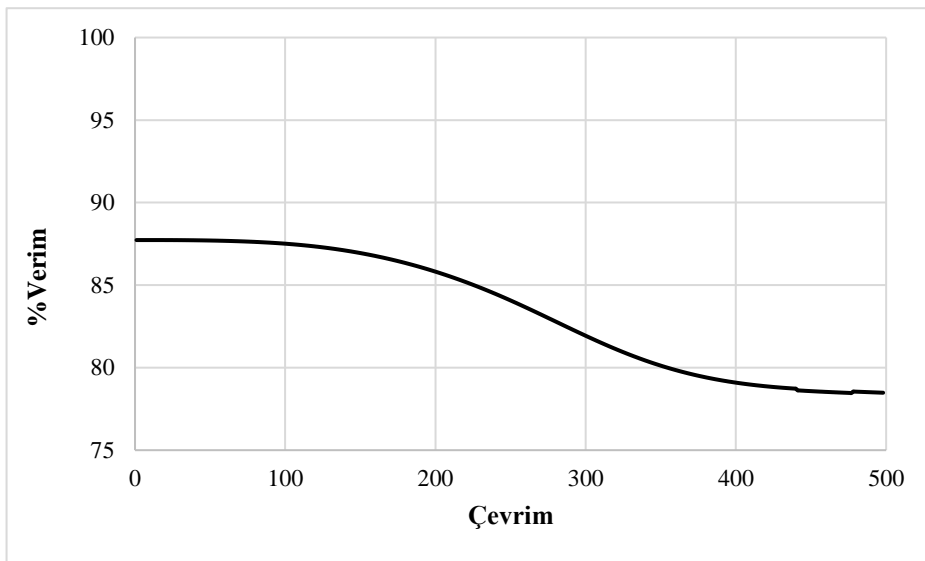
Tablo 1. Kapasitelerin çevrime bağlı yüzdelik değişimleri

Çevrim	Şarj (%)	Deşarj (%)
0	100,00	100,00
50	99,90	99,87
100	99,61	99,37
150	98,90	98,03
200	97,52	95,43
250	95,21	91,29
300	91,94	85,90
350	87,98	80,38
400	83,67	75,44
450	79,19	70,93
500	74,66	66,70

2.2.2 Batarya veriminin deęiřimi

Batarya verimi, Eřitlik 2’de g r ld ę  gibi ilgili řarj-deřarj d ng s nde deřarj kapasitesinin řarj kapasitesine b l m  ile elde edilmiřtir. 1. evrimde %87,73 verimlilięe sahip olan batarya paketi, son evrim olan 500. evrime ulařtıęında ise %78,48 verim ile  m r sonuna ulařmıřtır. Őekil 6’da evrim sayısına baęlı batarya veriminin deęiřim grafięi verilmiřtir.

$$\text{Batarya Verimi} = \frac{\text{Deřarj Kapasitesi}}{\text{Őarj Kapasitesi}} \times 100 \quad (2)$$



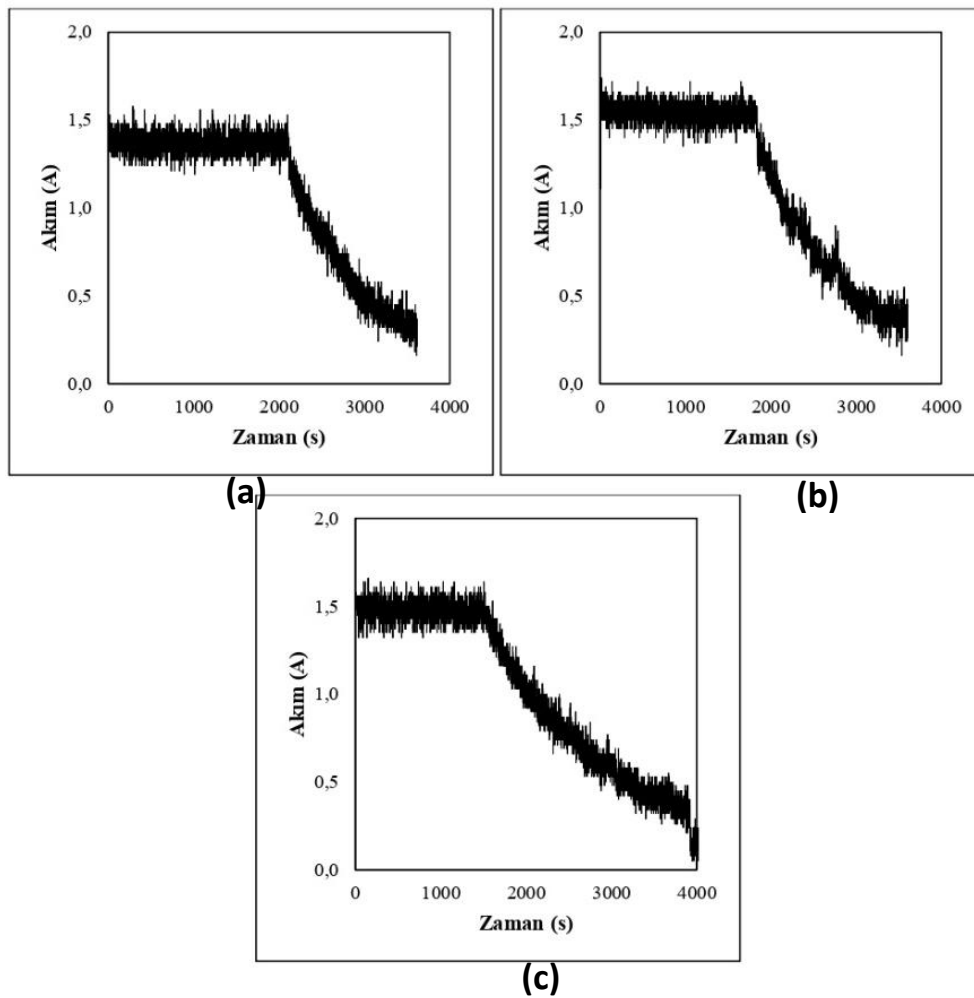
Őekil 6. evrim sayısına baęlı batarya verimi

2.2.3 Batarya y zey sıcaklıklarının deęiřimi

Batarya paketi deřarj ařamasına 25 C oda sıcaklıęında bařlarken deřarj sonuna ulařtıęında 45 C sıcaklıklara kadar y kseldięi g zlemlenmiřtir. Deřarj s reci sonunda 45 C sıcaklıęa ulařan batarya paketleri yeniden řarj edilirken aynı sıcaklıkta řarj edilmeye bařlanmıř řarj sonuna ulařıldıęında ise y zey sıcaklıęının oda sıcaklıęına d řt ę  g zlemlenmiřtir. Őarj ve deřarj s relerinin kısalmasına raęmen deřarj s relerinde sıcaklık artıřı yine 45 C’ye ıkmıřtır. Őarj ařamasında ise 300. evrimden sonra oda sıcaklıęına ulařılmadan řarj iřleminin tamamlandıęı g r lm řt r.

2.2.4 Batarya şarj profili deęiřimi

Excel ortamına aktarılan her çevrime ait akım verileri ile kapasite deęerlerinin elde edilmesinin yanında ilgili çevrime ait şarj eęrisi profili de elde edilmiştir. Bataryanın ilk şarj aşamasında CC (sabit akım) periyodu 2100 s boyunca devam etmiş, sonrasında ise 1600 s boyunca CV (sabit voltaj) periyodu ile şarj tamamlanmıştır. İlk şarjda 2100 s olan CC periyodu son çevrime ulařıldığında 1515 s seviyesine gerilerken, CV periyodunda ise 2500 s'ye çıktıęı gözlemlenmiştir. Deşarj aşamasında beklenildięi gibi deşarj süresi azalmış fakat deşarj akımlarında deęişim görülmemiştir. Şekil 7'de 3 farklı çevrime ait şarj profil eęrileri verilmiştir.



Şekil 7. Çevrimlere baęlı şarj profili grafikleri; a: 1. Çevrim, b: 250. Çevrim, c: 500. Çevrim

3. SONUÇ

Gerçekleştirilen çalışmada elektrikli ve hibrit araç kullanıcılarının en büyük sorularından biri olan Li-iyon bataryanın ömür kestirimi üzerine çalışılmıştır. Çalışma batarya karakteristik verilerinin elde edilmesi ve elde edilen verilerle her çevrim için sağlık durumunun belirlenmesi temellerine dayandırılmıştır. Batarya karakteristik verilerinin çıkarımı süreci 500 şarj-deşarj çevrimi boyunca sürmüştür, süreç içerisinde 450 çevrim ve sonrasında batarya ilk kapasitesine göre %70'in altına düşerek ömür sonuna ulaştığı görülmüştür. Gerçekleştirilen 500 çevrim boyunca batarya oda sıcaklığında tutulmuştur. Batarya paketi sağlıklı ömrü boyunca şarj periyotlarını 25°C oda sıcaklığında tamamlamıştır,deşarj süreçlerinin sonunda ise 45°C'ye kadar ısındığı görülmüştür. Her çevrim için elde edilendeşarj kapasitesinin şarj kapasitesine oranlanması ile batarya verimi elde edilmiştir. Batarya paketinin 1. çevrimde %87,73 olan verimi, son çevrime ulaşıldığında %78,48'e gerilediği görülmüştür. Toplanmış olan verilerin işlenebilmesi için MATLAB ortamında ile veriler filtrelenmiştir. Elde edilen şarj-deşarj profilleri ve çevrime bağlı kapasite kaybı ile anlık şarj durumu, anlık sağlık durumu ve batarya verim değerlerinin beklenildiği gibi azaldığı görülmüştür. Bu çalışma, elektrikli ve hibrit araçlarda bulunan Li-iyon batarya paketlerinin ömür kestirimleri için değerli bilgiler sağlamıştır. Elde edilen sonuçlar Li-iyon batarya performanslarının zamanla daha iyi anlaşılmasına katkıda bulunarak, batarya teknolojisinin gelişmesine dolayısıyla elektrikli ve hibrit araçların genel performanslarını artırma girişimlerini desteklemektedir.

Yazar Katkı Beyanı

Yazarların çalışmadaki katkı oranları eşittir.

Etik kurul onayı ve çıkar çatışması beyanı

Hazırlanan makalede etik kurul izni alınmasına gerek yoktur. Hazırlanan makalede herhangi bir kişi/kurum ile çıkar çatışması bulunmamaktadır.

Teşekkür

Yazarlar, mali destek için Pamukkale Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü'ne (PAÜ, BAP, Proje Numarası:2022FEBE030) teşekkür eder.

KAYNAKÇA

Abd Wahab, M. H., Anuar, N. I. M., Ambar, R., Baharum, A., Shanta, S., Sulaiman, M. S., & Hanafi, H. F. (2018). IoT-based battery monitoring system for electric vehicle. *International Journal of Engineering & Technology*, 7(4.31), 505-510.

Asaad, M., Ahmad, F., Alam, M. S., & Rafat, Y. (2018). IoT enabled monitoring of an optimized electric vehicle's battery system. *Mobile Networks and Applications*, 23, 994-1005.

- Attidekou, P. S., Wang, C., Armstrong, M., Lambert, S. M., & Christensen, P. A. (2017). A new time constant approach to online capacity monitoring and lifetime prediction of lithium ion batteries for electric vehicles (EV). *Journal of the Electrochemical Society*, 164(9), A1792.
- Deng, D. (2015). Li-ion batteries: basics, progress, and challenges. *Energy Science & Engineering*, 3(5), 385-418.
- Gelmanova, Z. S., Zhabalova, G. G., Sivyakova, G. A., Lelikova, O. N., Onishchenko, O. N., Smailova, A. A., & Kamarova, S. N. (2018, May). Electric cars. Advantages and disadvantages. In *Journal of Physics: Conference Series*, 1015(5), 052029, IOP Publishing.
- Gerssen-Gondelach, S. J., & Faaij, A. P. (2012). Performance of batteries for electric vehicles on short and longer term. *Journal of power sources*, 212, 111-129.
- Haidar, A. M., Muttaqi, K. M., & Sutanto, D. (2014). Technical challenges for electric power industries due to grid-integrated electric vehicles in low voltage distributions: A review. *Energy Conversion and Management*, 86, 689-700.
- Hua, C. C., & Lin, M. Y. (2000, December). A study of charging control of lead-acid battery for electric vehicles. In *ISIE'2000. Proceedings of the 2000 IEEE International Symposium on Industrial Electronics (Cat. No. 00TH8543)*, 1, 135-140, IEEE.
- Lee, J., Kwon, D., & Pecht, M. G. (2018). Reduction of Li-ion battery qualification time based on prognostics and health management. *IEEE Transactions on industrial electronics*, 66(9), 7310-7315.
- Li, D., Ouyang, J., Li, H., & Wan, J. (2015). State of charge estimation for LiMn2O4 power battery based on strong tracking sigma point Kalman filter. *Journal of power sources*, 279, 439-449.
- Omariba, Z. B., Zhang, L., & Sun, D. (2019). Review of battery cell balancing methodologies for optimizing battery pack performance in electric vehicles. *IEEE Access*, 7, 129335-129352.
- Özbay, H., Közkurt, C., DALCALI, A., & Tektaş, M. (2020). Geleceğin ulaşım tercihi: Elektrikli araçlar. *Akıllı Ulaşım Sistemleri ve Uygulamaları Dergisi*, 3(1), 34-50.
- Pradhan, S. K., & Chakraborty, B. (2022). Battery management strategies: An essential review for battery state of health monitoring techniques. *Journal of Energy Storage*, 51, 104427.
- Sarrafan, K., Muttaqi, K. M., & Sutanto, D. (2018, September). Real-time state-of-charge tracking system using mixed estimation algorithm for electric vehicle battery system. In *2018 IEEE Industry Applications Society Annual Meeting (IAS)*, 1-8, IEEE.
- Sarrafan, K., Sutanto, D., & Muttaqi, K. M. (2017, December). An electric circuit based EV battery model for runtime prediction and state of charge tracking. In *2017 IEEE Transportation Electrification Conference (ITEC-India)*, 1-6, IEEE.
- Saqli, K., Bouchareb, H., Oudghiri, M., & M'Sirdi, N. (2019). An overview of State of Charge (SOC) and State of Health (SOH) estimation methods of Li-ion batteries. *IMAACA 2019*.
- Schweiger, H. G., Obeidi, O., Komesker, O., Raschke, A., Schiemann, M., Zehner, C., ... & Birke, P. (2010). Comparison of several methods for determining the internal resistance of lithium ion cells. *Sensors*, 10(6), 5604-5625.
- Wang, Y. N. (2019). Power battery performance detection system for electric vehicles. *Procedia computer science*, 154, 759-763.
- Wang, B., Fernandez, J. H., & Massoud, A. (2019, October). A wireless battery temperature monitoring system for electric vehicle charging. In *2019 IEEE SENSORS*, 1-4, IEEE.
- Wang, K., Wan, J., Xiang, Y., Zhu, J., Leng, Q., Wang, M., ... & Yang, Y. (2020). Recent advances and historical developments of high voltage lithium cobalt oxide materials for rechargeable Li-ion batteries. *Journal of Power Sources*, 460, 228062.
- Yang, N., Zhang, X., & Li, G. (2015). State of charge estimation for pulse discharge of a LiFePO4 battery by a revised Ah counting. *Electrochimica Acta*, 151, 63-71.

HİDROJEN YAKITININ TAŞITLARDA KULLANIMININ YAYGINLAŞTIRILMASI

Mehmet ZENCİRKIRAN

Başkent Üniversitesi, Kahramankazan Meslek Yüksekokulu, Motorlu Araçlar ve Ulaştırma Teknolojileri Bölümü, Ankara, Türkiye

ORCID ID: 0000-0003-0068-0467

ÖZET

Dünya üzerinde birçok enerji kaynağı yer almaktadır. Bu enerji kaynakları yeryüzünün her bölgesinde eşit dağılım göstermemektedir. Bu eşit olmayan enerji dağılımı çok farklı alternatif enerji kaynaklarının ortaya çıkmasına neden olmaktadır. Özellikle petrol kaynaklı yakıtların dünya üzerinde hızla tüketilmesi de yeni enerji kaynaklarının ortaya çıkarılmasında en önemli rolü üstlenmektedir. Birçok alternatif enerji kaynağı yer almasına karşın hidrojen enerjisi çevreci ve verimlilik açısından petrol kaynaklı yakıtlardan daha verimli olduğu görülmektedir. Hidrojen enerjisinin sürdürülebilir olması bu enerji kaynağının sınırının çok yüksek seviyelerde olacağını ve rekabet açısını da etkileyip fiyat dengesini de sağlayacağı öngörülmektedir. Hidrojenin taşıtlar için kullanılması otomotiv sektörü açısından büyük önem arz etmektedir. Bu enerji kaynağının taşıtlar için kullanılması için en önemli neden petrol kaynaklı yakıtların çevre ve hava kirliliği gibi küresel ısınma sorunlarını yol açması gösterilebilir. Hidrojenin taşıtlarda kullanımı için içten yanmalı motorların hidrojen yakıtına uygun sistemlere dönüştürülmesi ile gerçekleştirilebilir. Bu dönüşümün yanı sıra ulusal ve uluslararası hidrojen yakıt alt ve üst yapı sistemlerinin hayata geçirilmesi hidrojen yakıtının yaygınlaşmasına önemli bir katkı sağlayacaktır. Bu sebeple hem yeni iş imkanları yaratılmış olup hem de doğa ve çevremize zarar vermeden sıfır emisyonlu yakıt kullanımı ortaya çıkacaktır. Otomotiv sektörünün hidrojen yakıtı üzerine daha çok durması bu konuda ulusal ve uluslararası hükümetlerin teşviklerinin artırılması taraftarı olduğumu belirtmekteyim.

Anahtar Kelimeler: Hidrojen enerjisi, Otomotiv, Yenilenebilir enerji, Sıfır emisyon

ABSTRACT

There are many energy sources in the world. These energy sources do not show an equal distribution in every region of the earth. This unequal energy distribution leads to the emergence of very different alternative energy sources. The rapid consumption of petroleum-based fuels in the world also plays the most important role in the emergence of new energy sources. Although there are many alternative energy sources, hydrogen energy seems to be more efficient than petroleum-based fuels in terms of environmental friendliness and efficiency. It is foreseen that the sustainability of hydrogen energy will have a very high limit for this energy source, and it will also affect the competitiveness and ensure the price balance. The use of

hydrogen for vehicles is of great importance for the automotive industry. The most important reason for using this energy source for vehicles is that petroleum-based fuels cause global warming problems such as environmental and air pollution. For the use of hydrogen in vehicles, it can be realized by converting internal combustion engines to systems suitable for hydrogen fuel. In addition to this transformation, the implementation of national and international hydrogen fuel infrastructure and superstructure systems will make a significant contribution to the widespread use of hydrogen fuel. For this reason, both new job opportunities will be created and zero emission fuel will be used without harming nature and our environment. I state that I am in favor of increasing the incentives of national and international governments to focus more on hydrogen fuel in the automotive sector.

Keywords: Hydrogen energy, Automotive, Renewable energy, Zero emissions

1. GİRİŞ

Son yıllarda en çok tartışılan konulardan bir tanesi de petrol kaynaklarının azaldığı ve buna çözüm yolu arama çalışmalarına girilmiş olup yeni temiz ve çevreci olan enerji kaynaklarına olan ilginin artmasıdır. Bu konuda pek çok alternatif enerji kaynaklarından güneş enerjisi, jeotermal enerji, rüzgar enerjisi, biyoyakıtlar ve hidrojen enerjisi gibi enerji kaynakları üzerine olan çalışmalar hız kazanmıştır.

Ulaşım denilince akla ilk gelen taşıtlarda tüketilen enerji kaynağı bugüne kadar tamamına yakını petrol türevli yakıtlardan karşılanmıştır. Bu durumda ise taşıtlarda alternatif yakıt kaynaklarının kullanım zorunluluğunu ortaya çıkarmıştır. Bu sebeple taşıtlarda güneş, elektrik, hidrojen enerjisi kullanılmasına yönelik geliştirme çalışmaları tüm dünyada devam etmektedir. Yapılan çalışmalar neticesinde hibrid taşıtlar, bu ortaya çıkan yeni alternatif yakıt teknolojilerinin uyum sağlama sürecinde bir basamak olacağı görünmektedir. Bu sebeple tüm dünyada önde gelen otomotiv firmaları ciddi bir şekilde AR-GE, prototip üretim ve hatta seri üretime yönelik değişik yönlerden ele almaktadır. Bu firmaların yaptıkları çalışma ve projeler arasında hidrojen yakıtlı sistemler önemli bir yer almaktadır. Buradaki en önemli sebep ise bir alternatif enerji kaynağı olan hidrojenin sürdürülebilir ve çevreci olmasıdır. Dünyanın $\frac{3}{4}$ 'ünü oluşturan su ve pek çok gezegende var olan hidrojenin, oksijenle tepkimesi sonucu su oluşur. Bu da hidrojene çevreci bir yakıt özelliği, sudan elektoliz yöntemi ile ayrıştırılabilmesi ise tersinir olma özelliği kazandırır (Şenaktaş, 2005).

Hidrojen yakıtının kullanımındaki diğer bir avantaj ise, hava kirliliğinin ortaya çıkmasındaki etkisinin çok az bir seviyede olmasıdır. Hidrojen hava ile tepkimesi sonucunda, hidrokarbon bulunan yakıtlarda ortaya çıkan CO, CO₂, SO₂ gibi gazlar ve tam yanmamış hidrokarbonlar

ortaya çıkmamaktadır. Bu da yanma sonucu ortaya çıkan ürünlerin meydana getirdiği fotokimyasal sis, asit yağmuru, sera etkisi gibi durumlar hidrojen yakıtının yanması sonucu ortaya çıkmamaktadır. Hidrojenin yanmasıyla birlikte oluşan NO_x emisyonları seviyesi ise, sıcaklık seviyelerinin artışı nedeniyle, diğer yakıtlara nazaran daha fazla olabilmektedir. Hidrojen yakıtının depolama ve üretim maliyetinin hala yüksek olması hidrojenin yaygınlaşmasında dezavantaj bir durum yaratan etkenlerden biridir. Fakat hidrojen yakıtının yaygınlaşarak kullanımının artışı ve aynı zamanda üretim kapasitesinin de artması ile beraber maliyette de doğal olarak bir düşüş olacaktır (Swain, Adt and Pappas, 1983).

2. HİDROJEN YAKITININ TAŞITLARDA KULLANIMI

Hidrojen yakıtı enerji olarak birçok sektörde kullanılacağı gibi en önemlisi ise taşıtlarda kullanılması ile büyük bir etki yaratacaktır. Bu konuda birçok AR-GE çalışmaları yapılmış olup yapılmaya da devam etmektedir. Hem çevreci oluşu hem de sürdürülebilir bir yakıt olması nedeniyle taşıtlar için çok büyük önem arz etmektedir.

Hidrojen yakıtının içten yanmalı motorlarda kullanılabilmesi için pek çok çalışmalar yapılmaktadır. Fakat yapılan bu çalışmalar benzinli motorlar üzerine sistem kurularak yapılmaktadır ve bu motorlar hidrojen yakıtının kullanılmasına izin verecek şekilde dizayn edilmişlerdir. Hidrojen yakıtının içten yanmalı motorlarda kullanılması ile birlikte bazı incelemeler doğrultusunda aşağıdaki sonuçlar ortaya çıkmıştır (Vorst, D and Finegold, 1975).

- Birkaç ufak değişiklikler ile benzinli motorlar hidrojen yakıtı ile çalışacak hale getirilebilirler. Isıl verimleri ise benzinli motorlara yakındır.
- Stokiyometrik çalışma koşullarında hidrojen ile çalışan motorda yüksek oranda NO_x oluşur. Fakat silindirlerin içerisine gönderilen yakıt karışımı fakirleştirilerek NO_x gazı oluşumu azaltılabilir.
- Benzinli motordan hidrojen yakıtlı motora dönüştürülen motorda, stokiyometrik hidrojen-hava karışımında %20 oranında güç düşüşü ortaya çıkar.
- Karbüratörlü motorların emme manifoldunda oluşan alev tepmesi önemli bir sorundur.

Hidrojen yakıtıyla çalışan bu motorun dezavantajları, benzinli motorlar ile kıyaslama durumunu azaltmaktadır. Fakat bu zamana kadar ki çalışmalar ile bu sorunlar çözülerek, hidrojen yakıtlı motorun verimine ve hava kirliliği oranının azaltılmasına olan etkileri görülmüştür. Hidrojen yakıtının sıkıştırma oranı yüksek motorlar için kullanılarak neden olduğu güç düşüşü azaltılabilir. Ayrıca aşırı doldurma sistemleri kullanılarak ek bir güç sağlanabilir. Sıkıştırma oranının artırılması ve fakir karışımla hidrojen yakıtlı motorun ısıl veriminde, benzinli motora

kıyasla %25'lik bir artış ortaya çıkabilir. Fakir karışımla alev tepmesi ciddi miktarlarda azaltılabilir (İnt. Kyn. 1).

Hidrojen yakıtı taşıtlarda, içten yanmalı motorlarda kullanıldığı gibi, elektrik motorlarının güç kaynağı olarak da kullanılmaktadır. Ayrıca içten yanmalı motorlarda tek başına kullanılabildiği gibi benzinli ve dizel motorlara yakıt zenginleştirilmesi olarak da kullanılmaktadır (Temelci, 2000).

3. HİDROJENİN DİĞER YAKITLARLA EMİSYON KARŞILAŞTIRILMASI

Hava kirliliği hidrokarbon içeren yakıtların yanması sonucunda oluşmaktadır ve açığa çıkan; HC, CO, NO_x ve partikül madde emisyonları yeryüzündeki havayı kirleterek önemli sağlık problemleri ortaya çıkarmaktadır. Karbon emisyonu ortaya çıkaran yakıtları yakan endüstriyel motorlar, sabit motorlar ve evsel kazanlar gibi makinelerden ortaya çıkan egzoz gazlarının hava kirliliği yaratmasındaki etkileri her ne kadar fazlaysa da yapılan çalışmalar sonucunda büyük kentlerde motorlu taşıtların çıkardığı egzoz emisyonlarının hava kirliliğine toplam hava kirliliği içindeki oranının % 50'lere kadar ulaştığı bilinmektedir (Şahin, 1996 ve Sharma and Khara, 2001).

Son yıllarda petrol kaynaklarının azalacağı düşüncesi ve artan çevre bilincine paralel şekilde özellikle gelişmiş ülkelerin koyduğu yaptırımlar, çevre bilinci esaslı üniversitelerin firmaları çevreyi kirletmeyen üretimlere yönlendirmesi, alternatif yakıtla çalışan motorların imal edilmesine yönlendirmiştir. Bu sebeple otomotiv firmaları egzoz emisyonlarını düşürecek önlemler almaya ve alternatif yakıtların kullanılabildiği motorlar imal etmeye başlamıştır (Nichols, 1982; Gümüş ve Tekin, 2001).

Hidrojen, alternatif ve sürdürülebilir, petrol kaynaklı yakıtlar gibi karbon ve hidrokarbon emisyonları ortaya çıkarmayan bir yakıt türüdür. Hidrojenin, çevreci yanma ürünleri ve petrol kaynaklı yakıtlara göre daha verimli bir yanma performansı sağlaması, hidrojen yakıtının kullanımına yönelik çalışmalara hız kazandırmıştır. Hidrojenin, yanması sonucunda temel yanma ürünü olarak H₂O ortaya çıkmakta olup, içerisinde C bulunan bir yakıt türü olmadığından, NO_x haricinde; CO, HC, CO₂, SO_x ve organik asitler ortaya çıkmamaktadır (Gillingham, 2007).

Tüm dünyada benzinli ve dizel yakıtlı taşıtlar kullanılmaktadır. Bu taşıtların tork ve güç açısından kullandıkları araç marka ve modelleri farklılık göstermektedir. Her geçen yıl bu taşıtlardaki emisyonları azaltma üzerine birçok farklı sistemler uygulanmaktadır. Bu

sistemlerin uygulanmasına karşın emisyonları sıfıra indirme konusunda net bir çözüm ortaya çıkarılamamıştır. Hidrojen ise alternatif yakıtlar arasında emisyon değerlerini sıfıra indirebilecek potansiyele sahip bir yakıt türüdür.

4. SONUÇ

Volkswagen otomotiv firmasının Eylül 2015 tarihinde Amerika Birleşik Devletleri'nin Çevre Koruma Ajansı (EPA) tarafından Amerika Birleşik Devletlerin de satışı yapılan bazı Volkswagen markalı dizel otomobillerde yapılan emisyon testleri sonucunda normalde dışarı salınan emisyon değerlerinin 40 katı kadar daha fazla egzoz emisyon salınımı tespit edilmiştir. Bu otomobillerde yanıtıcı yazılım kullanımından kaynaklı olduğu ortaya çıkmıştır. Bu durum temiz ve çevreci alternatif yakıtların önemini bir kez daha gözler önüne sermiştir.

Dünya üzerinde bakıldığında pek çok bölgede yenilebilir alternatif enerji kaynaklarının olduğu bilinmektedir. Yüzyıllardan beri bilinmesine karşın petrol kaynaklı yakıtlar tüketilmeye devam etmiştir. Ta ki son yıllarda ortaya çıkan petrol kaynaklarının azalması ve bazı emisyon skandallarının gündeme gelmesi ile yenilenebilir enerji kaynakları ile ilgili çalışmalar hız kazanarak devam etmektedir.

Yenilenebilir enerji kaynaklarının arasında yaygın olarak kullanılabilir yakıtlardan bir tanesi de hidrojenidir. Hidrojen farklı yakıt kaynaklarından ve farklı yöntemlerle elde edilebilmektedir. Büyük bir bölümü ise doğalgazda bulunan metanın su buharı ile katalitik olarak oksidasyonu sonucunda elde edilmektedir. Hidrojenin çevreci enerji kaynakları olan rüzgar, güneş gibi kaynaklardan elde edilmesine yönelik çalışmalara ağırlık verilmesi petrol kaynaklarına olan bağımlılığı azaltacaktır.

Hidrojen yakıtının geleceği ile ilgili olarak Britain Royal Automobil Clup (RAC) isimli bir kuruluş, 2050'li yıllara dönük araştırma yapmış olup geleceğin otomobilleri üzerindeki çalışmaları sonucunda ortalama olarak Avrupa'daki bir otomobilin 2050'de günümüzdeki araçlarla aynı ağırlık ve hacimde olacağı fakat yakıt olarak kesinlikle sıkıştırılmış hidrojen yakıtının kullanılacağı vurgulanmaktadır (Calestous, Juma & Cheong, Lee Yee, 2005).

İnsanlık açısından bakıldığında ise hidrojen yakıtının fayda sağlayacağı görülmektedir. Bazı teknolojik ve finansal sorunlar görülsede bu sorunların çözülebileceği fakat bunların önünde siyasi ve politik durumların engel teşkil etmesi sorunun ana nedeni olmaktadır.

KAYNAKLAR

- Şenaktaş, B. (2005). Hidrojen Enerjisi, Üretimi ve Uygulamaları. Pamukkale Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.
- Swain, M.R., Adt, R.R. ve Pappas, J.M. (1983). Experimental Hydrogen Fuelled Automotive Eng Design Data-Base Project, Report prepared for U.S. Dept. Of Energy.
- Vorst, W., D.V., Finegold, J.G. (1975). Automotive Hydrogen Engines, And Onboard Storage Methods, Hydrogen Energy Fundamentals, Miami Beach, Florida U.S.A.
- <http://www.youthforhab.org.tr/>
- Temelci, F. E., (2000). Taşıtlarda Alternatif Yakıt Olarak Hidrojen Kullanımı. Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.
- Sharma, P. and Khara, M. (2001). Modeling of Vehicular Exhaust-A Review, Transportation Research, 179-198.
- Nichols, R. (1982). Application of Alternative Fuels, SAE Paper 821573, USA.
- Gümüş, M. ve Tekin, M. (2001). Çift Yakıtlı (Dizel+Doğal Gaz) Dizel Motorunun Yanma Ürünleri Analizi, TMMOB Makine Mühendisleri Odası VII. Otomotiv ve Yan Sanayi Sempozyumu, 26-27 Ekim 2001, Bursa, 96-101.
- Şen, Z. ve Şahin A. (1996). Future Prospects of Fossil and Alternative Energy Sources, Proceedings of The First International Energy and Environment Symposium, 29-31 July 1996, Trabzon.
- Gillingham K. (2007). Hydrogen Internal Engine Vehicles: A Prudent Intermediate Step or A Step in The Wrong Direction? Department of Management Science & Engineering Global Climate and Energy Project, Precourt Institute for Energy Efficiency, Stanford University, sf 1-28.
- Calestous, Juma & Cheong, Lee Yee, (2005) Innovation: Applying Knowledge in Development, UN Millennium Project, NY.
- Abd Wahab, M. H., Anuar, N. I. M., Ambar, R., Baharum, A., Shanta, S., Sulaiman, M. S., & Hanafi, H. F. (2018). IoT-based battery monitoring system for electric vehicle. *International Journal of Engineering & Technology*, 7(4.31), 505-510.
- Asaad, M., Ahmad, F., Alam, M. S., & Rafat, Y. (2018). IoT enabled monitoring of an optimized electric vehicle's battery system. *Mobile Networks and Applications*, 23, 994-1005.
- Attidekou, P. S., Wang, C., Armstrong, M., Lambert, S. M., & Christensen, P. A. (2017). A new time constant approach to online capacity monitoring and lifetime prediction of lithium ion batteries for electric vehicles (EV). *Journal of the Electrochemical Society*, 164(9), A1792.
- Deng, D. (2015). Li-ion batteries: basics, progress, and challenges. *Energy Science & Engineering*, 3(5), 385-418.
- Gelmanova, Z. S., Zhabalova, G. G., Sivyakova, G. A., Lelikova, O. N., Onishchenko, O. N., Smailova, A. A., & Kamarova, S. N. (2018, May). Electric cars. Advantages and disadvantages. In *Journal of Physics: Conference Series*, 1015(5), 052029, IOP Publishing.
- Gerssen-Gondelach, S. J., & Faaij, A. P. (2012). Performance of batteries for electric vehicles on short and longer term. *Journal of power sources*, 212, 111-129.
- Haidar, A. M., Muttaqi, K. M., & Sutanto, D. (2014). Technical challenges for electric power industries due to grid-integrated electric vehicles in low voltage distributions: A review. *Energy Conversion and Management*, 86, 689-700.

- Hua, C. C., & Lin, M. Y. (2000, December). A study of charging control of lead-acid battery for electric vehicles. In *ISIE'2000. Proceedings of the 2000 IEEE International Symposium on Industrial Electronics (Cat. No. 00TH8543)*, 1, 135-140, IEEE.
- Lee, J., Kwon, D., & Pecht, M. G. (2018). Reduction of Li-ion battery qualification time based on prognostics and health management. *IEEE Transactions on industrial electronics*, 66(9), 7310-7315.
- Li, D., Ouyang, J., Li, H., & Wan, J. (2015). State of charge estimation for LiMn2O4 power battery based on strong tracking sigma point Kalman filter. *Journal of power sources*, 279, 439-449.
- Omariba, Z. B., Zhang, L., & Sun, D. (2019). Review of battery cell balancing methodologies for optimizing battery pack performance in electric vehicles. *IEEE Access*, 7, 129335-129352.
- Özbay, H., Közkurt, C., DALCALI, A., & Tektaş, M. (2020). Geleceğin ulaşım tercihi: Elektrikli araçlar. *Akıllı Ulaşım Sistemleri ve Uygulamaları Dergisi*, 3(1), 34-50.
- Pradhan, S. K., & Chakraborty, B. (2022). Battery management strategies: An essential review for battery state of health monitoring techniques. *Journal of Energy Storage*, 51, 104427.
- Sarrafan, K., Muttaqi, K. M., & Sutanto, D. (2018, September). Real-time state-of-charge tracking system using mixed estimation algorithm for electric vehicle battery system. In *2018 IEEE Industry Applications Society Annual Meeting (IAS)*, 1-8, IEEE.
- Sarrafan, K., Sutanto, D., & Muttaqi, K. M. (2017, December). An electric circuit based EV battery model for runtime prediction and state of charge tracking. In *2017 IEEE Transportation Electrification Conference (ITEC-India)*, 1-6, IEEE.
- Saqli, K., Bouchareb, H., Oudghiri, M., & M'Sirdi, N. (2019). An overview of State of Charge (SOC) and State of Health (SOH) estimation methods of Li-ion batteries. *IMAACA 2019*.
- Schweiger, H. G., Obeidi, O., Komesker, O., Raschke, A., Schiemann, M., Zehner, C., ... & Birke, P. (2010). Comparison of several methods for determining the internal resistance of lithium ion cells. *Sensors*, 10(6), 5604-5625.
- Wang, Y. N. (2019). Power battery performance detection system for electric vehicles. *Procedia computer science*, 154, 759-763.
- Wang, B., Fernandez, J. H., & Massoud, A. (2019, October). A wireless battery temperature monitoring system for electric vehicle charging. In *2019 IEEE SENSORS*, 1-4, IEEE.
- Wang, K., Wan, J., Xiang, Y., Zhu, J., Leng, Q., Wang, M., ... & Yang, Y. (2020). Recent advances and historical developments of high voltage lithium cobalt oxide materials for rechargeable Li-ion batteries. *Journal of Power Sources*, 460, 228062.
- Yang, N., Zhang, X., & Li, G. (2015). State of charge estimation for pulse discharge of a LiFePO4 battery by a revised Ah counting. *Electrochimica Acta*, 151, 63-71.

ORGANİK ÜRÜNLERE YÖNELİK ALGININ ARACILIĞI DURUMUNDA TÜKETİCİLERİN ORGANİK GIDA TÜKETİM NİYETLERİNİ ETKİLEYEN ETMENLERİN BELİRLENMESİ

Gizem YENER

Independent Researcher, Gaziantep 27100, Turkey

ORCID ID: 0000-0001-5543-8999

Arzu SEÇER

Çukurova University, Faculty of Agriculture, Department of Agricultural Economics, Sarıcam, Adana.

ORCID ID: 0000-0003-1347-4988

ÖZET

Tarımsal ürünlerin üretimi ve tüketimi, çevre ve insan sağlığı üzerinde büyük etkilere sahiptir. Bu nedenle, tarım sektöründe çevresel sürdürülebilirlik yönünde dönüşümler elde etmek önemli olup son yıllarda farklı yaklaşımlar gündeme gelmektedir. Bu yaklaşımlardan organik ürün üretimi ve tüketimi oldukça önemli kabul edilmektedir. Son yıllarda organik ürün tüketiminin hızlı bir şekilde artmış olması nedeniyle tüketicilerin bu ürünleri tercih etmesini etkileyen faktörlerin belirlenmesi çeşitli çevrelerce oldukça önemli bir konu haline gelmiştir. Bu çalışma ile Gaziantep ilinde tüketicilerin organik ürünleri tüketme niyetini etkileyen faktörler ve bu faktörlerin birbirleri ile ilişkileri organik ürünlere yönelik algının aracılığı dikkate alınarak ortaya konulmuştur. Çalışmanın ana materyalini 210 kişiyle online olarak yapılmış anketlerden elde edilen veriler oluşturmaktadır. Araştırmada elde edilen veriler yapısal eşitlik modellemesi ile analize tutulmuştur. Elde edilen bulgulara göre; tüketicilerin organik ürünlere algısı, yetenekleri ve hedonizm organik ürün satın alma niyetini pozitif yönde etkilemektedir. Bununla beraber tüketicilerin organik ürünlere algısının hedonizm ve sosyal normlar ile satın niyeti arasında aracı olma özelliğine sahiptir. Çalışma sonucu elde edilecek veriler organik ürünlerin üretimi ve tüketimi ile ilgilenen firmaların, kamu kurumlarının, araştırma kurumlarının geleceğe yönelik planlama yapmalarına katkıda bulunacaktır.

Anahtar Kelimeler: Organik ürün tüketimi, algı, sosyal normlar, hedonizm, yapısal eşitlik modellemesi.

DETERMINATION OF THE FACTORS AFFECTING CONSUMERS' INTENTION TO CONSUME ORGANIC FOOD AS MEDIATED BY PERCEPTION ABOUT ORGANIC PRODUCTS

ABSTRACT

The production and consumption of agricultural products wield profound implications for both the environment and human health. As a result, the pursuit of transformations leading to environmental sustainability within the agriculture sector has become an imperative, with various approaches gaining prominence in recent years. Organic product production and consumption stand out as particularly significant among these strategies. In recent years, the rapid upsurge in organic product consumption underscores the importance of identifying the determinants that shape consumers' preferences for such products, a subject of paramount significance in diverse spheres. This study reveals factors influencing consumers' intentions to engage in organic product consumption in Gaziantep, considering the mediating role of consumers' perceptions of organic products and the intricate interrelationships among these factors. The primary dataset employed in this study derives from online surveys administered to 210 individuals. The data obtained underwent analysis employing structural equation modeling techniques. The results reveal that consumers' perception towards organic products, their individual capabilities, and hedonistic considerations have a positive influence on their intention to purchase organic products. Furthermore, consumers' perception towards organic products are found to mediate the relationship between hedonism and adherence to social norms in the context of purchase intentions. The insights gleaned from this study hold significant implications for future planning initiatives by corporations, public institutions, and research organizations involved in the production and consumption of organic products.

Keywords: Organic food, consumer intention, perception, hedonism, social norms, structural equation modelling.

INTRODUCTION

The rapid onset of the industrialization movement in the 18th century had some impacts such as global population growth and urbanization. These developments have increased the demand for food, prompting the intensive use of chemical inputs in agriculture to meet this demand (Pawlak and Małgorzata, 2020; Thomas et al., 2022). This condition has enabled both an increase in agricultural production and higher yields per unit of land. However, the use of these chemical inputs has polluted the environment, and consequently, adversely affected human health. These developments led to consumers' need for some alternatives to avoid health risks and environmental damage from food consumption (FAO, 2017; Popp et al., 2013).

Organic agriculture is recognized as one of the remarkable approaches contributing to food and nutrition security within the scope of sustainable farming (Gamage et al., 2023). Organic food production represents a human and environmentally-centered approach that emphasizes the preservation and improvement of ecological diversity by using as less agricultural inputs as possible (Underwood et al., 2011). The higher awareness of the natural environment and increasing health concerns by society have led to changes in consumer behavior, resulting in a heightened interest in organic food products. In recent years, organic food consumption has experienced rapid growth in global demand. In other words, consumer and environmentally-oriented approaches motivate individuals to consume more organic food (Rana and Paul, 2017; Parashar et al., 2022).

The influence of consumer demand in Europe has had a significant impact on the development of the organic products market (Nechaev et al., 2018). Consequently, the increase in education and income levels among consumers in Turkey has further emphasized the importance of this sector. These developments are of interest to professionals in the field of marketing. Understanding and interpreting changes in consumer behavior and developing strategies have become integral aspects of organic food marketing (Aydoğdu and Kaya, 2020; Erdal and Turhan, 2020).

This study aims to reveal factors affecting consumers' intention to purchase organic food products and the mediating role of perceptions about organic food. The literature review shows that factors affecting consumers' intention to purchase organic food products are defined as perceptions about organic food, subjective norms, consumers' abilities, hedonism, and openness to new experiences. The findings of this study may provide market shareholders with the opportunity to have a better understanding of consumer behaviors toward organic food products.

CONCEPTUAL FRAMEWORK

In this study, the factors affecting consumers' intention to purchase organic food products were derived from previous studies. In line with the literature review, the conceptual framework consists of perception about organic food, subjective norms, abilities, hedonism and openness to new experiences. Definitions of these factors are given in Table 1.

Table 1. Definitions of the factors

Factors	Explanations
Perception about organic food	Perception is an intertwined cognitive process through which individuals systematically organize and interpret sensory data conveyed by their sensory organs. This intricate process enables human beings to derive meaning from the various stimuli originating from the objects and events within their surrounding environment (White et al., 2019).
Subjective Norms	The term is defined as the pressure perceived by an individual to endorse or adopt a specific behavioral pattern, arising from the social dynamics in which the individual is situated or from individuals who share common social values with them (Ajzen, 1991).
Ability	Ability is seen as a complex entity that includes a combination of factors such as awareness, experience, knowledge, skills, accessibility to information, and financial resources (Ryan and Jepson, 2018)
Hedonism	Some consumers consider pleasure and happiness as significant life goals and may shape their consumption preferences accordingly. Hedonism is referred to as the behavior of continuously seeking pleasure and enjoyment from consumption or shopping (Tarka et al., 2022).
Openness to new experiences	This concept expresses how consumers engage with novel products, services, technologies, and ideas, and approach to these innovations (Tan, C. S., 2010; Gomes et al., 2022).

Research hypotheses related to the perception about organic food, subjective norms, abilities, hedonism, and openness to new experiences on consumers' intention to purchase organic food are presented below.

H1: Perception about organic food has a direct effect on consumers' intention to purchase organic food products.

H2: Subjective norms have a direct effect on consumers' intention to purchase organic food products.

H3: Abilities have a direct effect on consumers' intention to purchase organic food products.

H4: Hedonism has a direct effect on consumers' intention to purchase organic food products.

H5: Openness to new experiences has a direct effect on consumers' intention to purchase organic food products.

H6: Perception about organic food has a mediator role between subjective norms and intention to purchase organic food products.

H7: Perception about organic food has a mediator role between hedonism and intention to purchase organic food products.

H8: Perception about organic food has a mediator role between openness to new experiences and intention to purchase organic food products.

METHODOLOGY

The primary data obtained through face-to-face surveys with consumers constitute the main material of the study. A standardized survey form was used in the study, which consists of two sections. The first section contains questions about the demographic characteristics of the consumers, while the second section aims to present the scales to identify the factors influencing their intention to purchase organic food products.

The items in the scales used in the study were compiled from previous research. A five-point Likert scale (1: strongly disagree...3: neither agree nor disagree...5: strongly agree) was employed to assess consumers' agreement with these items. The survey form was presented to consumers online, using the snowball sampling method. The data obtained from the survey was analyzed using descriptive statistics and structural equation modeling.

FINDINGS

Demographic Characteristics of the Consumers: Of all the participants, 61.9% were female. With an average age of 38.4 years, a significant proportion of the participants, accounting for 41.4%, were aged between 41 and 71. Approximately 45.2% of these individuals had a bachelor's degree, 17.1% graduated from a vocational school, and 15.2% held a high school diploma. The participants were predominantly workers in the private sector and public sector or self-employed professionals (Table 2).

Table 2. Demographic Characteristics of Consumers

Characteristics	Frequency	Percent
Gender		
Women	130	61.9
Men	80	38.1
Total	210	100.0
Age		
18-30	65	31.0
31-40	58	27.6
41-72	87	41.4
Total	210	100.0
Mean	38.4	
Education		
Primary school	8	3.8
Secondary School	5	2.4
High School	32	15.2
Vocational School	36	17.1
Bachelor Degree	95	45.2
Master and doctorate	34	16.2
Total	210	100.0

Table 2. Demographic Characteristics of Consumers (cont.)

Characteristics	Frequency	Percent
Occupations		
Private Sector	47	22.4
Government staff	45	21.4
Self-employed	40	19.0
Housewives	27	12.9
Unemployment	12	5.7
Retired	11	5.2
Student	18	8.6
Others	10	4.8
Total	210	100.0

Confirmatory Factor Analysis:

The reliability and validity of scales are evaluated using Cronbach’s alpha, composite reliability (CR) and average variance extracted (AVE) values in a confirmatory factor analysis. Cronbach’s alpha value assesses the internal consistency of the items within a scale. A value exceeding 0.6 indicates that the scale is quite reliable. CR (Composite Reliability) is another criterion that provides insights into the construct reliability, and it is deemed suitable when it exceeds 0.7. AVE is a measure of the convergent validity among items representing a latent construct. When this value is above 0.5, it indicates that the construct possesses convergent validity. It is also important that CR values should be above AVE values to represent the reliability and validity of scales.

In this study, Cronbach's alpha values of the scales range from 0.675 to 0.901. These values indicate that the scales possess internal consistency. The CR values were found to be between 0.665 and 0.816, signifying the structural reliability of the scales. The AVE values, ranging from 0.474 to 0.670, indicate the construct validity of the scales. It should also be noted that the CR values are above the AVE values. These results indicated that the scales satisfied the requirements for further analysis (Table 3).

The decision on whether the tested model is supported by the overall collected data is determined by examining the model fit indices generated as a result of CFA. In this study, the goodness-of-fit values (CMIN/DF=1.838; NFI=0.883; CFI=0.942; RMSEA=0.063; SRMR=0.0510) indicate that the proposed model is coherent with the data and is considered acceptable.

Table 3. Cronbach Alpha, CR and AVE Values

Scales	Cronbach's Alpha	CR	AVE
Intention to purchase organic food products	0.801	0.748	0.583
Perceptions about organic food	0.901	0.816	0.632
Subjective Norms	0.675	0.665	0.522
Abilities	0.768	0.778	0.474
Hedonism	0.859	0.732	0.670
Openness	0.824	0.735	0.630

Structural Analysis:

The analysis results indicate that the model fit indices for the structural model (CMIN/DF=1.867; NFI=0.880; CFI=0.939; RMSEA=0.064; SRMR=0.0545) confirm the fitness of the measurement model. Perception ($\beta=0.423$, $p<0.001$), ability ($\beta=0.248$, $p=0.016$) and hedonism ($\beta=0.348$, $p=0.006$) has positive impacts on consumers' intention to purchase organic food products in the model. Moreover, hedonism ($\beta=0.460$, $p<0.001$) and subjective norms ($\beta=0.481$, $p<0.001$) are directly related to perceptions about organic food. Finally, perception has a mediating role between both hedonism and intention ($\beta=0.195$, $p=0.003$) and subjective norms and intention ($\beta=0.203$, $p=0.002$).

Table 4. Path Analysis Results

Paths	Standardized coefficients	p-values	Hypothesis Evaluation
Int <--- Perception	.423	***	Accepted
Int <--- Ability	.248	.016	Accepted
Int <--- Openness to new experiences	.153	.156	Rejected
Int <--- Hedonism	.348	.006	Accepted
Int<--- SNorms	-.164	.182	Rejected
Perception <--- Openness to new experiences	-.165	.174	Rejected
Perception <--- Hedonism	.460	***	Accepted
Perception <--- Subjective Norms	.481	***	Accepted
Int <--- Perception <--- Openness to new experiences	-.070	.171	Rejected
Int <--- Perception <--- Hedonism	.195	.003	Accepted
Int <--- Perception <--- Subjective Norms	.203	.002	Accepted

CONCLUSION

The development of organic food products has been driven by the increasing awareness of consumers about health and environmental issues. The increase in this consumption initially began in Europe and later spread to Turkey. Consequently, understanding consumer behaviors in organic food product marketing and developing strategies have become highly important for stakeholders in the sector. This study aims to highlight the factors influencing consumers'

intentions to purchase organic products and the significance of perception among these factors. The study is based on data obtained from 210 consumers through online surveys conducted in Gaziantep province. The data obtained from the surveys was analyzed using structural equation modeling.

According to the data obtained from the analysis, perception, hedonism, and ability have a direct impact on intention. Hedonism and subjective norms lead to a higher positive perception, which in turn increases intention. In strategic efforts aimed at increasing the consumption of organic products, it would be beneficial to enhance the positive attitude towards organic products in society, support consumers' hedonistic values, and create a higher positive perception among consumers.

REFERENCES

- Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50 (2), 179-211.
- Aydođdu, M. & Kaya, F. (2020). Factors Affecting Consumers' Consumption of Organic Foods: A Case Study in GAP-Şanlıurfa in Turkey. *Journal of Agricultural Science and Technology*. 22. 347-359.
- FAO. (2017). The future of food and agriculture – Trends and challenges. Rome.
- Gamage, A., Gangahagedara, R., Gamage, J., Jayasinghe, N., Kodikara, N., Suraweera, P. & Merah, O. (2023). Role of organic farming for achieving sustainability in agriculture. *Farming System*, 1 (1), 100005. <https://doi.org/10.1016/j.farsys.2023.100005>.
- Gomes, G. M., Moreira, N., Ometto, A. R. (2002). Role of consumer mindsets, behaviour, and influencing factors in circular consumption systems: A systematic review. *Sustainable Production and Consumption*. 32, 1-14.
- Johnson, J. S.; Friend, S. B. (2015) Contingent cross-selling and up-selling relationships with performance and job satisfaction: An MOA-theoretic examination. *J. Pers. Sell. Sales Manag.* 35, 51–71.
- Nechaev, V., Mikhailushkin, P. & Alieva, A. (2018). Trends in demand on the organic food market in the European countries. *MATEC Web of Conferences*. 212, 07008. <https://doi.org/10.1051/mateconf/201821207008>.
- Parashar, D., Singh, S. & Sood, G. (2022). Examining the role of health consciousness, environmental awareness and intention on purchase of organic food: A moderated model of attitude. *Journal of Cleaner Production*. 386, 135553. <https://doi.org/10.1016/j.jclepro.2022.135553>.
- Pawlak, K. & Małgorzata K. (2020). The Role of Agriculture in Ensuring Food Security in Developing Countries: Considerations in the Context of the Problem of Sustainable Food Production. *Sustainability*, 12 (13), 5488. <https://doi.org/10.3390/su12135488>
- Popp, J., Pető, K. & Nagy, J. (2013). Pesticide productivity and food security. A review. *Agron. Sustain. Dev.* 33, 243–255 (2013). <https://doi.org/10.1007/s13593-012-0105-x>.
- Rana, J. & Paul, J. (2017). Consumer behavior and purchase intention for organic food: A review and research agenda. *Journal of Retailing and Consumer Services*, 38, 157-165. <https://doi.org/10.1016/j.jretconser.2017.06.004>.
- Ryan, W. Gerard & Jepson, Allan. (2018). Applying the Motivation, Opportunity, Ability (MOA) model, and Self-Efficacy (S-E) to better understand student engagement on Undergraduate Event Management Programmes.. *Event Management*. 22. <https://doi.org/10.3727/152599518X15173356116718>.
- White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT Consumer Behaviors to be More Sustainable: A Literature Review and Guiding Framework. *Journal of Marketing*, 83 (3), 22-49. <https://doi.org/10.1177/0022242919825649>

- Tan, C. S. (2010). Understanding Consumer Purchase Behavior in The Japanese Personal Grooming Sector. *Journal of Yasar University*. 17 (5): 2821-2831.
- Tarka, P., Kukar-Kinney, M. & Harnish, R. J., 2022. Consumers' personality and compulsive buying behavior: The role of hedonistic shopping experiences and gender in mediating-moderating relationships. *Journal of Retailing and Consumer Services*. 64 – 102802. <https://doi.org/10.1016/j.jretconser.2021.102802>.
- Thomas A., Alpha A., Barczak A. & Zakhia-Rozis N. (Eds.), 2022. Sustainable food systems for food security. Need for combination of local and global approaches. Versailles, Quæ, 222 p.
- Underwood, T., McCullum-Gomez, C., Harmon, A. & Roberts, S. (2011). Organic Agriculture Supports Biodiversity and Sustainable Food Production. *Journal of Hunger & Environmental Nutrition*. 6. 398-423. <https://doi.org/10.1080/19320248.2011.627301>.

BİTKİ TOHUMLARINA DUMAN SOLÜSYONU İLE PRIMİNG UYGULAMASI**Musa ÇEVİK**Yozgat Bozok University, Faculty of Agriculture, Department of Field Crops, Erdoğan Akdağ
Campus**ORCID ID: 0000-0002-7634-2889****Medine ÇOPUR DOĞRUSÖZ**Yozgat Bozok University, Faculty of Agriculture, Department of Field Crops, Erdoğan Akdağ
Campus**ORCID ID: 0000-0002-9159-1699****ÖZET**

Duman solüsyonu uygulamaları son yıllarda önemi artan, ucuz ve en önemlisi bitkisel artıkların değerlendirilmesi kapsamında çevre dostu olması sebebi ile sürdürülebilir tarıma hizmet eden bir uygulamadır. Tarımsal üretimde hasat sonrası kalan artıkların yakılması ile dumanın su içerisine muhafaza edilmesiyle duman solüsyonları elde edilmektedir. Bitkisel kaynaklı duman solüsyonlarının; çimlenme, büyüme, gelişme, stres toleransı, kalite ve verimlilik gibi pek çok aşamada bitki gelişimini destekleyici etkilerinin bulunduğu bildirilmiştir. Pek çok bitkide duman solüsyonunun oldukça az miktarda uygulanmasının ciddi verim ve kalite kazanımı sağladığı da bilinmektedir. Ayrıca duman solüsyonlarının küçük miktarlarının etkili olması ucuz ve kolay ulaşılabilir olduğunu göstermektedir. Bu solüsyonlar doğrudan toprağa sulama yoluyla, yaprak veya köke spreyleme ile uygulanabildiği gibi tohumlara priming şeklinde de uygulanabilmektedir. Priming uygulaması genellikle suda bekletme olarak uygulanmakta olup farklı kimyasal veya biyokimyasalların ilavesi ile de yapılmaktadır. Duman solüsyonu ile priming uygulamasında, solüsyonun bitki kaynağı, kullanılan konsantrasyonu, priming süresi ve uygulamanın yapıldığı bitkiye göre etkileri farklılık gösterebilmektedir. Bu çalışmada, tüm bu konular önceki çalışmalar bir araya getirilerek ortaya konulmuştur.

Anahtar Kelimeler: Duman solüsyonu, Ön hazırlama, Verim, Kalite**PRIMING APPLICATION TO PLANT SEEDS WITH SMOKE SOLUTION****ABSTRACT**

Smoke solution applications are an application that has increased in importance in recent years, is cheap, and most importantly, serves sustainable agriculture because it is environmentally friendly within the scope of utilizing vegetal residues. In agricultural production, smoke solutions are obtained by burning the residues remaining after harvest and preserving the smoke in water. Plant derived smoke solutions; It has been reported that it has supportive effects on plant development at many stages such as germination, growth, development, stress tolerance, quality and productivity. It is also known that applying very small amounts of smoke solution

in many plants provides serious yield and quality gains. In addition, the fact that small amounts of smoke solutions are effective shows that they are cheap and easily accessible. These solutions can be applied directly to the soil by irrigation, by spraying on leaves or roots, or can be applied to seeds as priming. Priming application is generally applied as soaking in water, but it is also be with the addition of different chemicals or biochemicals. In the priming application with smoke solution, the effects may vary depending on the plant source of the solution, the concentration used, priming duration and the plant on which the application is made. In this study, all these issues were presented by bringing together previous studies.

Keywords: Smoke solution, Priming, Yield, Quality.

1. GİRİŞ

Tarım, insanların hayatlarına devam edebilmesi için vazgeçilmez olan beslenmeyi, bitkisel ve hayvansal üretime dayalı olarak sürdürülebilmelerini sağlayan bir faaliyet alanıdır. Dünya nüfusunun artmasına paralel olarak tarımsal ürün ihtiyacı da giderek artmaktadır. Bu artan ihtiyaçlar doğrultusunda kalite ve verimi artırmak amacı ile küresel olarak araştırılan ve üretime katkı sağlayabilecek alternatif ve çevre dostu uygulamalar üzerine çalışmalar yapılmaktadır. Bu çalışmalardan birisi de bitkisel kaynaklı duman solüsyonlarıdır. Tarımsal faaliyetler sonucunda ortaya çıkan bitkisel atıklar kullanılarak üretilen duman solüsyonlarının çimlenme, büyüme, gelişme, stres toleransı, kalite ve verimlilik gibi pek çok aşamada bitki gelişimini destekleyici etkilerinin bulunduğu bildirilmiştir.

Duman solüsyonları; kuru veya taze bitkisel materyallerde yer alan aktif maddelerin 160-200 °C sıcaklıklarda buharlaştırılarak, suda çözünebilir uçucu bileşikler halinde depolanmaları prensibine göre hazırlanmaktadır (Jäger ve ark., 1996; Gerhard ve ark., 2006; Ngoroyemoto ve ark., 2019).

Duman solüsyonu uygulamalarının son zamanlarda kullanımı gittikçe yaygınlaşmakta olup solüsyonlar ister tohum priming olarak ister toprağa doğrudan uygulanabilmektedir (Doğrusöz ve ark. 2021). Priming, ekim öncesinde tohum yapılan çeşitli uygulamalar olup, çimlenme için gerekli metabolik aktiviteyi başlatacak, ancak kök çıkışına imkan tanımayacak seviyedeki kontrollü su alımı olarak tanımlanmaktadır.

(De Lange and Boucher, 1990). De Lange ve Boucher (1990) tarafından ilk olarak duman içerisinde bulunan kimyasalların çimlenme üzerinde olumlu etkiler yaptığı bildirilmiş ayrıca yapılan başka bir çalışmada ise dormansinin kırılmasında büyük rol oynadığı tespit edilmiştir (Renzi ve ark., 2016). Ayrıca tohumun çimlenme ve fide gelişimi üzerinde, duman solüsyonun

elde edildiği bitkininde önemli bir etkiye sahip olduğu belirtilmektedir (Jefferson ve ark., 2008; Lindon ve Menges, 2008; Dixon ve ark., 2009).

2. BİTKİSEL KAYNAKLI DUMAN SOLÜSYONLARI VE DOZLARI

Bitkilerden elde edilen duman, kolay ve ekonomik yöntemlerle hazırlanabilmektedir. Bitkilerden elde edilen duman çözeltisi üretmek için en yaygın yol, dumanın biyolojik olarak aktif bileşiklerini su içinde çözmek için dumanı su yoluyla dışarı çıkarmaktır. Duman bir tambur içinde üretilir ve sıkıştırılmış hava kullanılarak saf suyun içerisinde tutulur. Bu şekilde hazırlanan stok solüsyonlar, saf su ile seyreltikten sonra kullanılmaktadır. Bu yöntem ile çeşitli bitki materyalleri kullanılarak duman solüsyonu hazırlanmaktadır (Brown ve van Staden, 1997). Duman solüsyonunda oluşan aktif maddenin, bitki materyalinin 160 ila 200°C arasındaki bir sıcaklıkta ısıtıldığında oluştuğu bildirilmiştir. Bitki materyalinin 200°C'nin üzerinde ısıtılması, aktif maddelerin uçucu hale gelmesine neden olmaktadır. Genellikle tüm bitki materyalleri duman solüsyonu hazırlamak için uygundur (Jäger ve ark., 1996). Duman solüsyonu hazırlamada kullanılan bitki materyalinin kuru olması ve bitkinin ekonomik kısmı alındıktan sonra kalan kısmının kullanılması önemlidir. Ayrıca yakılan materyalin ağırlığı ve tutulan suyun miktarın solüsyonun konsantrasyonunu etkilemesi sebebi ile kritik öneme sahiptir. Hazırlanan solüsyonlar gerekli miktarlarda seyreltilerek kullanılmalıdır. Yine bu oranlar kullanılan materyale uygulanan bitki türüne göre değişmekle birlikte 1/10000 gibi küçük miktarlardan 1/1 oranlarında kullanılabilir (Dogrusoz 2022).

Yapılan literatür taramaları sonucu pek çok türün yakılması ile duman solüsyonu çözeltisi elde edildiği tespit edilmiştir. Bu türler arasında ayçiçeği, alovera, ginkgo, Cymbopogon jwarancusa (Kamran ve ark., 2017), kakao, çekirdeği kabuğu (Harti ve ark., 2020), buğday samanı (Başaran ve ark., 2019; Akeel ve ark., 2019), yabani yulaf (Light ve ark., 2010), mürdümük samanı (Doğrusöz ve ark., 2021), bezelye (Dogrusoz, 2022), marul (Adriansz ve ark., 2000), yabani tütün (Wang ve ark., 2017), beyaz söğüt, adaçayı, pirinç samanı, biberiye, okaliptus (Elsadek ve Yousef, 2019), kanguru pençesi (Flematti ve ark., 2011) gibi bitkiler yer almaktadır.

3. DUMAN SOLÜSYONLARININ ETKİLERİ VE ETKEN MADDELERİ

3.1. Bitkisel Duman Solüsyonlarının Çimlenme Üzerine Etkileri

Raizada ve Raghubanshi (2010), duman uygulamalarının *Lantana camara* (Verbenaceae)'da tohum çimlenmesi, çimlenme hızı ve canlılık indeksinde artış gözlemlendiğini tespit ederken; Sriharti ve ark. (2020), kakao kabuğu kabuğundan elde edilen duman çözeltisinin *Capsicum annum L.* (Solanaceae) tohumlarının büyümesini arttırdığını bildirmiştir.

Bitkisel kaynaklı dumanın, Güney Afrika-Akdeniz (Light ve ark., 2002; Brown ve ark., 2003) ve Kaliforniya-Chaparral (Egerton-Warburton, 1998; Keeley ve Fotheringham, 1998) gibi çeşitli bitki topluluklarında çimlenme sürecini iyileştirdiği tespit edilmiştir.

3.2. Bitkisel Duman Solüsyonlarının Fide gelişimi Üzerine Etkileri

Buğday samanından elde edilen duman solüsyonu ile muamele yapılarak yeşil alanlarda kullanılan bazı bitkilerin çimlenme ve fide gelişimi üzerinde bir çalışma yürütülmüştür. Araştırma sonucunda incelenen yeşil alan çim bitkilerinin çimlenme ve fide gelişimini olumlu etkilediği tespit edilmiştir Özbek A. (2019).

Duman uygulamalarının fidelerde büyüme üzerine bu teşvik edici etkide bitkisel dumanda yer alan bütenolid bileşiğinin önemli bir rol oynadığı bildirilmektedir (Sparg ve ark., 2006; Kulkarni ve ark., 2006; Kulkarni ve ark., 2007; Kulkarni ve ark., 2008). Mavi ve ark. (2010), tarafından yapılan bir araştırmada dumanın aktif bileşenlerinden olan bütenolid'in kavunda priming uygulaması sonrasında fidelerde çıkış hızını artırdığını tespit etmişlerdir.

Abdollahi, (2011) tarafından süt devedikeni (*Silybum marianum* L.) bitkisinin tohum çimlenmesi ve fide gelişimini incelemek için bir çalışma yapılmıştır. Düşük konsantrasyonlarda doz uygulamalarının çimlenme yüzdesi, çimlenme hızı, fide uzunluğu ve canlılık indeksi değerlerini önemli ölçüde artırdığı bildirilmiştir.

3.3. Bitkisel Duman Solüsyonlarının Ürün Verimi Üzerine Etkileri

Kulkarni ve ark. (2007), duman uygulamalarının domates yetiştiriciliğinde erken hasadı kolaylaştırarak meyve sayısının artırılması bakımından etkin bir uygulama olduğunu; aynı zamanda, bu teknoloji kullanılarak işletme maliyetlerinin en aza indirilebileceğini ifade etmişlerdir.

Dogrusoz (2021) ise, *Hordeum vulgare* L. ve *Triticum aestivum* L. (Poaceae) kaba yemlerinin verim ve kalitesinde duman solüsyonu uygulamalarının destekleyici etkiye sahip olduğunu bildirmişlerdir.

Bazı araştırmacılar yem bitkileri tohumlarına bitki kaynaklı duman solüsyonlarıyla priming işlemi uygulamış ve hidroponik ortamda üretim yapmışlardır. Bu araştırmalar sonucunda kalite ve verim üzerinde olumlu sonuçlar elde edildiğini (Dogrusoz ve ark. 2019; Başaran ve ark. 2019), bu elde edilen sonuçların etkinliğinin ise priming bekletme süresi ve kaynağından ayrıca bitki materyalinden kaynaklı olduğunu (Dogrusoz ve ark.2020), duman solüsyonlarının yüksek dozlarda olumsuz düşük dozlarda ise olumlu sonuçlar ortaya koyduğunu bildirmişlerdir

Baklagil familyasından bir yem bitkisi olan mürdümük üzerinde, hidroponik ortamda duman solüsyonu uygulaması sonucunda verim ve kalitesi bakımından incelemeler yapılmıştır.

Yapılan araştırma sonucunda hidroponik ortamda filizlerin taneye oranla kuru madde kaybına uğraması, duman solüsyonu uygulaması ile azaltılmış olup elde edilen filizlerden mineral madde, ADF, NDF ve protein bakımından da etkili sonuçlar elde edildiği bildirilmiştir (Doğrusöz ve ark. 2021).

Duman solüsyonu için materyal olarak kuru kırmızı ot (*Themeda triandra*) yaprağının kullanıldığı sera koşullarında ‘‘ Heinz-1370’’ domatesin üzerinde yapılan bir başka çalışma sonucunda; domatesin yaprak sayısı, boyu, gelişimi ve meyve sayısında olumlu sonuçlar elde edilmiştir. Meyve boyutlarında kontrolle bir fark oluşmamıştır. Ayrıca duman solüsyonunun hidroponik sistemde domates yetiştirmede faydalı olacağı, örtü altı üretimin tarlada üretime göre daha pahalıya mal olduğu, yapılan bu çalışma ile meyve sayısındaki artış ve bitkide oluşan hızlı büyüme elde edilmesi ile maliyetin düşmesinden dolayı örtü altı üretimde fayda sağlayacağı bildirilmiştir (Kulkarni, Ascough ve Van Staden, 2008).

3.4. Bitkisel Duman Solüsyonlarının Antimikrobiyal Etkileri

Roche ve ark. (1997), Avustralya yerli türlerine ait tohum ve fidanlarda, doğrudan duman uygulaması ile en az 7 gün boyunca mikrobiyal etmenlere karşı koruma sağlanabileceği ifade etmişlerdir.

Bir diğer araştırma sonuçlarına göre, duman solüsyonu uygulamalarının *Syncarpha vestita* L. (Asteraceae) ve *Rhodocoma gigantea* Kunth. (Restionaceae) tohumlarında muhafaza süresini bir yılın üzerine çıkarılabileceği bildirilmiştir (Brown ve ark., 1994). Nautiyal ve ark. (2007)’nın yaptığı bir çalışmada kokulu ve şifalı bitkilerden elde edilen duman solüsyonlarının tarım alanlarında yetiştiricilik sorunlarına yol açan bazı mikrobiyal etmenleri ortadan kaldırdığı tespit edilmiştir.

3.5. Bitkisel Duman Solüsyonlarına Karşı Bitkilerin Fizyolojik ve Biyokimyasal Tepkileri

Bitki kaynaklı duman solüsyonlarının, fidelerin klorofil miktarı ile fotosentetik aktivite düzeylerinde artışlara neden olarak büyüme ve gelişmeyi teşvik ettiği rapor edilmiştir (Baxter ve van Staden, 1994). Yapılan bir çalışmada, duman solüsyonu uygulanmış *Triticum aestivum* L. (Poaceae) fidelerinde çeşitli fotosentetik pigmentlerin miktarında önemli bir artış gözlemlendiği bildirilmiştir (Iqbal ve ark., 2016; 2017).

Ayrıca bitki kaynaklı duman solüsyonlarının, büyüme üzerine etkili besin maddelerinin absorpsiyonunu artırarak protein biyosentezini desteklediği tespit edilmiştir (Jamil ve ark., 2014).

Bitkisel kaynaklı duman solüsyonları ile yapılan priming işleminin *Zea mays* L. (Poaceae) (Waheed ve ark., 2016; Aslam ve ark., 2019) ve *Lathyrus sativus* (Fabaceae)’ta (Başaran ve

ark., 2019) protein içeriğini arttırdığı tespit edilmiştir. Jamil ve ark. (2020), düşük konsantrasyonlarda duman solüsyonu ile priming yapılan *Oryza sativa* L. (Poaceae) tohumlarında protein ve karbonhidrat içeriğinin arttığını belirlemişlerdir.

3.6. Bitkisel Duman Solüsyonlarının Abiyotik Stres Toleransı Üzerine Etkileri

Duman solüsyonunun tuz stresi altında yetiştirilen buğday tohumlarının üzerine etkilerinin araştırıldığı çalışmada uygulanan duman solüsyonunun, tuz stresini azalttığı, çimlenme ve fide gelişiminde iyileşmeye neden olduğu tespit edilmiştir. Sonuç olarak, duman solüsyonu uygulamasının buğday bitkisinde tuz stresiyle oluşan hasarı uyarıcı bir etki yaparak kısmen azalttığını Kırkışla, (2018) bildirmiştir.

Akhtar ve ark. (2017), ağır metal, tuzluluk, kuraklık, düşük ve yüksek sıcaklık stresine maruz bırakılan bitkilerde, büyüme üzerindeki olumsuz etkilerin duman solüsyonu uygulamaları ile azalabileceğini bildirmektedir.

Çeşitli araştırmacılar tarafından, bitkisel duman uygulamalarının, *Oryza sativa* L. ve *Zea mays* L. (Poaceae)'ta tuz stresi (Jamil ve ark., 2014; Waheed ve ark., 2016); *Lycopersicon esculentum* L. (Solanaceae)'da sıcaklık stresi (Jain ve ark., 2006; Jain ve van Staden., 2007); *Lycopersicon esculentum* L. ve *Glycine max* (Fabaceae)'ta su stresi (Ghebrehiwot ve ark., 2008; Li ve ark., 2018) ve *Lactuca sativa* L. (Asteraceae)'da ABA stresine (Kamran ve ark., 2013) karşı toleransın sağlanmasında önemli bir biyostimülant olarak görev yaptığını ifade etmektedirler (Flematti ve ark., 2005; Jain ve ark., 2006; Verschaeve ve ark., 2006; Kulkarni ve ark., 2008; Dixon ve ark., 2009).

4. BİTKİ TÜREVLİ DUMANDAKİ BİLEŞENLER

Bitkisel kaynaklı dumanın önemli bir çimlenme faktörü olduğunun keşfinden sonra (De Lange ve Boucher, 1990), dumanın yapısında yer alan aktif bileşiklerin tanımlanması konusuna odaklanılmıştır. Yapılan araştırmalar duman solüsyonlarının içeriğinde fazla sayıda organik ve inorganik maddenin bulunduğunu göstermiştir. Dumanın yapısında bulunan kimyasal bileşikler, yakılan bitkinin türüne, alındıkları döneme ve ait oldukları dokuya göre farklılık gösterebilmekte olup, çimlenmeyi uyarabilmek için ısı, inkübasyon sıcaklığı ve ışık gibi diğer çevresel faktörlerle de etkileşime girebilmektedir (Brown ve ark., 1994).

4.1. Karrikinler

Chiwocga ve ark. (2009) karrikinlerin, doğal yollardan oluşan yeni nesil bir bitki gelişim düzenleyici grubu olarak kabul edildiğini bildirmiştir. Şimdiye kadar yapılan çalışmalarda tanımlanmış olmasına rağmen bazı araştırmalar 50 farklı KAR1 türevinin sentezlendiği

bildirilmektedir (Flematti ve ark., 2007; Goddard-Borger ve ark., 2007; De Cuyper ve ark., 2017). Çimlenme üzerindeki esas etkinin karrikinolid (Karrikin 1, KAR1) olarak da adlandırılan bütenolid (3-metil-2H-furo [2,3-c] piran-2-on) bileşiğinden kaynaklandığı bildirilmektedir (Baldwin ve ark., 1994; Sutcliffe ve Whitehead, 1995; van Staden ve ark., 1995b, 1995c; Jäger ve ark., 1996; Keeley ve Fotheringham, 1997; Downes ve ark., 2010; Downes ve ark., 2014; Keeley ve Pausas, 2018).

Bütenolidler, tohum çimlenmesini teşvik edici özelliklerinin yanı sıra, tarımsal iyileştirme ve ekolojik restorasyon konularında da geniş bir uygulama alanına sahip fitoreaktif bileşiklerdir (Dixon ve ark., 2009).

4.2. Siyanohidrinler

Siyanohidrinler, bitkisel kaynaklı dumandan izole edilen bir diğer önemli çimlenme uyarıcısı bileşiklerdir. Doğada oldukça yaygın olan siyanohidrinlerin, su veya bir hidroksinitril liyaz aracılığıyla hidrolize uğrayarak, ortama hidrojen siyanür ve bir aldehit (veya keton) bıraktıkları bilinmektedir (Gregory, 1999; Siegien ve Bogatek, 2006). Açığa çıkan siyanür, aldehit ve keton gibi bileşiklerin ise düşük konsantrasyonlarda tohum çimlenmesini uyabildikleri bilinmektedir (Taylorson ve Hendricks, 1973; Footitt ve Cohn, 2001; Oracz ve ark., 2008).

Siyanohidrinlerin, buldukları toprakların üst katmanlarında uzun bir kalıcılık süresine sahip olmaları, etkilerinin uzun süreli olmasına imkan tanımaktadır (Flematti ve ark., 2011)

4.3. Diğer bileşenler

Duman solüsyonunun içeriğinde, çimlenme uyarıcılarının yanı sıra, bir takım çimlenme inhibitörlerinin de yer aldığı tespit edilmiştir. Duman çözeltisinde yaygın olarak bulunan 3, 4, 5-trimetilfuran-2(5H)-on'un, çimlenmeyi teşvik eden KAR1'in etkisini azaltarak, *Lactuca sativa* L. (Asteraceae) tohumlarında çimlenmeyi inhibe ettiği belirlenmiştir (Light ve ark., 2010).

5. SONUÇ

Sonuç olarak bitkisel kaynaklı duman solüsyonları, hasat artıklarının değerlendirilmesi kapsamında geri dönüşüm odaklı çevre dostu ve özellikle sürdürülebilir tarımsal üretime destek sağlayıcı bir uygulamadır. Duman solüsyonlarının tohumlara priming işleminde kullanılması son yıllarda yaygınlaşmıştır. Priming işleminde küçük miktarlarda bile uygulanan duman solüsyonunun çimlenme, fide gelişimi, verimde artış, dormansiyi kırma, biyotik ve abiyotik strese karşı savunma mekanizmasını geliştirdiği yapılan çalışmalarda görülmüştür. Ancak yüksek konsantrasyonlarda uygulan solüsyonların toksik etki yapabildiği de ortaya konmuştur. Bu

nedenle bitkisel kaynaklı duman solüsyonlarının kullanımında, yakılan materyale, kullanılan konsantrasyona ve uygulanan bitki türüne göre sonuçlar farklılık göstermektedir. Bu yüzden bitki ve solüsyon kaynağı bazında özel çalışmaların artırılması öngörülmektedir.

KAYNAKÇA

- Abdollahi, M. R., Mehrshad B. and Moosavi, S. S. 2011. Effect of method of seed treatment with plant derived smoke solutions on germination and seedling growth of milk thistle (*Silybum marianum* L). *Seed Sci Tech.* 39: 225-229.
- Abedi, M., Zaki, E., Erfanzadeh, R., Naqinezhad, A. 2018. "Germination patterns of the scrublands in response to smoke: The role of functional groups and the effect of smoke treatment method", *South African Journal of Botany*, 115, 231-236
- Abu, Y., Romo, J.T., Bai, Y., Coulman, B. 2016. "Priming seeds in aqueous smoke solutions to improve seed germination and biomass production of perennial forage species", *Canadian Journal of Plant Science*, 96, 551-563.
- Adkins, S.W., Peters, N.C.B. 2001. "Smoke derived from burnt vegetation stimulates germination of arable weeds", *Seed Science Research*, 11, 3, 213-222.
- Adriansz, T.D., Rummey, J.M., Bennett, I.J. 2000. Solid phase extraction and subsequent identification by gas chromatography, Mass-Spectrometry of a germination cue present in smoky water. *Anal. Lett.* 33, 2793-2804.
- Akeel, A., Khan, M. M. A., Jaleel, H., Uddin, M. 2019. Smoke-saturated water and karrikinolide modulate germination, growth, photosynthesis and nutritional values of carrot (*Daucus carota* L.). *Journal of Plant Growth Regulation*, 38, 1387-1401.
- Akhtar, N., Khan, S., Malook, I., Rehman, S.U., Jamil, M. 2017. "Pb-induced changes in roots of two cultivated rice cultivars grown in lead-contaminated soil mediated by smoke", *Environmental Science and Pollution Research*, 24, 21298-21310.
- Aslam, M., Rehman, S., Khatoon, A., Jamil, M., Yamaguchi, H., Hitachi, K., Tsuchida, K., Li, X., Sunohara, Y., Matsumoto, H., Komatsu, S. 2019. "Molecular responses of maize shoot to a plant derived smoke solution", *International Journal of Molecular Sciences*, 20, e1319.
- Aslam, M., Jamil, M., Khatoon, A., Salah, E.E.H., Nasser, A.A.S., Shakirullah, K.S., Ijaz, M., Shafiq, U.R., 2015. "Does weeds-derived smoke improve plant growth of wheat", *Journal of Bio-Molecular Sciences*, 3, 2, 86-96.
- Baldwin, I.T., Staszak-Kozinski, L., Davidson, R. 1994. "Up in smoke: I. Smoke-derived germination cues for post- fire annual *Nicotiana attenuate* Torr. Ex. Watson", *Journal of Chemical Ecology*, 20, 2345-2371.
- Başaran, U., Doğrusöz, M., Gülümser, E., Mut, H. 2019. "Using smoke solutions in grass pea (*Lathyrus sativus* L.) to improve germination and seedling growth and to reduce toxic compound ODAP", *Turkish Journal of Agriculture and Forestry*, 43, 518-526.
- Baxter, B.J.M., van Staden, J. 1994. "Plant-derived smoke: An effective seed pre-treatment", *Plant Growth Regulation*, 14, 279-282.
- Brown, N.A.C., van Staden, J. 1997. "Smoke as a germination cue: A review", *Plant Growth Regulation*, 22, 115-124.
- Brown, N.A.C., Jamieson, H., Botha, P.A. 1994. "Stimulation of seed germination in South African species of Restionaceae by plant-derived smoke", *Plant Growth Regulation*, 15, 1, 93-100.
- Chiwocga, S.D.S., Dixon, K.W., Flematti, G.R., Ghisalberti, E.L., Merritt, D.J., Nelson, D.C., Riseborough, J.A.M., Smith, S.M., Stevens, J.C. 2009. "Karrikins: A new family of plant growth regulators in smoke", *Plant Science*, 177, 4, 252-256.

- De Cuyper, C., Struk, S., Braem, L., Gevaert, K., De Jaeger, G., Goormachtig, S. 2017. “Strigolactones, karrikins and beyond”, *Plant, Cell & Environment*, 40, 1691-1703.
- De Lange, J.H. and Boucher, C. (1990). Aut ecological studies on *Audouinia capitata* (Bruniaceae). I. Plant-derived smoke as a seed germination cue. *South African Journal of Botany*, 56; 700-703.
- Dixon, K.W., Merritt, D.J., Flematti, G.R., Ghisalberti, E.L. 2009. “Karrikinolide - a phytoactive compound derived from smoke with applications in horticulture, ecological restoration and agriculture”, *Acta Horticulturae*, 813, 155-170.
- Doğrusöz, M., Gulumser, E., Basaran, U., Mut, H. 2019. “The effect of smoke solutions on the germination and seedling growth of common vetch (*Vicia sativa* L.) and grass pea (*Lathyrus sativus* L.)”, 2nd international scientific research congress, 27-29 September, Kayseri, 97-105.
- Doğrusöz M.Ç., Başaran U., Mut H., Gülümser E. 2020. Hidroponik Yeşil Yem Üretiminde Arpa, Buğday Ve Mürdümünün Verim Ve Kalitelerinin Zamana Bağlı Değişimi.7:9, 158-167.
- Doğrusöz, M.Ç., Başaran, U., Gülümser, E., Mut, H. 2021. Hidroponik Mürdümük Üretimde Bitkisel Kaynaklı Duman Solüsyonlarının Etkisi. *Anadolu Tarım Bilimleri Dergisi*, 36(2), 227-233.
- Doğrusöz M.Ç., Başaran U., Mut H., Gülümser E. 2022. Farklı Priming Uygulamalarında Macar Fiğinin (*Vicia pannonica* Crantz.) Çimlenme Özellikleri ve Fide Gelişimi *ISPEC Tarım Bilimleri Dergisi* 6(3): 437-447, 2022
- Downes, K.S., Lamont, B.B., Light, M.E., van Staden, J. 2010. “The fire ephemeral *Tersonia cyathiflora* (Gyrostemonaceae) germinates in response to smoke but not the butenolide 3-methyl-2H-furo [2,3-c] pyran-2-one. *Annals of Botany*, 106, 381-384.
- Downes, K.S., Light, M.E., Posta, M., Kohout, L., Van Staden, J. 2014. “Do fire-related cues, including smoke-water, karrikinolide, glyceronitile and nitrae, stimulate the germination of 17 *Anigozanthos taxa* and *Blancoa canescens* (Haemodoraceae)?”, *Australian Journal of Botany*, 62, 347-358.
- Drewes, F.E., Smith, M.T., van Staden, J. 1995. “The effect of a plant derived smoke extract on the germination of light-sensitive lettuce seed”. *Plant Growth Regulation*, 16, 205-209.
- Egerton-Warburton, L.A. 1998. “Smoke-induced alteration of the sub-testa cuticle in seeds of the post-fire recruiter, *Emmenanthe penduliflora* Benth. (Hydrophyllaceae)”, *Journal of Experimental Botany*, 49, 1317-1327.
- Elsadek, M. A., Yousef, E.A. 2019. Smoke-water enhances germination and seedling growth of four horticultural crops. *Plants*, 8(4), 104.
- Flematti, G.R., Goddard-Berg, E.D., Merritt, D.J., Ghisalberti, E.L., Dixon, K.W., Trengove, R.D. 2007. “Preparation of 3-methyl-2H-furo[2,3-c] pyran-2-one derivatives and evaluation of their germination-promoting activity”, *Journal of Agricultural and Food Chemistry*, 55, 2189-2194.
- Flematti, G.R., Merritt, D.J., Piggott, M.J., Trengove, R.D., Smith, S.M., Dixon, K.W., Ghisalberti, E.L. 2011. “Burning vegetation produces cyanohydrins that liberate cyanide and promote seed germination”, *Nature Communications*, 2, 360.
- Flematti, G., Dixon, K., Smith, S.M. 2015. “What are karrikins and how were they ‘discovered’ by plants?”, *BMC Biology*, 13, 108.
- Footitt, S., Cohn, M.A. 2001. “Developmental arrest: from sea urchins to seeds”, *Seed Science Research*, 11, 1, 3-16.
- Gerhard, E.O., Sandra, C.M., Valerio, D.P., Jorg, P.F. 2006. “No heat stimulated germination found in herbaceous species from burned subtropical grassland”, *Plant Ecology*, 184, 237-243.

- Ghebrehiwot, H.M., Kulkarni, M.G., Kirkman, K.P., Van Staden, J. 2008. "Smoke-water and a smoke-isolated butenolide improve germination and seedling vigour of *Eragrostis tef* (Zucc.) Trotter under high temperature and low osmotic potential". *Journal of Agronomy and Crop Science*, 194, 270-277.
- Goddard-Borger, E.D., Ghisalberti, E.L., Stick, R.V. 2007. "Synthesis of the germination stimulant 3-methyl-2H-furo[2,3-c] pyran-2-one and analogous compounds from carbohydrates", *European Journal of Organic Chemistry*, 3925-3934.
- Gregory, R.J. 1999. "Cyanohydrins in nature and the laboratory: biology, preparations, and synthetic applications", *Chemical Reviews*, 99, 12, 3649-3682.
- Harti, S., Indriati, A., Dyah, S. 2020. Utilization of liquid smoke from cocoa pod husk (*Theobroma cocoa* L) for germination of red seed (*Capsicum annum* L). *Asian Journal of Applied Sciences*, 8(1).
- Jamil, M., Kanwal, M., Aslam, M.M., Khan, S.S., Malook, I., Tu, J., Rehman, S.U. 2014. "Effect of plant-derived smoke priming on physiological and biochemical characteristics of rice under salt stress condition", *Australian Journal of Crop Science*, 8, 159-170.
- Jamil, M., Jahangir, M., Rehman, S.U. 2020. "Smoke induced physiological, biochemical and molecular changes in germinating rice seeds", *Pakistan Journal of Botany*, 52, 3, 865-871.
- Iqbal, M., Asif, S., Ilyas, N., Raja, N.I., Hussain, M., Sabir, S., Faz, M.N.A., Rauf, A. 2016. "Effect of plant derived smoke on germination and post germination expression of wheat (*Triticum aestivum* L.)", *American Journal of Plant Sciences*, 7, 806-813.
- Iqbal, M., Asif, S., Ilyas, N., Ul-Hassan, F., Raja, N.I., Hussain, M., Ejaz, H., Saira, M. 2017. "Smoke produced from plants waste material elicits growth of wheat (*Triticum aestivum* L.) by improving morphological, physiological and biochemical activity". *Biotechnology Reports (Amsterdam)*, 13, 35-44.
- Jain, N., Kulkarni, M.G., van Staden, J.A. 2006. "Butenolide isolated from smoke, can overcome the detrimental effects of extreme temperature during tomato seed germination", *Plant Growth Regulation*, 49, 263-267.
- Jain, N., Van Staden, J. 2007. "The potential of the smoke-derived compound 3-methyl-2H-furo[2,3-c]pyran-2-one as priming agent for tomato seeds", *Seed Science Research*, 17, 175-181.
- Jäger, A. K., Light, M. E., Van Staden, J. 1996. Effects of source of plant material and temperature on the production of smoke extracts that promote germination of light-sensitive lettuce seeds. *Environmental and Experimental Botany*, 36(4), 421-429.
- Jefferson, L.V., Pennacchio, M, Havens, K., Forsberg, B., Sollenberger, D. 2008. "Ex situ germination responses of Midwestern USA prairie species to plant-derived smoke", *The American Midland Naturalist*, 159, 251-256.
- Kamran, M., Imran, Q., Khatoon, A., Lee, I., Rehman, S. 2013. "Effect of plant extracted smoke and reversion of abscisic acid stress on lettuce", *Pakistan Journal of Botany*, 45, 1541-1549.
- Kamran, M., Khan, A.L., Ali, L., Hussain, J., Waqas, M., Al-Harrasi, A., Lee, I.J. 2017. Hydroquinone; a novel bioactive compound from plant-derived smoke can cue seed germination of lettuce. *Front. Chem.*, 5, 30.
- Keeley, J.E., Fotheringham, C.J. 1997. "Trace gas emissions and smoke-induced seed germination", *Science*, 276, 5316, 1248-1250.
- Keeley, J.E., Pausas, J.G., 2018. "Evolution of 'smoke' induced seed germination in pyroendemic plants", *South African Journal of Botany*, 115, 251-255.
- Kırkışla, M. (2018). Bitki Kökenli Duman Solüsyonunun Tuz Stresi Altındaki Buğday (*Triticum Aestivum* L.) Bitkisinde Çimlenme Ve Fide Gelişimi Üzerine Etkisi. Muğla Sıtkı Koçman Üniversitesi Fen Bilimleri Enstitüsü Biyoloji Anabilim Dalı Yüksek Lisans Tezi.

- Kulkarni, M.G., Ascough, G.D., van Staden, J. 2007. "Effects of foliar applications of smoke-water and a smoke-isolated butenolide on seedling growth of okra and tomato", *HortScience*, 42, 179-182.
- Kulkarni, M.G., Ascough, G.D., van Staden, J. 2008. "Smoke-water and smoke-isolated butenolide improve growth and yield of tomatoes under greenhouse conditions. *Horticulture Technology*, 18, 449-454.
- Li, X., Rehman, S.U., Yamaguchi, H., Hitachi, K., Tsuchida, K., Yamaguchi, T., Sunohara, Y., Matsumoto, H., Komatsu, S. 2018. "Proteomic analysis of the effect of plant-derived smoke on soybean during recovery from flooding stress", *Journal of Proteomics*, 181, 238-248.
- Light, M.E., Gardner, M.J., Jäger, A.K., van Staden, J. 2002. "Dual regulation of seed germination by smoke solutions", *Plant Growth Regulation*, 37, 135-141.
- Light, M.E., Burger, B.V., Staerk, D., Kohout, L., van Staden, J. 2010. "Butenolides from plant-derived smoke: Natural plant growth regulators with antagonistic actions on seed germination", *Journal of Natural Products*, 73, 267-269.
- Lindon, H.L., Menges, E. 2008. "Effects of smoke on seed germination of twenty species of fire-prone habitats in Florida", *Castanea*, 73, 106-110.
- Mavi, K., Light, M.E., Demir, I., van Staden, J., Yasar, F. 2010. "Positive effect of smoke-derived butenolide priming on melon seedling emergence and growth", *New Zealand Journal of Crop and Horticultural Science*, 38, 147-155.
- Mojzes, A., Kalapos, T. 2014. "Plant-derived smoke stimulates germination of four herbaceous species common in temperate regions of Europe", *Plant Ecology*, 215, 411-415.
- Nautiyal, C.S., Chauhan, P.S. ve Nene, Y.L. (2007) Medicinal smoke reduces airborne bacteria. *Journal of Ethnopharmacology* 114, 446-451.
- Ngoroyemoto, N., Gupta, S., Kulkarni, M.G., Finnie, J.F., van Staden, J. 2019. "Effect of organic biostimulants on the growth and biochemical composition of *Amaranthus hybridus* L.", *South African Journal of Botany*, 124, 87-93.
- Oracz, K., El-Maarouf-Bouteau, H., Bogatek, R., Corbineau, F., Bailly, C. 2008. "Release of sunflower seed dormancy by cyanide: cross-talk with ethylene signalling pathway", *Journal of Experimental Botany*, 59, 8, 2241-2251.
- Özbek A. 2019, Bitkisel kökenli duman solüsyonlarının bazı yeşil alan bitkilerinin çimlenme ve fide gelişimine etkileri. Yozgat Bozok Üniversitesi, Fen Bilimleri Enstitüsü, Tarla Bitkileri Anabilim Dalı, Yüksek Lisans Tezi.
- Raizada, P., Raghubanshi, A.S. 2010. "Seed germination behavior of *Lantana camara* in response to smoke", *Tropical Ecology*, 51, 347-352.
- Renzi, J. P., Chantre, G. R., Cantamutto, M. A. 2016. Effect of water availability and seed source on physical dormancy break of *Vicia villosa* ssp. *Villosa*. *Seed Science Research*, 26, 254-263.
- Roche, S., Dixon, K.W., Pate, J.S. 1997. "Seed ageing and smoke: partner cues in the amelioration of seed dormancy in selected Australian native species", *Australian Journal of Botany*, 45, 783-815.
- Siegien, I., Bogatek, R. 2006. "Cyanide action in plants-from toxic to regulatory", *Acta Physiologiae Plantarum*, 28, 5, 483-497.
- Sparg, S.G.M., Kulkarni, G., van Staden, J. 2006. "Aerosol smoke and smoke water stimulation of seedling vigor of a commercial maize cultivar", *Crop Science*, 46, 1336-1340.
- Sutcliffe, M.A., Whitehead, C.S. 1995. "Role of ethylene and short-chain saturated fatty acids in the smoke-stimulated germination of *Cyclopia* seed", *Journal of Plant Physiology*, 145, 3, 271-276.

- Taylor, J.L.S., van Staden, J. 1996. "Root initiation in *Vigna radiates* (L.) Wilczek hypocotyls cuttings are stimulated by smoke-derived extracts", *Plant Growth Regulation*, 18, 165-168.
- Taylorson, R.B., Hendricks, S.B. 1973. "Promotion of seed germination by cyanide", *Plant Physiology*, 52, 1, 23-27.
- Tieu, A., Dixon, K.A., Sivasithamparam, K., Plummer, J.A. 1999. "Germination of four species of native Western Australian plant using plant-derived smoke", *Australian Journal of Botany*, 47, 207-219.
- van Staden, J., Drewes, F.E., Brown, N.A.C. 1995b. "Some chromatographic characteristics of germination stimulants in plant-derived smoke extracts", *Plant Growth Regulation*, 17, 3, 241-249.
- van Staden, J., Drewes, F.E., Jäger, A.K. 1995c. "The search for germination stimulants in plant-derived smoke extracts", *South African Journal of Botany*, 61, 5, 260-263.
- van Staden, J., Jäger, A.K., Light, M.E., Burger, B.V. 2004. "Isolation of the major germination cue from plant derived smoke", *South African Journal of Botany*, 70, 654-659.
- Verschaeve, L., Maes, J., Light, M.E., van Staden, J. 2006. "Genetic toxicity testing of 3-methyl-2H-furo[2,3-c] pyran-2-one, an important biological active compound from plant-derived smoke", *Mutation Research - Genetic Toxicology and Environmental Mutagenesis*, 611, 89-95.
- Waheed, M.A., Muhammad, J., Muhammad, D.K., Shakirullah, K.S., UrRehman, S. 2016. "Effect of plant-derived smoke solutions on physiological and biochemical attributes of maize (*Zea mays* L.) under salt stress", *Pakistan Journal of Botany*, 48, 1763-1774.
- Wang, M., Schoettner, M., Xu, S., Paetz, C., Wilde, J., Baldwin, I.T., Groten, K. 2017. Catechol, a major component of smoke, influences primary root growth and root hair elongation through reactive oxygen species-mediated redox signaling. *New Phytologist*. 213, 1755-1770.

HİDROPONİK SİSTEMDE BAKLAGİL KARIŞIM ORANLARININ KALİTE ÜZERİNE ETKİSİ

Musa ÇEVİK

Yozgat Bozok University, Faculty of Agriculture, Department of Field Crops, Erdoğan Akdağ
Campus

ORCID ID: 0000-0002-7634-2889

Medine ÇOPUR DOĞRUSÖZ

Yozgat Bozok University, Faculty of Agriculture, Department of Field Crops, Erdoğan Akdağ
Campus

ORCID ID: 0000-0002-9159-1699

ÖZET

Hidroponik sistem, alternatif bir kaba yem üretim sistemi olup, bitki tohumlarının topraksız bir ortamda çimlendirilmesini kapsamaktadır. Bu sistemde genel olarak arpa, buğday, mısır gibi bitkiler 7 gün çimlendirme ortamına bırakılarak oluşan filizler köklerle birlikte hayvanlara doğrudan verilir. Çalışmada, bu sistemde daha önce kullanılmamış ya da çok az denenmiş baklagil yem bitkileri tohumları (mürdümük, yaygın fiğ ve yem bezelyesi) ve karışım oranları kullanılmıştır. Üç türün tohumları yalın ve ikişerli karışım oranları 75:25, 50:50, 25:75 ve eşit oranda üçlü tek karışım ile toplamda 13 işlem oluşturulmuştur. Oluşturulan karışım ve yalın tohumlar hidroponik kaplarına yerleştirilerek kontrollü şartlarda 8 gün yetiştirilmiştir. 8. günün sonunda alınan kaplarda kuru ağırlık, ham protein oranı, ADF, NDF ve mineral madde (Ca, Mg, K ve P) içerikleri incelenmiştir. Analiz sonucunda en yüksek kuru ağırlık yalın mürdümük işleminden elde edilmiş ve ham protein oranı en yüksek yine aynı işlem ve mürdümük karışımlarının yüksek olduğu karışım oranlarından elde edilmiştir. Mineral madde bakımından ise %25 mürdümük %75 fiğ karışım oranları ön plana çıkmaktadır. Sonuç olarak baklagil yem bitkilerinden mürdümük, yaygın fiğ ve yem bezelyesinin hidroponik ortamda başarılı bir şekilde yetiştirilebileceği belirlenmiştir.

Anahtar Kelimeler: Hidroponik, Mürdümük, Yem bezelyesi, Yaygın fiğ, ot kalitesi.

EFFECT OF LEGUME MIXED RATIOS ON QUALITY IN HYDROPONIC SYSTEM ABSTRACT

The hydroponic system is an alternative forage production system and involves germinating plant seeds in a soilless environment. In this system, plants such as barley, wheat and maize are generally left in the germination environment for 7 days and the resulting sprouts are given directly to animals along with the roots. In the study, seeds of forage legumes (grass pea, common vetch and forage pea) and their mixture ratios, which have not been used before or

have been tried very little in this system, were used. A total of 13 treatments were created with the seeds of the three species, using pure and double mixture ratios of 75:25, 50:50, 25:75 and three single mixtures in equal proportions. The created mixture and plain seeds were placed in hydroponic containers and grown under controlled conditions for 8 days. At the end of the 8th day, dry weight, crude protein ratio, ADF, NDF and mineral matters (Ca, Mg, K and P) contents were examined in the containers. As a result of the analysis, the highest dry weight was obtained from the pure grass pea treatment and the highest crude protein ratio was obtained from the same treatment and the mixture ratios with high grass pea mixtures. In terms of mineral matter contents, the mixture ratios of 25% grass pea and 75% vetch come to the fore. As a result, it was determined that grass pea, common vetch and forage pea, which are forage legumes, can be grown successfully in hydroponic environment.

Keywords: Hydroponic system, grass pea, Forage pea, Common vetch, Forage quality

1. GİRİŞ

Hidroponik sistem, bitki çimlenmesi ve büyümesi için gerekli olan nem, sıcaklık, ışık ve diğer gereksinimlerin topraksız bir ortamda karşılanmasını içerir. Bu yöntemde tohumlar genellikle 6-8 gün içinde çimlenir ve kökleri birbirine dolanarak halı benzeri bir görünüm oluştururlar. Bitki 20-25 cm boyuna ulaştığında 6-10 kat daha fazla yeşil yem üretilir. Şaşırtıcı bir şekilde tarla üretiminde kullanılan suyun sadece %3-5'i, aynı miktarda hidroponik üretim için yeterlidir (Karaşahin, 2014; Baytekin, 2015). Hidroponik tarım, bitkinin zengin lif, protein, vitamin ve mineral içeriği, yıl boyu üretim yapabilme yeteneği, yeşil yem tüketimi ile hayvan performansının artışı, tahılların daha iyi sindirilebilirliği gibi sistemle ilgili özel avantajları nedeniyle son yıllarda küresel olarak popülerlik kazanmıştır (Al-Karaki ve Al-Hashimi, 2012; Atıcı, 2012).

Hızlı nüfus artışı, su kaynaklarının azalmasına ve su kalitesinin düşmesine yol açmıştır. Bu durum, su kaynaklarının en büyük kullanıcısı olan tarımda kısıtlamalara neden olmuştur ve tarım, toplam su kullanımının %70'ini oluşturur. Bu nedenle, bitki yetiştirme işleminde suyun etkili ve verimli kullanılmasını sağlayan hidroponik sisteme olan ilgi artmıştır (Karaşahin, 2014). Sistem, az miktarda suyla çalışabilme, fazla suyun yeniden kullanılabilir olması, suyun etkili kullanımı ve gübre kullanılmaması nedeniyle çevresel kirlilik olmaması gibi avantajlara sahiptir. Hayvanlar tarafından sürekli tahıl bazlı yem tüketiminin, toksik bileşikler içermesi nedeniyle hayvan sağlığı üzerinde olumsuz etkilere yol açtığı bulunmuştur (Naik vd., 2013). Buna karşılık, hidroponik yem bitkileri sisteminde yetiştirilen bitkilerin, hayvanların sindirim,

süt verimi, kırmızı kan hücre sayısı ve kan oksijen seviyelerinde olumlu artışlara yol açtığı gözlemlenmiştir, bu da yüksek hayvan performansına neden olmuştur (Sharif vd., 2013).

Bu sistemde yaygın olarak arpa, buğday gibi tahıllar ağırlıklı olarak kullanılmaktadır. Özellik yüksek protein oranına sahip baklagil yem bitkilerinin sistemde kullanılarak daha etkin ve kaliteli bir kaba yem üretmek mümkün olabilir. Ürünlerin besin değerini değerlendirirken sadece yeşil ve kuru madde ağırlığına değil, aynı zamanda enerji ve protein değerlerine de dikkat edilmelidir. Özellikle protein, hayvan gelişimi ve performansı için kritik bir öneme sahip olduğundan, yemdeki protein miktarı yemin değerini belirlemede büyük bir öneme sahiptir. Hidroponik sistemlerde yeşil yem üretimi sırasında, vitamin E, beta-karoten, biyotin ve serbest folik asit gibi besin maddelerinin miktarında önemli artışlar gözlemlenmiştir (Sneath ve McIntosh, 2003; Dung ve ark., 2010). Hidroponik üretimde verim ve kaliteyi etkileyen başlıca faktörler arasında sistem yönetimi, kullanılan tohumun çeşidi ve kalitesi, suyun pH ve kalitesi, sulama süresi ve sıklığı, sıcaklık, nem, ışık ve yetiştirme süresi gibi faktörler bulunmaktadır (Sneath ve McIntosh, 2003; Fazaeli ve ark., 2012).

Ayrıca özellikle baklagil tane yemler yoğun olarak tüketildiklerinde içermiş oldukları konsantre besinler veya toksik bileşikler hayvan sağlığını tehdit edebilmektedir (Naik ve ark., 2013). Bu anlamda tane yemlerin 7-10 gün süreyle çimlendirilmesiyle hem bu tür olumsuzlukların önüne geçilebilmekte hem de kısa sürede tanenin 10 katına kadar ağırlıkta taze yem üretebilmektedir. Dolayısıyla bu teknoloji verimliliği artırmakta ve özellikle kurak bölgelerde veya kış aylarında hayvanların taze yem ihtiyaçlarının giderilmesi açısından büyük önem taşımaktadır. Bu anlamda hidroponik yem üretim sisteminde yaygın olarak değerlendirilen arpa ve buğdayın, dışında daha önce bu sistemde çok az değerlendirilmiş mürdümük, yem bezelyesi ve yaygın fiğın yalın ve karışık ekim oranlarında kullanım potansiyellerinin ve kalite özelliklerinin belirlenmesi araştırılmıştır.

2. MATERYAL VE YÖNTEM

Çalışmada materyal olarak mürdümük “Gürbüz”, yaygın fiğ “Tamkoç-2000” ve yem bezelyesinin “Özkaynak” çeşitleri kullanılmıştır. Çalışma Yozgat Bozok üniversitesi, ziraat fakültesinde bulunan iklim odasında yürütülmüştür.

Yaygın fiği, yem bezelyesi ve mürdümük tohumları, türler arası ikişer tane olmak üzere toplamda 4 farklı tohum oranında (100:0, 75:25, 50:50, 25:75) ve üç tür eşit miktarlarda karıştırılarak 1 oranında kullanılmıştır. Kullanılan tohum miktarı, 15×16×5 cm boyutundaki kaplar için yalın mürdümük ve yem bezelyesi için 80 gram, yaygın fiği için ise 100 gram olarak

ayarlanmış ve bu miktarlar kullanılarak karışım oranları hesaplanmıştır. Tartılan tohumlar %5 sodyum hipoklorit solüsyonunda 30 dakika boyunca sterilize edilmiştir (Al-Karaki ve Al-Momani, 2011) ve ardından priming işlemine hazır hale getirilmiştir (Erbaş Köse ve ark., 2019). Sterilize edilen tohumlar tekrar yıkanmış ve aynı kaplara yerleştirilmiş, ardından iklim odasına alınmıştır. Deneme, iklim odasında 8 gün boyunca sürdürülmüş ve ilk iki gün 25 °C'de karanlık koşullarda, geri kalan 6 gün ise 25 °C'de 16:8 saat aydınlık/karanlık fotoperiyot koşullarında devam etmiştir. Sulama günde 6 kez sprey şeklinde ve eşit miktarlarda gerçekleştirilmiştir.

Kuru ağırlık (g): Sekiz günün sonunda tüm kaplardaki bitki materyali toplanmış ve 65 °C'de 48 saat boyunca bir kurutma kabini içinde kurutulmuş ve kuru ağırlıkları gram cinsinden hesaplanmıştır. Kuru ağırlık (KA) hesaplanırken işleme ait tüm kaplardaki filizlerin tartıldığı unutulmamış ve bu nedenle g/ işlem cinsinden ifade edilmiştir. Ham protein, ADF, NDF ve mineral madde (Ca, K, Mg ve P) içerikleri (%): Kurutulmuş örnekler öğütülerek 1 mm elekten geçirilmiştir. Ardından, öğütülmüş örnekler NIRS (Foss 6500) cihazında (near infrared reflectance spectroscopy; Silver Spring, MD, USA) IC0904-FE programı kullanılarak ham protein (HP;%), ADF (acid detergent fiber;%), NDF (neutral detergent fiber;%) ve mineral madde (Ca, P, K ve Mg;%) analizleri yapılmıştır..

3. BULGULAR

Tablo1. Hidroponik ortamda Baklagiller ve karışım oranlarının kuru ağırlık (gr/işlem), ham protein, ADF, NDF ve mineral madde içerikleri (%)

	Kuru Ağırlık	Ham protein	ADF	NDF	Ca	Mg	K	P
Yaygın fiğ	89.32	32.39	15.01	22.57	0.30	0.30	4.83	0.50
Mürdümük	102.9	34.04	16.95	22.01	0.66	0.27	4.96	0.59
Yem bezelyesi	95.50	30.15	13.83	19.32	0.49	0.25	5.45	0.54
25M-75F	78.42	31.75	21.44	34.08	0.86	0.42	4.66	0.58
50M-50F	85.07	32.44	20.86	32.94	0.67	0.36	4.86	0.56
75M-25F	89.07	34.33	24.09	36.54	0.74	0.33	4.73	0.62
25B-75F	76.27	30.32	19.39	30.90	0.68	0.32	5.23	0.57
50B-50F	84.27	30.52	20.74	33.97	0.61	0.34	5.25	0.59
75B-25F	90.67	31.34	12.25	17.83	0.34	0.23	5.32	0.51
25M-75B	94.42	30.64	22.21	35.88	0.67	0.36	4.96	0.58
50M-50B	97.07	31.72	23.65	36.81	0.61	0.31	5.08	0.62
75M-25B	96.00	34.33	14.22	18.06	0.55	0.24	5.11	0.54
3 Karışım	86.40	31.62	24.22	38.37	0.64	0.33	4.90	0.63

Mürdümük, yem bezelyesi ve yaygın fiğ yalın ve farklı karışım oranlarının uygulandığı hidroponik üretimde kuru ağırlık içeriği en yüksek 102.9 gr/işlem olarak yalın mürdümükte

belirlenmiştir. Bu işlemi %50 mürdümük %50 yem bezelyesi ile %75 mürdümük %25 yem bezelyesi işlemleri takip etmiştir. Ancak en düşük kuru madde değeri %25 yem bezelye %75 yaygın fiğ işleminden (76.27 gr/işlem) elde edilmiştir.

Yapılan işlemler sonucunda %75 mürdümük %25 yaygın fiğ ile %75 mürdümük %25 yem bezelyesi uygulamaları %34.33 oranı ile her ikisi de en yüksek ham protein oranına sahip olup yalın mürdümük ise %34.04 oranı ile yüksek bir değere sahip olmuştur. Tabloya göre en düşük ham protein yalın yem bezelyesi(%30.15) işleminde görülmüştür.

ADF oranları açısından baktığımızda ise 3 karışım uygulaması %24.22 oranı ile en yüksek işlem olmuştur. Bu oranı %24.09 ADF değerine sahip olan %75 mürdümük %25 yaygın fiğ işlemi takip etmiştir.%75 yem bezelyesi %25 yalın fiğ (%12.25) ADF işleminde en düşük değere sahip olmuştur.

Hidroponik sistemde, yalın ve farklı karışım oranları uygulayarak yetiştirdiğimiz baklagil yem bitkilerinde en yüksek NDF değeri 3 karışım şeklinde uyguladığımız işlemden %38.37 değeri ile elde edilmiş olup %50 mürdümük %50 yem bezelyesi işlemi %36.81 değeri elde edilerek en yüksek ikinci değer olmuştur. %75 yem bezelye %25 yaygın fiğ işlemi (%17.83) ise en düşük NDF oranına sahip olmuştur.

Hidroponik sistemde yaptığımız baklagil yem bitkileri araştırmamızın en yüksek Ca oranı %25 mürdümük %75 yaygın fiğ işleminden % 0,86 değeri ile elde edilmiştir. Bu değeri takiben %0,74 Ca değerine sahip %75 mürdümük %25 yaygın fiğ işlemi ikinci en büyük değere sahip olmuştur. Ca oranı olarak en düşük değer %0,30 ile yalın yaygın fiğ işleminden elde edildiği görülmüştür.

Hidroponik ortamda üretimini yaptığımız baklagil karışımlarının analiz sonuçlarına göre tablomuzda %25 mürdümük %75 yaygın fiğ işlemimiz %0,42 değerine sahip olarak en yüksek Mg içeriğine sahip olmuştur. Ancak %75 yem bezelye %25 yaygın fiğ işlemi %0.23 değeri ile en düşük Mg değerine sahip olmuştur.

Mineral madde içeriklerinden K(potasyum) değerlerine baktığımız zaman en yüksek K değeri % 5.45 ile yalın yem bezelyesinden elde edilmiştir. % 5.32 K değeri ile ikinci en yüksek değer yine yem bezelyesinin yoğun olduğu karışım olan %75 yem bezelyesi %25 yaygın fiğ işleminde olduğu görülmüştür. %4.66 K oranı ile %25 mürdümük %75 yaygın fiğ işlemi tablomuzda en düşük K oranı olmuştur.

Hidroponik ortamda yetiştirdiğimiz ürünlerin P (fosfor) değerlerine baktığımız zaman en yüksek değer 3'lü karışım (%0.63) işleminden elde edilmiştir. Bu işlemi %50 mürdümük %50 yem bezelyesi ile %75 mürdümük %25 yaygın fiğ işlemi %0.62 p oranına sahip olarak takip etmiştir. En düşük P değeri ise yalın yaygın fiğ işleminden (%0.50) elde edilmiştir

4. SONUÇ

Hidroponik sistem topraksız bir ortamda bitkinin yetiştirilmesi esasına dayalı bir sistemdir. 6 ile 8 gün sonunda çimlenen bitkinin kökleri birbirine dolanarak halı benzeri bir görünüm oluşturmakta olup tohum halindeki ağırlığının ise 6 ile 10 katı bir ağırlığa ulaşmaktadır. Ayrıca tarla ortamında üretildiğinde kullanılan suyun sadece %3-5'i kadar oranda bir su kullanımı ile aynı miktarda ürün elde edilebilmektedir. Hidroponik sistem yıl boyunca üretim yapılabilmesi, bitkinin zengin lif, protein, vitamin ve mineral içeriği, yeşil yem tüketimi ile hayvan performansının artışı, gibi avantajları sebebiyle son yıllarda küresel olarak kaba yem üretimi içinde alternatif bir üretim biçimi olmuştur.

Bizim çalışmamızın sonucunda ise alışılmışın dışında daha önce çalışmalarda yoğun olarak kullanılan buğdaygil yem bitkilerine (arpa, buğday ve mısır) alternatif bitkiler ve karışımlar ile de yem elde etmenin mümkün olabileceğini belirlenmiştir. Ayrıca hidroponik sistemde karışım halindeki üretimin ürünün kuru ağırlık, ham protein, ADF, NDF ve mineral madde (Ca, Mg, K ve P) içerikleri bakımından birbirlerine olumlu etki yaptığı ve elde edilen ürünün kalite ve verimini artırdığı tespit edilmiştir.

TEŞEKKÜRLER

Yozgat Bozok Üniversitesi, Lisansüstü Eğitim Enstitüsü tarafından yürütülmüş olan Musa Çevik' in tezinden alınmıştır.

KAYNAKÇA

Al-Karaki, G.N., Al-Momani, N. 2011. Evaluation of some barley cultivars for green fodder production and water use

Al-Karaki and Al-Hashimi, 2012.Green Fodder Production and Water Use Efficiency of Some Forage Crops under Hydroponic Conditions. ISRN Agronomy 2012(5).

Atıcı, K.D., 2012. Hasılatik yem derdini ortadan kaldırıyor. Tarım Gündem Dergisi, Sayı 9 (Temmuz-Ağustos), Sayfa:96-97.Basaran, U., Dogrusoz, M., Gulumser, E., Mut, H. 2019. Using smoke solutions in grass pea (*Lathyrus sativus* L.) to improve germination and seedling growth and to reduce toxic compound ODAP. Turk J Agric For 43:518–526.

Baytekin, H., 2015. Kaba yeme alternatif lazım. Erişim adresi: <http://bigagunlugu.com/yazarDetay.aspx?yazarID=5&haberID=3987> Erişim tarihi: 01.04.2015

- Dung DD., Godwin IR and Nolan JV., 2010. Nutrient content and in sacco digestibility of barley grain and sprouted barley. *Journal of Animal and Veterinary Advances*, 9: 2485-2492.
- Erbaş Köse, Ö.D., Kardeş, Y.M., Karaer, M., Mut, Z. 2019. Yeşil Mercimek (*Lens culinaris* Medik.) Çeşitlerinde Farklı Priming Uygulamalarının Çimlenme ve Fide Gelişimi Üzerine Etkileri. *Bilecik Şeyh Edebali Üniversitesi Fen Bilimleri Dergisi*, 6. Cilt - Prof. Dr. Fuat SEZGİN Bilim Yılı Özel Sayısı, 247-255.
- Fazaeli H., Golmohammadi HA., Tabatabayee SN and Asgari- Tabrizi M., 2012. Productivity and nutritive value of barley green fodder yield of hydroponic system. *World of Applied Sciences Journal*, 16: 531-539.
- Fazaeli H., Golmohammadi HA., Tabatabayee SN and Asgari- Tabrizi M., 2012. Productivity and nutritive value of barley green fodder yield of hydroponic system. *World of Applied Sciences Journal*, 16: 531-539.
- Karavaşin M. 2014. Kaba Yem Kaynağı Olarak Hidroponik Arpa Çimi Üretiminde Kuru Madde ve Ham Protein Verimleri Üzerine Farklı Uygulamaların Etkileri. *Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi* 9 (1):27-33
- Naik P.K., Dhuri R.B., Karunakaran M., Swain B.K., Singh N.P., “Hydroponic technology for green fodder production”. *Indian Dairyman*, 65: 54-58, 2013.
- Sharif, M., Hussain, A., Subhani, M., 2013. Use of sprouted grains in the diets of poultry and ruminants *Indian Journal of Research* 2(10):4-7.
- Sneath R and McIntosh F., 2003. Review of hydroponic fodder production for beef cattle.

TOPLAM EKİPMAN ETKİNLİĞİ İLE PERFORMANS VERİMLİLİĞİNİN ARTTIRILMASI: BUZDOLABI ÜRETİM HATTI UYGULAMASI

Kübra TEZEL

Yıldız Technical University, Institute of Science, Faculty of Engineering, Department of Industrial,
Davutpaşa Campus

Umut Rifat TUZKAYA

Yıldız Technical University, Institute of Science, Faculty of Engineering, Department of Industrial,
Davutpaşa Campus

ORCID ID: 0000-0003-3933-7906

ÖZET

Bir üretim hattının verimliliği, modern endüstriyel süreçlerin önemli bir ölçüsü olarak nitelendirilmektedir. Bu çalışma, bir buzdolabı üretim hattındaki verimliliği artırmayı amaçlamıştır. Bu amaçla ilgili önemli adımları ve sonuçları incelemektedir. Üretim hattının verimliliğini artırmak, firmanın maliyetlerini azaltmak, ürün kalitesini iyileştirmek ve rekabetçiliği artırmak için kritik bir öneme sahiptir. Bu çalışmada, Toplam Ekipman Etkinliği (OEE) hesaplamalarından yararlanılarak önemli gelişmeler kaydedilmiştir. OEE, bir üretim hattının kullanılabilirlik, performans ve kalite açısından nasıl performans gösterdiğini ölçen bir göstergedir. Bu çalışmada, OEE'yi artırmak için iyileştirmeler yapılmasını amaçlamıştır ve bu iyileştirmelerin işletme için ne kadar önemli olduğunu vurgulamaktadır.

İlk olarak, Toplam Duruş süresini azaltmak amacıyla 'tox station' adlı bir destek istasyonu kullanılmıştır. Bu sayede toplam duruş süresi 21633 saniyeden 19958 saniyeye düşürülmüştür. Ayrıca, operatörlerin daha hızlı çalışabilmesi için konveyör bandı operatörün yanına getirilmiştir, bu da verimliliği artırmıştır. Net çalışma süresi 93900 saniyeden 73942 saniyeye düşürülmüştür ve net çalışma oranı 0,769'dan 0,787'ye yükseltilmiştir. Performans oranı hesaplamalarında, günlük üretim miktarı ve makine hızı göz önünde bulundurulmuştur. Bu sayede performans oranı %77,8'den %95'e yükseltilmiştir. Son olarak, kalite oranı kalıp bakımı ile iyileştirilmiş ve kalite oranı %98,08'den %99'a yükseltilmiştir. Bu iyileştirmeler sonucunda Toplam Ekipman Etkinliği (OEE) %0,586'dan %0,74'e yükseltilmiştir. Bu çalışmada, üretim hattındaki verimliliği artırmak için yapılan çalışmalarla birlikte somut adımlar atılmış ve verimlilik artırılarak firmanın üretim hattına önemli bir katkı sağlanmıştır.

Anahtar Kelimeler: Toplam Ekipman Etkinliği, Verimlilik, Net Çalışma Süresi, Performans Oranı, Kalite Oranı

IMPROVING PERFORMANCE EFFICIENCY WITH OVERALL EQUIPMENT EFFECTIVENESS: A REFRIGERATOR PRODUCTION LINE APPLICATION

ABSTRACT

The efficiency of a production line is considered a significant measure of modern industrial processes. This study aimed to improve the efficiency of a refrigerator production line. It examines the key steps and results related to this objective. Enhancing the efficiency of a production line is crucial for reducing costs, improving product quality, and increasing competitiveness for a company. This study makes use of calculations related to Overall Equipment Effectiveness (OEE), which is an indicator that measures how a production line performs in terms of availability, performance, and quality. The aim of this study was to make improvements to increase OEE and emphasize the importance of these improvements for the business.

Firstly, a support station called 'tox station' was used to reduce the Total Downtime. This reduced the total downtime from 21,633 seconds to 19,958 seconds. Additionally, to enable operators to work faster, the conveyor belt was brought closer to the operator, further increasing efficiency. The net working time decreased from 93,900 seconds to 73,942 seconds, and the net working ratio increased from 0.769 to 0.787. Performance ratio calculations took into account daily production quantities and machine speed, resulting in an increase in the performance ratio from 77.8% to 95%. Lastly, the quality ratio was improved through mold maintenance, raising the quality ratio from 98.08% to 99%. As a result of these improvements, the Overall Equipment Effectiveness (OEE) increased from 0.586 to 0.74. This study demonstrates concrete steps taken to enhance productivity, contributing significantly to the company's production line efficiency.

Keywords: Overall Equipment Effectiveness, Efficiency, Net Working Time, Performance Ratio, Quality Ratio

1. GİRİŞ

Toplam Ekipman Etkinliği, üretim yapılan bir tesiste üretimin hangi etkinlikte gerçekleştirildiğini gösteren önemli bir performans göstergesi olup, üretimin üç bileşeni olan zaman kullanımı, performans (hız) ve kalite seviyesi arasında ilişki kuran ve bunları takip imkânı sağlayan bir ölçüm sistematığıdır(Kalpande, 2014).

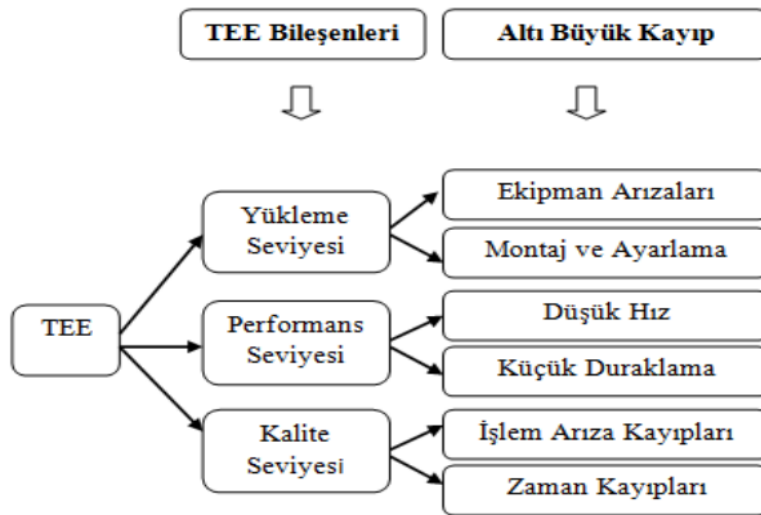
Her firmanın amacı kar ederek firmayı ileri bir seviyeye taşımaktır. Firmaların kendi aralarında rekabet edebilmesi için maliyetlerin düşürülmesi gerekmektedir. Verimliliğin ve etkinliğin en üst seviyede olması ve bu kriterlerin takip edilmesi firmanın geleceği açısından çok önemlidir.

Böylece etkili bir performans ölçüm sistemine ihtiyaç duyulmaktadır. Makine ve ekipmanların performans ölçüm ve analizleri yapılarak minimum hata ve arıza olması hedeflenmektedir. Arızalardan kaynaklanan kayıpların önlenmesi ve azaltılması için analizlerin yapılması gerekmektedir.

Üretimde yaşanan kapasite sorunlarına çözüm olabilmek ve taleplerine karşılık bulabilmek için toplam ekipman etkinliği çalışmalarına başvurulur. Bu yöntem, mevcut ekipmanlarla daha verimli bir şekilde üretim yapılmasını sağlamak, üretim süreçlerinin daha hızlı ve daha kaliteli hale getirilmesini sağlamak, atıl kapasitenin minimize edilmesini sağlamak ve işletmenin rekabet gücünü artırmak gibi avantajlar sağlar.

Mevcut ekipmanlarla üretim organizasyonunun performansını optimize etmek için öncelikle mevcut süreçlerin analiz edilmesi gerekir. Bu analiz sonucunda hangi süreçlerin daha verimsiz olduğu belirlenir ve bu süreçlerin nasıl iyileştirilebileceği araştırılır. Örneğin, üretim hattındaki bir makinenin sık sık arıza yapması nedeniyle sürekli olarak üretim duruyorsa, bu makinenin bakımının düzenli olarak yapılması veya yeni bir parça takılması gibi çözümler düşünülebilir (Kalpande, 2014).

Ekipman etkinliğini düşüren ve kaybına neden olan 6 büyük kaybın TEE bileşenleriyle ilişkisi Şekil 1.1 'de gösterilmektedir.



Şekil 1. 1. TEE ve Altı Büyük Kayıp İlişkisi, (Acar & Çakırkaya, 2018)

Toplam Ekipman Etkinliğinin amacı 6 büyük kayıp listesinde yer alan olayları azaltmaktır. 6 büyük kayıp üretimde verimlilik düşüşünün ve önemli mali sonuçlara yol açmaktadır. 6 büyük

kaybın açıklaması Şekil 1’de gösterilmiştir. 6 Büyük kayıp adı altında kayıpları Tablo 1.1’deki şekilde sıralayabiliriz.

Tablo 1. 1. 6 Büyük Kayıp, (Pomorski, 2004)

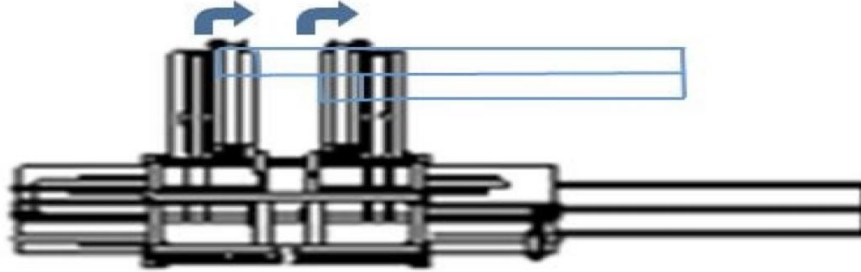
6 Büyük Kayıp	TEE Sisteminde Kayıp	Örnek Olaylar
Arıza	Duruş Kaybı	Kalıp arızası Plansız bakım Makina arızası
Set-Up ve Ayar	Duruş Kaybı	Ayar, hazırlık Isınma zamanı Kalıp değişimi
Küçük Duruş (5 dakikadan kısa süren duruşlar)	Hız Kaybı	Ürün akışının engellenmesi Sensörün bloke olması Besleme düzeninde problem Temizlik / Kontrol
Yavaş Çalışma (Teorik hızın altında çalışma durumu)	Hız Kaybı	Problemlı malzeme Ekipmanın eski olması Operatörün yetersizliği Problemlı tasarım Makina problemleri
Ayar, Set-Up Firesi	Kalite Kaybı	Hurda Yeniden işlem Bozuk üretim Hatalı montaj
Üretim Firesi	Kalite Kaybı	Hurda Yeniden işlem Bozuk üretim Hatalı montaj

2. ARAŞTIRMA VE BULGULAR

2.1. Takviye Beslenme

Yapılan duruş analizlerine göre üretim hattına takviye besleme yapılırken hatta çalışan kişi sayısı tek olduğunda üretim hattında duruşun olduğu gözlemlenmiştir. Bu duruşu azaltmak amacıyla inceleme çalışmaları yapılmıştır. Vardiya sırasında bir operatör, molalar nedeniyle makinede toplam 110 dakika tek başına çalışmaktadır. Üretim hattına takviye ilave yapılması işlemi yaklaşık her 15 dakikada bir yapılan bir işlemdir. Bu işlem üretim boyunca süreklilik arz ettiği için iyileştirilmesinin Toplam Ekipman Etkinliğinin artırılmasını sağlayacağı düşünülmüştür. Operatörün takviye ilavesi yapacağı hatta ortalama yürüme süresi 20 saniyedir. Takviye besleme süresi 40 saniyedir. Bu işlem için toplam çalışma süresi 60 saniyedir. Bu da üretim hattının 60 saniye durmasına sebep olmaktadır. Takviye ilave edilmesi işlemi toplam duruşların % 7,74’dür. Bu duruşun ortadan kaybolması için bir çalışma başlatılmıştır. İncelemeler sonrası takviyeyi üretim hattına besleyen taşıyıcı bantların personele

yakınlaştırılması ile personelin yürüyerek harcadığı zaman kaybı azaltılması planlanmıştır. Projenin ayrıntıları Şekil 1.2.'de gösterilmiştir.



Şekil 1. 2. Panel Taşıyıcı Bantlarının Yer Değişikliği

Üretim hattındaki duruş sürelerini azaltma ve bu süreleri optimize etme, birçok farklı süreç iyileştirme yöntemi ile ilgili olabilmektedir. Bu iyileştirmedeki hedef metodlar; Kaizen ve SMED (Single-Minute Exchange of Die) gibi tekniklerle sağlanmıştır. Bu duruş süresi azaltma çalışması, özellikle SMED ile ilişkilendirilebilir.

SMED (Single-Minute Exchange of Die - Kalıp Değişim Süresi Azaltma): Bu yöntem, ekipmanların veya makinenin bir işten diğerine geçiş sürelerini minimize etmeyi amaçlar. Bu, duruş sürelerini azaltma amacını taşır. SMED, işçilerin hızlı bir şekilde bir görevden diğerine geçmelerine ve makinelerin daha az durmasına olanak tanımaktadır. Panel hattında çalışanların vardiya sırasında daha hızlı çalışabilmesi için iyileştirme süreçleri, SMED'in bir parçasıdır (Singh & Khanduja, 2010).

Kaizen (Sürekli İyileştirme): Kaizen, sürekli olarak iş süreçlerini iyileştirme yaklaşımını benimser. Sürekli çalışanların vardiya sırasında daha verimli çalışmalarını sağlamak, Kaizen felsefesinin bir parçasıdır. İyileştirmelerin küçük adımlar halinde yapılması ve sürekli olarak uygulanması, Kaizen'in temel prensiplerindendir (Url-1).

Özellikle bu iki yöntem, duruş sürelerini azaltmaya ve verimliliği artırmaya yönelik etkili yaklaşımlardır. Bu çalışmada işletmenizin spesifik ihtiyaçlarına ve duruş sürelerini azaltma hedeflerine dikkat ettiğimizde bu iki yaklaşımdan faydalanarak duruş sürelerini azaltarak Toplam Ekipman Etkinliği artırılmıştır.

2.2. Kalıp Bakım Programı

Belirlenen bir zaman periyodunda makinaların ve ekipmanların verimli çalışması için bakımları ve onarımlarının yapılması gerekmektedir. Düzenli olarak makinalar ve ekipmanlar gözden geçirilmektedir. Tespit edilen arızalar ile arıza oluşturma olasılığı olan durumlar

düzeltilmektedir. Bu yöntemde arıza çıkması beklenmemektedir. Ekipmanlara daha önceden yapılan bakımlar nedeniyle olası arızaların önüne geçilmektedir. Bunun sonucunda arızanın çıkma olasılığı büyük oranda azaltılmış olur.

Üretimdeki maliyetleri azaltmak, iş gücü performansını, üretimdeki performansı ve ürün kalitesini arttırmak, üretimdeki duruşları mümkün olduğunca minimum düzeye indirmek, kapasite kullanım oranının artırılmasını sağlamak, işletmede malzeme, ürün, ekipmanların ömrünü uzatmak için bir bakım programı oluşturulmalıdır.

Yapılan analizler sonucunda kalıp problemlerinden dolayı oldukça fazla duruş yaşanmaktadır ve bu da fabrika için maliyet oluşturmaktadır. Kalıplarda düzenli bakım programının planlanması ve bu programın sürekli takibinin yapılması duruşların azalmasına sebep olacaktır. Bu nedenle üretilen tüm kalıpların planlı takibinin hata yapmadan düzenli olarak yapılmasını sağlamak için yazılım aracılığı ile oluşturulan seri numaralarıyla kayıt altına alınabilir. Her kalıpla ilgili tüm çizim, resim vb. evraklar bu modülde tutulabilmektedir. Kalıp çeşitleri oldukça geniştir. Bunların hepsi ayrı ayrı adlandırılır. Ayrıca işlevlerine göre gruplandırılır. Örneğin köşe kesimi yapan kalıplar ile delme yapan kalıplar ve ayırma işlemini yapan kalıplar birbirinden ayrılır. Kalıpların çeşitlerine göre gruplandırıldıktan sonra belirli bir sıraya göre işlemler başlatılır. Daha sonra bileme işlemi ve kontroller gerçekleşir. İticiler kontrolü ve süzdürücü yay ve civata kontrolü yapılır. Böylece istasyonda her ürün sırasıyla bu işlemlerden geçer. Bunun ile ilgili örnek Tablo 1.2.'de verilmiştir. Buzdolabı firmasının özellikle Kalıp bakım programında ön gördüğü adımlar ve süreler bu şekilde belirlenmiştir.

Tablo 1. 2. Buzdolabı üretim hattı kalıp bakım işlemleri

İSTASYON	KALIP	BİLEME	İTİCİLER KONTROLÜ	SUZDURUCU YAY VE CIVATA KONTROLÜ	Aylar									
					Oca.09	Şub.09	Mar.09	Nis.09	May.09	Haz.09	Tem.09	Ağu.09	Eyl.09	Eki.09
KÖŞE KESİM	A-KALIBI	100.000	200.000	400.000	52.250	105.567	157.817	210.067	262.317	314.567	366.817	419.067	471.317	523.567
	B-KALIBI	100.000	200.000	400.000	7.855	11.782	14.149	25.450	48.355	63.848	80.773	101.391	124.258	143.687
	C-KALIBI	100.000	200.000	400.000	51.719	103.437	155.156	206.875	258.594	310.313	362.032	413.751	465.728	517.447
	D-KALIBI	100.000	200.000	400.000	21.391	42.782	64.173	85.564	106.955	128.346	149.737	171.128	192.519	213.919
	E-KALIBI	100.000	200.000	400.000	10.897	21.794	32.691	43.588	54.485	65.382	76.279	87.176	98.073	108.970
	F-KALIBI	100.000	200.000	400.000	52.215	104.430	156.645	208.806	261.075	313.290	365.505	417.720	469.935	522.150
	G-KALIBI	100.000	200.000	400.000	21.035	42.070	63.105	84.140	105.575	126.210	147.245	168.280	189.315	210.350
	H-KALIBI	100.000	200.000	400.000	39.515	79.030	118.545	158.060	197.575	237.090	276.605	316.120	355.635	395.150
	I-KALIBI	100.000	200.000	400.000	40.102	80.204	120.306	160.408	200.510	240.612	280.714	320.816	360.918	401.020
	L-KALIBI	100.000	200.000	400.000	3.955	7.509	13.485	16.399	21.578	27.699	35.277	43.964	57.322	65.378
	M-KALIBI	100.000	200.000	400.000	39.469	78.938	118.407	157.876	197.345	236.814	276.283	315.752	355.222	394.691
DELME	B-KALIBI	100.000	200.000	400.000	17.954	33.691	52.674	70.297	88.321	105.912	123.524	145.397	162.579	183.645
	C-KALIBI	100.000	200.000	400.000	3.895	8.611	12.097	16.248	19.555	23.841	27.921	31.699	35.245	38.955
	D-KALIBI	100.000	200.000	400.000	1.023	2.046	3.069	4.093	5.115	6.138	7.161	8.184	9.207	10.230
	F-KALIBI	100.000	200.000	400.000	55.285	110.570	165.855	221.141	276.428	331.710	386.995	442.280	497.566	552.841
	G-KALIBI	100.000	200.000	400.000	236	472	708	946	1.184	1.422	1.660	1.898	2.136	2.372
	H-KALIBI	100.000	200.000	400.000	91.743	183.486	275.229	366.972	458.715	550.458	642.201	733.942	825.687	917.430
	I-KALIBI	100.000	200.000	400.000	81.398	162.796	244.194	325.592	406.990	488.388	569.789	651.184	732.582	813.980
	L-KALIBI	100.000	200.000	400.000	24.951	49.285	74.269	99.248	124.137	148.325	174.069	198.583	223.954	248.588
AYIRMA	AYIRMA MAKAS	100.000	200.000	400.000	51.467	102.934	154.401	205.868	257.335	308.802	360.269	411.736	463.203	514.670

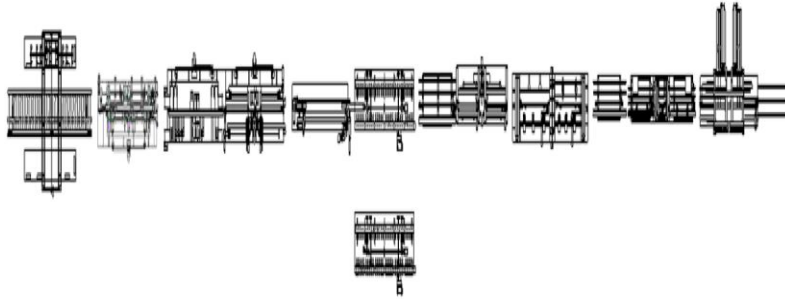
Bahsettiğiniz iyileştirme, özellikle Kaizen (Sürekli İyileştirme) ve 5S gibi süreç iyileştirme yöntemleri ile ilişkilendirilerek planlanmıştır.

Kalıp bakım süreçlerinin daha verimli ve düzenli hale getirilmesi, Kaizen felsefesinden çıkarılmıştır. Kaizen, sürekli olarak süreçleri geliştirmeyi hedefleyen bir yaklaşım olduğu için kalıp bakımının daha etkili bir şekilde yapılması için bilgisayar tabanlı bir takip sistemi oluşturmak ve otomasyonu kullanarak hataları en aza indirmek, Kaizen'in temel prensiplerine uygun bir yaklaşımı temsil etmiştir. Ek olarak 5S, iş yerinin düzenini sağlamayı ve temiz tutmayı amaçlar. Kalıp bakımının düzenli ve etkili bir şekilde yapılması için çalışma alanının düzenli, temiz ve düzenli tutulması büyük ölçüde önem taşır. E-posta haberleşmesi gibi otomasyonlar, iş süreçlerini düzenlemek ve bildirimleri düzenli bir şekilde iletmek için 5S ilkelerinin uyumlu olduğu anlaşılmıştır.

Sonuç olarak, kalıp bakımının düzenli yapılmasını sağlamak için geliştirilen bu işlemler, hem sürekli iyileştirme felsefesi olan Kaizen'i hem de iş yerinin düzen ve temizlik ilkelerini içeren 5S yaklaşımlarından faydalanarak sağlanmıştır.

2.3. Model Değişimi Sürelerinin Azaltılması

Üretim hatlarında tek tip model üretimi yapılmamaktadır. Birden fazla model üretimi olduğu için model değişimi süreleri de duruşa sebep olmaktadır. Üretim hattının layoutu Şekil 1.3.'te verilmiştir. Operatör model değişimi ve arabada sac kalmadığı zamanlarda üretimin hattının bir ucundan hattın en sonuna kadar yürümesi gerekmektedir. Bu da zaman kaybına yol açmaktadır. Bilgisayar sistemini roll-form istasyonunda da (üretim hattının ortasında) kurulması zaman tasarrufu sağlamaktadır. Bu da duruş süresini azaltmaktadır. Böylelikle gidiş dönüş süresi 40 saniye azaltılmaktadır.



Şekil 1. 3. Üretim hattı layout

Bu adımdaki süreç iyileştirme yaklaşımı, SMED (Single-Minute Exchange of Die - Kalıp Değişim Süresi Azaltma) yönteminden faydalanarak geliştirilmiştir.

SMED, başlangıçta "kalıp değişim süresi azaltma" için tasarlanmış olmasına rağmen, genel olarak iş süreçlerindeki herhangi bir tür değişim veya ayarlama süresini azaltma amacını taşımaktadır. Model değişimi ve arabada sac kalmadığı zamanlarda üretim hattının bir ucundan hattın en sonuna kadar yürüme süresini azaltmak, iş süreçlerinde bir tür değişiklik anlamına gelmektedir.

Özellikle SMED yöntemi, işçilerin veya operatörlerin hızla değişiklikler yapmalarını sağlamayı amaçlar. İşçilerin hızlı bir şekilde model değişimi yapabilmeleri, bu tür değişimlerin hızlandırılması gerektiğini gösterir. İşte bu yüzden, SMED, işçilerin daha hızlı hareket etmelerini ve ayarlamaları daha verimli bir şekilde yapmalarını sağlamak için uygulanan bir süreç iyileştirme tekniği olarak bu durum ele alınarak Toplam Ekipman Etkinliğinin artırılmasında etkisi gözlemlenmiştir.

2.4. Toplam Ekipman Etkinliği Hesaplamaları

$$OEE = A \times P \times Q \quad (1)$$

Burada;

- OEE** : Toplam Ekipman Etkinliği
A : Availability (Net Çalışma Oranı)
P : Performans Oranı
Q : Kalite'yi ifade etmektedir.

2.4.1. Net Çalışma Oranı

Toplam Duruş süresini azaltmak amacıyla 'tox station' adlı bir destek istasyonu kullanılmıştır. Bu sayede toplam duruş süresi 21633 saniyeden 19958 saniyeye düşürülmüştür. Ayrıca, operatörlerin daha hızlı çalışabilmesi için konveyör bandı operatörün yanına getirilmiştir, bu da verimliliği artırmıştır. Net çalışma süresi 93900 saniyeden 73942 saniyeye düşürülmüştür ve net çalışma oranı 0,769'dan 0,787'ye yükseltilmiştir. Bu hesaplamalar Tablo 1.3.'te gösterilmiştir.

Tablo 1. 3. Net Çalışma Oranı Hesaplamaları

Açıklama	Hesaplama
Başlangıç Duruş Süresi	21633 saniye
İlk Öneriye Bağlı Duruş Süresi	1675 saniye
Net Çalışma Süresi	21633 saniye - 1675 saniye = 19958 saniye
Net Çalışma Saati	93900 saniye - 19958 saniye = 73942 saniye
Net Çalışma Oranı	73942 saniye / 93900 saniye = 0.787 (veya %78.7)
İyileştirme Yüzdesi	(0.787 - 0.769) / 0.769 = 0.023 (veya %2.3)

2.4.2. Performans Oranı

Performans oranı hesaplamalarında, günlük üretim miktarı ve makine hızı göz önünde bulundurulmuştur. Makineye bakım yapılarak performans oranı iyileştirildi. Böylece makine hızlandırıldı. Bu sayede performans oranı %77,8'den %95'e yükseltilmiştir. Bu hesaplamalar Tablo 1.4.'te gösterilmiştir.

Tablo 1. 4. Performans Oranı Hesaplamaları

Açıklama	Hesaplama
Günlük Üretim Miktarı	11500
Standart Hız (Panel/Dakika)	8 (bir dakikada)
Fiili Üretim Süresi (saniye)	72267
Fiili Üretim Süresi (dakika)	72267 saniye / 60 = 1204,45 dakika
Fiili Üretim Hızı (Panel/Dakika)	7500 panel / 1204,45 dakika = 6,23 (bir dakikada)
Performans Oranı	6,23 / 8 = 0.778 (veya %77.8)
Günlük Üretim Miktarı	9380 panel
Net Çalışma Süresi (saniye)	73942 saniye
Net Çalışma Süresi (dakika)	73942 saniye / 60 = 1232,36 dakika
Fiili Üretim Hızı (Panel/Dakika)	9380 panel / 1232,36 dakika = 7,61 (bir dakikada)
Standart Hız (Panel/Dakika)	8 (kapasitesi)
Performans Oranı	7,61 / 8 = 0.951 (veya %95)

2.4.3. Kalite Oranı

Kalıp bakımı yapılarak kalite oranı iyileştirilmiştir. Bu hesaplamalar Tablo 1.5.'te gösterilmiştir.

Tablo 1. 5. Kalite Oranı Hesaplamaları

Açıklama	Hesaplama
Kalite Oranı	$7356 / 7500 = 0.9808$ (%98.08)
Kalite Oranı İyileştirme	$8120 / 8200 = 0.99$ (%99)

3. SONUÇ

Bu iyileştirmeler sonucunda Toplam Ekipman Etkinliği (OEE) %0,586'dan %0,74'e yükseltilmiştir. Bu hesaplamalar Tablo 1.6.'da gösterilmiştir. Bu çalışmada, üretim hattındaki verimliliği artırmak için yapılan çalışmalarla birlikte somut adımlar atılmış ve verimlilik artırılarak firmanın üretim hattına önemli bir katkı sağlanmıştır.

Tablo 1. 6. Toplam Ekipman Etkinliği Hesaplaması

Açıklama	Hesaplama
İyileştirme Stratejileri Yapılmadan Önceki OEE	$0,769 \times 0,778 \times 0,98 = 0,586$
İyileştirme Stratejileri Yapıldıktan Sonraki OEE	$0,787 \times 0,951 \times 0,99 = \mathbf{0,74}$

KAYNAKÇA

- Acar, Ö. E., & Çakırkaya, M. (2018). Bir Üretim Hattında Toplam Ekipman Etkinliğinin Ölçülmesi Ve Geliştirilmesi Üzerine Bir Uygulama. Gümüşhane Üniversitesi.
- Kalpande, S. D. (2014). OEE an Effective Tool for TPM Implementation. A Case Study, 8th International Quality Conference, 521-526. Serbia: Center for Quality, Faculty of Engineering, University of Kragujevac.
- Pomorski, T. (2004). Total Productive Maintenance(TPM) Concept and Literature Review.
- Singh, B. J., & Khanduja, D. (2010). SMED: For Quick Changeovers İn Foundry Smes. InternationalJournal Of Productivity And Performance Management.
- Url-1 <https://tr.wikipedia.org/wiki/Kaizen>

EXPERIMENTAL INVESTIGATION OF BIODIESEL PRODUCTION FROM SUNFLOWER OIL USING DIFFERENT TYPES OF CATALYSTS

Ayşe Hilal ULUKARDEŞLER

Bursa Uludag University, Vocational School of Technical Sciences, Bursa

ORCID ID: 0000-0001-6563-5785

ABSTRACT

The energy needs of countries are increasing rapidly due to industrialization and technological developments. Although the energy requirement is largely met by fossil fuels, the decrease in fossil fuel reserves, the increase in oil prices, the oil crisis and the pollutant emissions released from engines have led researchers and manufacturers to study renewable alternative fuels. Biodiesel is a type of renewable fuel produced from vegetable oils that can be consumed as food or not, and from waste vegetable and animal oils. Biodiesel consists of a mixture of fatty acid methyl esters obtained as a result of the transesterification reaction of triglyceride found in oils with short-chain alcohols such as methanol and ethanol in the presence of a suitable catalyst. Base homogeneous catalysts are the most used catalysts in industrial biodiesel production. Sodium hydroxide (NaOH), potassium hydroxide (KOH) may be given as an example to these types of catalysts. In general, acid homogeneous catalysts (H_2SO_4) are used before transesterification to reduce the high content of free fatty acids in the raw material. This process can be called raw material pretreatment. The disadvantages of both types of homogeneous catalysts include; the corrosive effects of acidic catalysts, saponification reaction which basic homogeneous catalysts cause, the difficulties in separation and purification of both types of catalysts. Heterogeneous catalysts have become preferred by researchers due to their reusability, non-corrosiveness, ease of separation and purification, high selectivity, and compatibility with batch and continuous systems. In this study, the production of biodiesel from sunflower oil through transesterification reaction was experimentally investigated. KOH and heterogeneous type catalyst which is an ion exchange resin (Amberlyst 15) were used as catalysts. The methanol/oil was studied at 12 and 15 molar ratios, and the amount of catalyst was studied at 1% and 3% ratios. As a result, the highest conversion was found with the experiment 3% KOH catalyst ratio and methanol/oil ratio of 15. In experiments conducted with Amberlyst 15 catalyst, conversion values were obtained over 90%.

Keywords: Biodiesel, Transesterification, Catalysts, Sunflower Oil

FARKLI TİP KATALİZÖRLER KULLANILAN AYÇİÇEK YAĞINDAN BİYODİZEL ELDESİNİN DENEYSEL OLARAK İNCELENMESİ

ÖZET

Ülkelerin enerji ihtiyaçları sanayileşme ve teknolojik gelişmelere bağlı olarak hızla artmaktadır. Dünyada enerji ihtiyacı büyük oranda fosil kaynaklı yakıtlarla karşılanmasına rağmen, fosil yakıtların rezervlerinin azalması, petrol fiyatlarının yükselmesi, yaşanan petrol krizleri ve motorlardan salınan kirletici emisyon değerleri, araştırmacı ve imalatçıları yenilenebilir alternatif yakıtlara yöneltmiştir. Biyodizel gıda olarak tüketilebilen veya tüketilemeyen bitkisel yağlar ile atık bitkisel ve hayvansal yağlardan üretilebilen yenilenebilir bir yakıt çeşitidir. Biyodizel, yağlarda bulunan trigliseridin metanol, etanol gibi kısa zincirli alkollerle uygun katalizör eşliğinde transesterifikasyon reaksiyonu sonucu elde edilen yağ asidi metil esterleri karışımından oluşur. Baz homojen katalizörler endüstriyel biyodizel üretiminde en çok kullanılan katalizörlerdir. Bu tip katalizörlere örnek olarak sodyum hidroksit (NaOH), potasyum hidroksit (KOH) verilebilir. Asit homojen katalizörler (H_2SO_4) genellikle hammaddede serbest yağ asidi yüksek orandaysa azaltmak amacıyla transesterifikasyondan önce kullanılır. Bu süreç genelde hammadde ön işlemi olarak isimlendirilebilir. Her iki tip homojen katalizörün dezavantajları arasında, asidik katalizörlerin korozif etkileri, bazik homojen katalizörlerin sabunlaşma reaksiyonuna neden olması, her iki tip katalizörün reaksiyon sonrası ayırma ve saflaştırma zorlukları sayılabilir. Heterojen katalizörler, yeniden kullanılabilirliği, korozif olmaması, ayırma ve saflaştırma kolaylığı ve yüksek seçiciliği, kesikli ve sürekli sisteme uyumluluğu nedeniyle araştırmacılar tarafından tercih edilir hale gelmiştir. Bu çalışmada ayçiçek yağından transesterifikasyon reaksiyonu yoluyla biyodizel eldesi deneysel olarak incelenmiştir. Katalizör olarak KOH ve heterojen tip katalizör olan iyon değişim reçinesi (Amberlyst 15) kullanılmıştır. Metanol/yağ oranı molar olarak 12 ve 15 oranlarında ve katalizör miktarı ise %1 ve %3 oranlarında değiştirilmiştir. Sonuç olarak, %3 KOH katalizör oranı ve metanol/yağ oranı 15 olan deneyde en yüksek dönüşüm bulunmuştur. Amberlyst 15 katalizörle yapılan deneylerde de %90'ın üzerinde dönüşüm değerleri elde edilmiştir.

Anahtar Kelimeler: Biyodizel, Transesterifikasyon, Katalizörler, Ayçiçek Yağı

1. INTRODUCTION

The increase in the world population and industrialization results an increase in energy demand. Since the beginning of industrialization, fossil resources such as oil, coal and natural gas have been used to meet the world's energy needs. However, it is predicted that in the near future these resources will become insufficient to meet these needs and will be depleted. While meeting the ever increasing energy need, it has become a necessity not to release greenhouse gases into the

atmosphere and to prevent or reduce the negative effects of these gases. This will only be possible by using sustainable, renewable and alternative energy sources that do not pollute the environment (Banerjee et al., 2014; Hazrat et al., 2022; Khan et al., 2022).

Biodiesel is an environmentally friendly, renewable fuel. Biodiesel is obtained as a result of the transesterification reaction of vegetable or animal oils with short chained alcohol in the presence of a suitable catalyst. Figure 1 shows the transesterification reaction (Ulukardesler, 2023). Biodiesel has low emission value, anti toxic and biodegradable properties. It is similar to the chemical and physical properties of other fossil fuels. Therefore, it can also be used by blending it with fossil fuels. Biodiesel production is generally carried out by transesterification reaction in homogeneous catalyst systems. However, due to the disadvantages such as the difficulty of removing the catalyst from the reaction medium in production with homogeneous catalysts, the impurity of biodiesel, and the formation of soap as a by product in the presence of free water and fatty acids, research in biodiesel production has turned to the use of heterogeneous catalysts that provide high efficiency (Jayakumar et al., 2021; Mohiddin et al., 2021; Mathew et al., 2021; Peter et al., 2021)

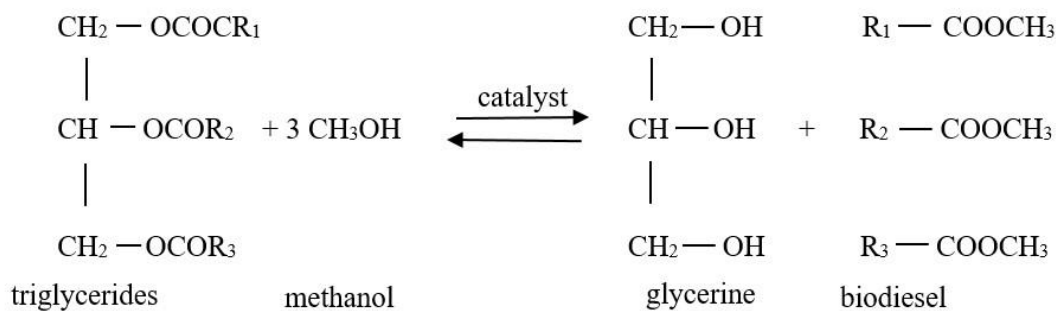


Figure 1. Transesterification reaction

Transesterification reactions depend significantly on the reaction conditions; alcohol/oil ratio, type of alcohol, amount and type of catalyst, reaction temperature, reaction time and the purity of the reactants. The most important factor affecting the efficiency of biodiesel production is the catalyst used in the reaction. Catalysts used in transesterification reactions can be divided into three main classes: homogeneous catalysts (acid homogeneous or alkali homogeneous), heterogeneous catalysts and enzymes. Alkali catalysts (NaOH, KOH, etc.) are preferred to acidic catalysts because they occur in shorter reaction times and at lower temperatures. On the other hand, an undesirable saponification side reaction may occur between the triglyceride and the alkaline catalyst. At the same time, after the transesterification reaction, an extra process is required to separate the alkaline catalyst dissolved in the reaction medium from the product,

which increases the cost of biodiesel production. Waste oils, which are cheaper than pure oil, can also be used in biodiesel production. However, they may cause saponification side reaction due to their high free fatty acid content. Therefore, when using waste oil, the free fatty acid amount of the waste oil is reduced firstly by processes such as esterification or distillation, and then the transesterification process is started. Enzyme catalysts such as lipase have also been tested in transesterification reactions. But, the high price and unstable catalytic activity of lipase enzyme have made this catalyst unsuitable for industrial applications.

The ion exchange resins are recommended in literature as heterogeneous type catalysts in order to eliminate all these disadvantages of homogeneous catalysts. Ion exchange resins can catalyze the reaction under average conditions. They are the catalysts with high selectivity and do not harm the environment. Also, they are frequently preferred because they are easily available commercially. Ion exchange resins are heterogeneous catalysts that can be easily separated from the product and easily regenerated (Avhad et al., 2015; Patino et al., 2018; Okolie et al., 2022; Mohadesi et al., 2019; Ulukardesler, 2023).

In this study, the production of biodiesel from sunflower oil through transesterification reaction was investigated experimentally. Potassium hydroxide (KOH) and heterogeneous type catalyst, an ion exchange resin (Amberlyst 15) were used as catalysts. The methanol/oil was studied at 12 and 15 molar ratios, and the amount of catalyst was studied at 1% and 3% ratios.

2. MATERIALS AND METHODS

2.1 Experimental Study

Transesterification method was used to obtain biodiesel from sunflower oil. The experiments were carried out in Bursa Uludag University, Vocational School of Technical Sciences, Agricultural Machinery Program Laboratory. The sunflower oil used was obtained from the market. Methanol with 99% purity was used as alcohol, and KOH and ion exchange resin named Amberlyst 15 were used as catalysts. The ion exchange resin, Amberlyst 15 was purchased from Rohm and Haas Co., Ltd. Oil, alcohol and catalyst weights were measured with a precision balance with an accuracy of 0.001 g. After measuring the amounts of alcohol and catalyst, the catalyst was completely dissolved in alcohol in a glass container. In case there was water in the sunflower oil, in order to evaporate it was heated to 100°C. Then, sunflower oil was heated to the desired temperature value and the prepared alcohol-catalyst mixture was added into the oil. To carry out the transesterification reactions, the mixture was stirred at 600 rpm for 2 hours in a hot water bath at 60°C. Then, the mixture was placed in a separating funnel to separate the biodiesel (ester) and glycerine and the biodiesel was obtained after waiting for 8 hours. The obtained biodiesel was washed with pure water and dried. Experiments were

carried out with 1% and 3% catalyst amounts by weight of the oil and methanol/oil molar ratios of 12:1 and 15:1. The operating conditions for the experiments are shown in Table 1.

Table 1. Operating conditions for the experiments

Catalyst	Methanol/Oil (molar)	Catalyst Amount (wt.%)
KOH	12	1
		3
	15	1
		3
Amberlyst 15	12	1
		3
	15	1
		3

2.2 Experimental Results

In this study, effect of molar ratio of methanol and oil and effect of catalyst amount was investigated for each catalyst due to biodiesel yield. As a result of the calculations, the comparison between two catalysts was made.

Biodiesel yield is calculated by dividing the weight of biodiesel to the total mass of the oil consumed (Chiang et al., 2020; Naeem et al., 2021). During the experimental study, to investigate the effect of each parameter, the specified parameter was changed as the others were kept constant.

One of the most important parameters that play a role in achieving maximum conversion in the production of biodiesel through transesterification is the alcohol/oil molar ratio. The stoichiometric molar ratio for this reaction is 3/1 for methanol/oil. However, large volumes of methanol are required to move the reaction forward and to obtain maximum yield. In some studies, it can be seen that the methanol/oil molar ratio exceeds 20 (Mohiddin et al., 2021; Khan et al., 2022). In this study, it was observed that when the ratio of methanol to oil was increased from 12 to 15, the biodiesel yield increased in all cases, for every catalyst ratio and for every catalyst type. (Figure 2).

Another important factor in biodiesel production is the amount of catalyst. More or less amount of catalyst has positive or negative effects on the reaction. Therefore, the most appropriate amount of catalyst must be provided for maximum biodiesel yield. In this study, the catalyst amount was tested at 1 wt.% and 3 wt.% values for both types of catalysts. When examined by keeping other parameters constant, it was seen that the biodiesel yield increased when the

amount of catalyst was increased. This is valid for both KOH, a homogeneous base type catalyst, and Amberlyst 15, a heterogeneous type catalyst (Figure 2).

Finally, if two different types of catalysts were compared, it had been found that the homogeneous type basic catalyst gave better results than the heterogeneous type ion exchange catalyst. However, it should not be overlooked that the biodiesel yield values with the Amberlyst 15 catalyst are close to or above 90% (Figure 2).

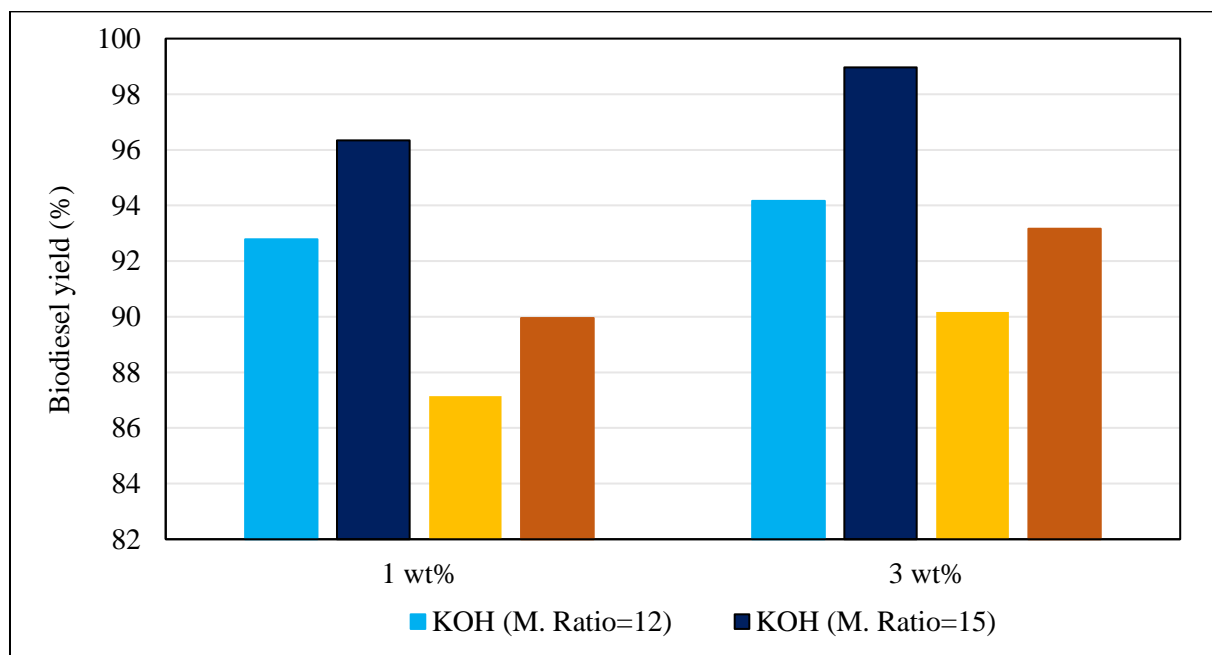


Figure 2. Biodiesel yield values with respect to catalyst amounts, molar ratios and catalyst types

3. CONCLUSION

Primary energy sources do not have the potential to meet the increasing energy need. The necessity of developing new energy technologies in addition to fossil energy sources is clearly visible. Countries ensure that they should use existing resources appropriately. They accelerated their implementation efforts. Biodiesel is an alternative diesel fuel obtained by chemical reaction from sources such as animal fats and vegetable oils. It reduces dependence on petroleum product diesel and its derivatives and has positive effects on the environment. Many studies are being carried out on the production of biodiesel and its use in engines.

There are many parameters that can be investigated in biodiesel studies. In this study, two different catalyst types, catalyst amounts and raw materials' ratios were examined. As a result, it has been found that ion exchange resins, which are heterogeneous catalyst types, can be an alternative to basic homogeneous type catalysts in terms of biodiesel yield.

As the next research step, the physical and chemical properties of the obtained biodiesel should be analyzed and compared according to the catalysts.

REFERENCES

- Avhad, M.R.; Marchetti, J.M. (2015). A Review on Recent Advancement in Catalytic Materials for Biodiesel Production. *Renewable and Sustainable Energy Reviews*, 50, 696-718. <https://doi.org/10.1016/j.rser.2015.05.038>.
- Banerjee, N.; Ramakrishnan, R.; Jash, T. (2014). Biodiesel Production from Used Vegetable Oil Collected from Shops Selling Fritters in Kolkata. *Energy Procedia*, 54, 161-165. <https://doi.org/10.1016/j.egypro.2014.07.259>.
- Chiang, C.L.; Lin, K.S.; Shu, C.W.; Wu, J.C.S.; Wu, K.C.W.; Huang, Y.T. (2020). Enhancement of Biodiesel Production via Sequential Esterification/Transesterification Over Solid Superacidic and Superbasic Catalysts. *Catalysis Today*, 348, 257-269. <https://doi.org/10.1016/j.cattod.2019.09.037>.
- Hazrat, M.A.; Rasul, M.G.; Khan, M.M.K.; Ashwath, N.; Silitonga, A.S.; Fattah, I.M.R.; Mahlia, T.M.I. (2022). Kinetic Modelling of Esterification and Transesterification Processes for Biodiesel Production Utilising Waste-Based Resource. *Catalysts*, 12, 1472. <https://doi.org/10.3390/catal12111472>.
- Jayakumar, M.; Karmegam, N.; Gundupalli, M.P.; Gebeyehu, K.B.; Asfaw, B.T.; Chang, S.W.; Ravindran, B.; Awasthi, M.K. (2021). Heterogeneous Base Catalysts: Synthesis and Application for Biodiesel Production- A Review. *Bioresource Technology*, 331, 125054. <https://doi.org/10.1016/j.biortech.2021.125054>.
- Khan, I.W.; Naeem, A.; Farooq, M.; Ghazi, Z.A.; Saeed, T.; Perveen, F.; Malik, T. (2022). Biodiesel Production by Valorizing Waste Non-Edible Wild Olive Oil Using Heterogeneous Base Catalyst: Process Optimization and Cost Estimation. *Fuel*, 320, 123828.
- Mathew, G.M.; Raina, D.; Narisetty, V.; Kumar, V.; Saran, S.; Pugazhendhi, A.; Sindhu, R.; Pandey, A.; Binod, P. (2021). Recent Advances in Biodiesel Production: Challenges and Solutions. *Science of the Total Environment*, 794, 148751. <https://doi.org/10.1016/j.scitotenv.2021.148751>.
- Mohadesi, M.; Aghel, B.; Maleki, M.; Ansari, A. (2019). Production of Biodiesel from Waste Cooking Oil Using a Homogeneous Catalyst: Study of Semi-Industrial Pilot of Microreactor. *Renewable Energy*, 136, 677-682.
- Mohiddin, M.N.B.; Tan, Y.H.; Seow, Y.X.; Kandedo, J.; Mubarak, N.M.; Abdullah, M.O.; Chan, Y.S.; Khalid, M. (2021). Evaluation on Feedstock, Technologies, Catalyst and Reactor for Sustainable Biodiesel Production: A Review. *Journal of Industrial and Engineering Chemistry*, 98, 60-81. <https://doi.org/10.1016/j.jiec.2021.03.036>.
- Naeem, A.; Khan, I.W.; Farooq, M.; Mahmood, T.; Din, I.U.; Ghazi, Z.A.; Saeed, T. (2021). Kinetic and Optimization Study of Sustainable Biodiesel Production from Waste Cooking Oil Using Novel Heterogeneous Solid Base Catalyst. *Bioresource Technology*, 328, 124831. <https://doi.org/10.1016/j.biortech.2021.124831>.
- Okolie, J.A.; Escobar, J.I.; Umenweke, G.; Khanday, W.; Okoye, P.U. (2022). Continuous Biodiesel Production: A Review of Advances in Catalysis, Microfluidic and Cavitation Reactors. *Fuel*, 307, 121821. <https://doi.org/10.1016/j.fuel.2021.121821>.
- Patiño, Y.; Mantecón, L.G.; Polo, S.; Faba, L.; Díaz, E.; Ordóñez, S. (2018). Effect of Sludge Features and Extraction-Esterification Technology on the Synthesis of Biodiesel from Secondary Wastewater Treatment Sludges. *Bioresource Technology*, 247, 209-216. <https://doi.org/10.1016/j.biortech.2017.09.058>.
- Peter, A.S.; Alias, M.P.; Iype, M.P.; Jolly, J.; Sankar, V.; Babu, K.J.; Baby, D.K. (2021). Optimization of Biodiesel Production by Transesterification of Palm Oil and Evaluation of Biodiesel Quality. *Materials Today: Proceedings*, 42, 1002-1007.
- Ulukardesler, A.H. (2023). Biodiesel Production from Waste Cooking Oil Using Different Types of Catalysts. *Processes*, 11, 2035. <https://doi.org/10.3390/pr11072035>

TEKSTİL ENDÜSTRİSİNDE MİKRODALGA ENERJİSİNİN KULLANIMI**Semiha EREN**

Bursa Uludağ University, Faculty of Engineering, Department of Textile Engineering, Görükle, Campus

ORCID ID: 0000-0002-2326-686X**Aliye AKARSU ÖZENÇ**

Bursa Uludağ University, Faculty of Engineering, Department of Textile Engineering, Görükle, Campus

ORCID ID: 0000-0001-5603-5913**ÖZET**

Mikrodalgaların tekstil endüstrisinde kullanımı, pek çok faydası nedeniyle giderek daha önemli hale gelmiştir. Mikrodalgalar, zaman ve enerji tasarrufunun çok değerli olduğu tekstil endüstrisinde çok önemli olan hızlı ve verimli bir ısıtma yöntemi sunar. Mikrodalgaları kullanmanın avantajlarından biri de tekstil malzemelerine derinlemesine nüfuz ederek eşit ve kapsamlı bir ısıtma sağlamasıdır. Bu, özellikle boyama veya terbiye işlemlerinden önce kirliliklerin ve kontaminantların giderilmesinin gerekli olduğu ön terbiye işlemlerinde faydalıdır. Dahası, mikrodalgalar işlem süresini önemli ölçüde azaltarak üretkenliğin ve maliyet etkinliğinin artmasını sağlayabilir. Bununla birlikte, her teknolojiye olduğu gibi, dikkate alınması gereken dezavantajlar da vardır. Mikrodalgalar lokal ısınmaya neden olabilir, bu da dikkatli bir şekilde kontrol edilmezse düzensiz boyama veya aprelemeye yol açabilir. Ayrıca, mikrodalga ekipmanına yapılan ilk yatırım maliyetli olabilir ve finansal sonuçların dikkatle değerlendirilmesi gerekir.

Bu zorluklara rağmen, tekstil endüstrisinde mikrodalgaların kullanımı sürdürülebilirlik çabalarına önemli katkılar sağlamıştır. Mikrodalga enerjisinin kullanımı, geleneksel ısıtma yöntemlerine kıyasla genel enerji tüketimini azaltmaktadır. Bu sadece işletme maliyetlerini azaltmakla kalmaz, aynı zamanda sera gazı emisyonlarını azaltarak çevresel etkiyi de en aza indirir. Ayrıca, mikrodalgalar sıcaklık ve işlem süresi üzerinde hassas kontrol sağlayarak su tüketimini ve kimyasal kullanımını azaltır. Bu, atıkları en aza indirerek ve kaynakları koruyarak tekstil üretiminin genel sürdürülebilirliğine katkıda bulunur. Sonuç olarak, tekstil endüstrisinde mikrodalgaların kullanımı, verimli ve hızlı ısıtma, derin penetrasyon ve azaltılmış işlem süresi gibi çok sayıda avantaj sunmaktadır. Dikkate alınması gereken bazı dezavantajlar olsa da, bu teknolojinin sürdürülebilirliğe katkısı göz ardı edilemez. Enerji tüketimini, su kullanımını ve kimyasal atıkları azaltarak, mikrodalgalar daha sürdürülebilir bir tekstil endüstrisinin teşvik edilmesinde hayati bir rol oynamaktadır.

Anahtar Kelimeler: Mikrodalga enerjisi, Tekstil endüstrisi, Sürdürülebilirlik

UTILIZATION OF MICROWAVE ENERGY IN THE TEXTILE

ABSTRACT

Microwaves have gained increasing importance in the textile industry, owing to their numerous benefits. They provide a rapid and efficient method of heating, which holds great significance in an industry where time and energy conservation are paramount. Microwaves excel at deeply penetrating textile materials, ensuring uniform and thorough heating. This quality is particularly valuable in pre-treatment processes, where the removal of impurities and contaminants is essential before dyeing or finishing operations. Furthermore, microwaves substantially reduce processing time, enhancing productivity and cost-effectiveness. However, like any technology, there are associated challenges. Microwaves can lead to localized heating, potentially causing uneven dyeing or finishing if not meticulously controlled. Additionally, the initial investment in microwave equipment can be substantial, necessitating careful financial evaluation.

Notwithstanding these challenges, the integration of microwaves in the textile industry has made remarkable contributions to sustainability initiatives. The utilization of microwave energy reduces overall energy consumption compared to traditional heating methods. This reduction not only cuts operating costs but also mitigates environmental impact by decreasing greenhouse gas emissions. Furthermore, microwaves offer precise control over temperature and processing time, leading to reduced water consumption and chemical usage. This contributes to the overall sustainability of textile production by minimizing waste and conserving resources.

In conclusion, the adoption of microwaves in the textile industry offers numerous advantages, including efficient and rapid heating, deep material penetration, and reduced processing time. While there are drawbacks to consider, the technology's contribution to sustainability is undeniable. By reducing energy consumption, water usage, and chemical waste, microwaves play a vital role in promoting a more sustainable textile industry.

Keywords: Microwave energy, Textile industry, Sustainability

1. GİRİŞ

Tekstil endüstrisi, sürdürülebilirlik ve çevresel etkileri konusunda giderek daha fazla bilinçlenen bir sektördür. Geleneksel tekstil üretim yöntemleri, su tüketimi, enerji kullanımı ve atık oluşumu gibi nedenlerle çevresel etkileri önemli ölçüde artırır (Eren ve diğ., 2018). Bu nedenle, çevreye duyarlılık ve sürdürülebilirlik, tekstil endüstrisi için önemli bir konu haline gelmiştir (Yiğit ve diğ., 2021, Samanta ve diğ., 2019). İnovatif tekstil yöntemleri, enerji kullanımını azaltmak, su tasarrufu sağlamak ve çevre dostu malzemeler kullanmak gibi sürdürülebilirlik hedeflerini desteklemek için geliştirilmektedir (Mohammad, 2014).

Mikrodalga enerjisi, tekstil endüstrisinde kullanılan yenilikçi yöntemlerden biridir (Lara ve diğ., 2022). Mikrodalga enerjisi, elektromanyetik bir spektrumun bir parçasıdır ve elektromanyetik dalga boylarının bir frekans aralığına karşılık gelir. Mikrodalga enerjisi, su moleküllerinin hareketini hızlandırarak ısı üretir (Komarov, 2021). Bu özelliği sayesinde tekstil endüstrisinde çeşitli alanlarda kullanılmaktadır (Haghi 2005). Mikrodalga enerjisi, tekstil endüstrisinde ön terbiye, boyama ve bitim aşamalarında kullanılmaktadır. Mikrodalga enerjisi, klasik yöntemlere göre birçok avantaja sahiptir. Mikrodalga enerjisi kullanılarak yapılan işlemlerin genellikle daha hızlı ve daha verimlidir olduğu ayrıca, mikrodalga enerjisinin kullanımıyla enerji tüketimi azaltılabileceği vurgulanmıştır.

2. MİKRODALGA ENERJİSİNİN ÇALIŞMA PRENSİBİ

Mikrodalga enerjisi, su moleküllerinin hareketini hızlandırarak ısı üretir. Mikrodalga enerjisi, elektromanyetik bir dalga olarak malzemeler tarafından emilir. Su molekülleri, mikrodalga enerjisine karşı duyarlıdır ve bu enerjiyi emerler. Su molekülleri, mikrodalga enerjisi tarafından döndürülür ve bu dönme hareketi ısı üretir (Büyükkakıncı, 2012).

3. TEKSTİL ENDÜSTRİSİNDE MİKRODALGA ENERJİSİNİN KULLANIMI

Mikrodalga enerjisi, tekstil endüstrisinde daha öncede belirtildiği gibi çeşitli işlemlerde kullanılır (Griffin ve diğ. 1986). Yapılan çalışmalar aşağıda bölümler halinde özetlenmiştir.

3.1.Ön Terbiye İşlemleri

Mikrodalga teknolojisinin kullanımı ile ön terbiye işlemlerinde geleneksel yöntemlere göre işlem süresinin %95 tasarruf sağladığı iddia edilmiştir (Panda ve diğ., 2021). Abou El-Kheir ve diğ. (2015) yürüttükleri çalışmalarında mikrodalga ışımasının yün ağartma işleminde enerji ve zaman tasarrufunu artırmak için kullanmışlardır. Ve bu yöntemin geleneksel ısıtma ile karşılaştırıldığında benzer beyazlık düzeyi sağladığını ve aynı zamanda yünün daha az hasar gördüğünü ifade etmişlerdir. Hashem ve diğ. (2014) tarafından yürütülen çalışmada mikrodalga ısıtmanın pamuk kumaşların ön işlem süresini, kimyasal kullanımını ve su tüketimini azaltmak için kullanılabilirliğini araştırılmıştır. Sonuçlar, mikrodalga (5 saniye) ile pamuk kumaşların hızlı bir şekilde işlenebildiğini ve geleneksel işlem (2,5-3 saat) sonuçlarına benzer kalitede olduğunu göstermektedir. Kale ve Bhat'ın (2011) tarafından yürütülen bir çalışmada poliester kumaşlar dimetilformamid çözeltisine batırılarak belirli sürelerde (15, 30, 45, 60 ve 90 saniye) mikrodalga ışımaya maruz bırakılmıştır. Elde edilen sonuçlarda mikrodalga ışımalarının poliester kumaşların çözücülerle işlenmesini hızlandırarak yüzey pürüzlülüğü ve boşluklar

oluşturarak geleneksel yöntemlere göre üç kat daha fazla boya emilimini sağladığı ifade edilmiştir.

3.2.Boyama İşlemleri

Mikrodalga teknolojisinin tekstil boyama alanında kullanımının geleneksel yöntemlere göre enerji ve zaman maliyetlerinin azalttığı vurgulanmıştır (Elshehy ve Haggag, 2019). Adeel ve diğ. (2023) tarafından yürütülen çalışmada mikrodalga ışınları kullanarak Acid Blue 07 boyası ile poliamid esaslı proteinli kumaşların boyanmasını incelemiştir. Elde edilen sonuçlarda sürdürülebilir bir teknoloji olarak mikrodalga ışınlarının kullanılmasının kumaş yüzeyini fiziksel olarak değiştireceğini renk tutma yeteneğini artırdığını ve renk haslığının iyi olduğunu göstermektedir. Amesimiku ve diğ. (2021) tarafından yürütülen çalışmada meta-aramid kumaşların temel boyalar kullanılarak kombinasyon halindeki ultrasonik-mikrodalga ışınlama ile boyanabilirliğini incelenmiş ve boyama konsantrasyonu, süre, sıcaklık, çözelti oranı ve carrier madde kullanımı gibi faktörler tarafından kontrol edilen optimum işlem koşullarını belirlemiştir. Renk ölçüm analizi sonuçlarına göre, 70 °C sıcaklıkta ve 150:1 likör/kumaş oranında en iyi sonuç elde edilmiştir. Ayrıca, boyama süresinin artırılması ve boyama konsantrasyonunun yükseltilmesiyle yüksek renk dayanıklılığı elde edilmiştir. Ultrasonik-mikrodalga ışınlama, büyük boyama moleküllerinin parçalanmasını kolaylaştırarak kumaş üzerinde hızlı boya emilimini sağlamıştır ve ışınlama işlemi termal kararlılık üzerinde olumsuz bir etki yaratmadığı ifade edilmiştir. Büyükkakıncı ve diğ. (2021) yürüttükleri çalışmada organik pamuk kumaşlarının mikrodalga ışınlama ve geleneksel boyama yöntemleriyle barberry, dyer's oak ve dyer's oak + barberry ile boyanmasını incelemekte olup, bu boyama işlemlerinin renk özellikleri, maliyet etkinliği ve zaman tasarrufu açısından mikrodalga yönteminin geleneksel boyama yöntemlerine üstün olduğunu bildirmişlerdir. Ghaffar ve diğ. (2019) yürüttükleri çalışmada mikrodalga ışınlamanın kullanılmasıyla pamuk kumaşların Reactive Blue 21 boyasıyla boyanmasının çevre dostu ve hızlı hale getirildiğini ve mikrodalga işleminin boyama kalitesini ve haslık özelliklerini artırdığını ifade etmişlerdir. Pamuklu kumaşlarda yapılan çalışmalarda Kiran ve diğ. (2019) ve Lei ve diğ. (2013) benzer sonuçları elde etmiştir. Adeel ve diğ. (2019) tarafından yapılan çalışma, mikrodalga radyasyonunun kullanımıyla Arjun kabuğundan elde edilen doğal boyar maddenin yün kumaş boyama işlemi için kullanımını incelemekte olup, asit metanolla çözülmüş özütün yün kumaşı daha koyu renklere boyadığı ve mikrodalga işleminin boyanın işlevsel özelliklerini artırdığı ve eklenen yeşil mordan maddelerin boyama sürecini daha estetik hale getirdiği sonucuna varmıştır. Benzer sonuçları Xue (2016) yürüttüğü çalışmada elde etmiştir. El Khatib ve diğ (2014) tarafından yürütülen

çalışmada, safrandan elde edilen doğal boya maddesiyle ipek kumaşların geleneksel ve mikrodalga ısıtma yöntemleri kullanılarak boyanmasını incelenmiş ve mikrodalga ışımının, geleneksel ısınma yöntemine göre daha etkili olduğu, aynı zamanda zaman ve enerji tasarrufu sağlayarak çevre dostu ve yüksek boya emilimi sağlayan ekonomik bir seçenek sunduğu vurgulanmıştır. Al-Mousawi ve diğ., (2013) tarafından yapılan çalışmada poliester kumaşların geleneksel ve mikrodalga ışınma koşullarında thienobenzochromene disperse boyalar ile boyanmasını incelemiş ve mikrodalga ışımının poliester kumaşların boyanabilirliğini artırmak için kullanılabileceğini belirtmişlerdir. Boyanan numunelerin haslık özelliklerinin başarılı olduğu ifade edilmiştir. Rehman ve diğ. (2022) yürüttükleri çalışmada mikrodalga ışınlamayı kullanarak safran ve safflower çiçeklerinden elde edilen doğal boyaların polyamide (nylon) kumaş boyama için izolasyonunu ve çevre dostu mordanlar kullanarak boyanmış kumaşların dayanıklılığını artırmayı amaçlamışlardır. Mikrodalga işleminin bu doğal boyaların kullanımını ve renklendirmeyi geliştirmek için yüksek bir potansiyele sahip olduğu yazarlar tarafından vurgulanmıştır.

3.3.Bitim İşlemleri

Mikrodalga teknolojisinin bitim işlemleri üzerinde etkili olabileceği çeşitli araştırmacılar tarafından vurgulanmıştır (Pendergrass ve diğ., 1972; Katović ve diğ., 2005). Mahltig ve Miao, (2017) yürüttükleri çalışmada mikrodalga ışınması altında tekstil materyali üzerinde titanyumdioksitin fotokatalitik aktivitesinin arttığını beyan etmişlerdir. Ali ve diğ., (2015) tarafından yürütülen çalışmada, safrandan elde edilen doğal boya ile boyanan ipek kumaşların mikrodalga ve geleneksel ısıtma yöntemleri ile antimikrobiyal aktivitesini incelenmiş ve elde edilen sonuçlarda chitosan ile işlenmiş ipek kumaşların test organizmalarına karşı daha yüksek bir inhibitör bölge gösterdiği ve mikrodalga ısıtmanın renk haslıkları üzerinde oldukça etkili olduğunu ifade edilmiştir. Budimir ve diğ. (2014) tarafından yürütülen çalışmada pamuk tıbbi tekstiller üzerine uygulanan antibakteriyel bir malzemenin, antibakteriyel ve antifungal etkisini incelemektedir. Sitrik asit, pamuk tıbbi tekstillerin antibakteriyel özellik kazandırılması amacıyla, yüksek ısı işlem veya mikrodalga ile uygulanarak, gram-negatif, gram-pozitif bakteriler ve maya üzerinde etkili olduğu ifade edilmiştir. Yazarlar bu işlemin, tıbbi tekstillerde hem antimikrobiyal hem de kırışıklık önleyici etkiler sağladığını ve 10 yıkama işlemine dayanıklı olduğunu ifade etmiştir. Mirabedini ve diğ. (2004) tarafından yürütülen çalışmada potasyum permanganatın varlığında polipropilen (PP) yüzey özelliklerinin mikrodalga ışınlamanın etkisi altında incelenmiştir. Elde edilen sonuçlarda yüzey enerjisinin görece olarak arttığı, yüzeyin mikrodalga ışınlamaya maruz kaldığında hidrofil hale geldiği, SEM analizi ile

yüzeyde hafif çukurlukların oluştuğu ve FTIR-ATR analizi ile kimyasal değişikliklerin gözlemlendiği belirtilmiştir. Vukusic ve diğ. (2003) tarafından yürütülen çalışmada mikrodalga enerjisinin kullanımını incelenmiş ve boyalı pamuk kumaşlara dayanıklı buruşma direnci kazandırmak için alternatif bir yaklaşımı araştırılmıştır. Elde edilen sonuçlarda mikrodalga ile iyileştirilen kumaşların büzülme direnci ve buruşma iyileştirmesi açısından geleneksel iyileştirmeye göre daha iyi sonuçlar sunduğu ifade edilmiştir.

4. SONUÇ

Bu çalışmada mikrodalga enerjisinin tekstil endüstrisinde kullanım alanları ve yapılan çalışmalar ile ilgili bilgiler verilmiştir. Mikrodalga enerjisi, tekstil endüstrisinde ön terbiye, boyama ve bitim gibi birçok alanda kullanılmaktadır. Mikrodalga enerjisi kullanılarak yapılan işlemlerin genellikle daha hızlı ve daha verimli olduğu çeşitli araştırmacılar tarafından vurgulanmıştır. Elde edilen sonuçlarda mikrodalga enerjisinin, tekstil endüstrisinde sürdürülebilirlik hedeflerini destekleyen yenilikçi bir yöntem olduğu düşünülmektedir.

KAYNAKLAR

- 1- Abou El-Kheir, A., Haggag, K., Mowafi, S. I., & El-Sayed, H. (2015). Microwave-assisted bleaching of wool fabrics. *Journal of natural fibers*, 12(2), 97-107.
- 2- Adeel, S., Zia, K. M., Azeem, M., Kiran, S., Zuber, M., Irfan, M., & Qayyum, M. A. (2019). Microwave-supported green dyeing of mordanted wool fabric with arjun bark extracts. *Journal of Natural Fibers*.
- 3- Adeel, S., Akram, H., Usman, M., Bokhari, T. H., Aftab, M., & Ozomay, M. (2023). Eco-friendly microwave assisted sustainable coloration of silk and wool fabric with Acid Blue 07 dye. *Environmental Science and Pollution Research*, 1-13.
- 4- Ali, N. F., El-Khatib, E. M., El-Mohamedy, R. S. S., & Ramadan, M. A. (2014). Antimicrobial activity of silk fabrics dyed with saffron dye using microwave heating. *Int. J. Curr. Microbiol. App. Sci*, 3(10), 140-146.
- 5- Al-Mousawi, S. M., El-Asasery, M. A., & Elnagdi, M. H. (2013). Microwave assisted dyeing of polyester fabrics with disperse dyes. *Molecules*, 18(9), 11033-11043.
- 6- Amesimeku, J., Fan, L., Jakpa, W., & Wang, C. (2021). Dyeing properties of meta-aramid fabric dyed with basic dye using ultrasonic-microwave irradiation. *Journal of Cleaner Production*, 285, 124844.
- 7- Budimir, A., Bischof Vukusic, S., & Grgac Flinec, S. (2012). Study of antimicrobial properties of cotton medical textiles treated with citric acid and dried/cured by microwaves. *Cellulose*, 19, 289-296.
- 8- Buyukakinci, Y. B., Guzel, E. T., & Karadag, R. (2021). Organic cotton fabric dyed with dyer's oak and barberry dye by microwave irradiation and conventional methods. *Industria Textila*, 72(1), 30-38.
- 9- Büyükakinci, B. Y. (2012). Usage of microwave energy in Turkish textile production sector. *Energy Procedia*, 14, 424-431.
- 10- El-Khatib, E. M., Ali, N. F., & Ramadan, M. A. (2014). Environmentally friendly dyeing of silk fabrics using microwave heating. *Int. J. Curr. Microbiol. Appl. Sci*, 3(10), 757-764.
- 11- Elshemy, N., & Haggag, K. (2019). New trend in textile coloration using microwave irradiation. *Journal of Textiles, Coloration and Polymer Science*, 16(1), 33-48.

- 12- Eren, S., Avinc, O., Saka, Z., & Eren, H. A. (2018). Waterless bleaching of knitted cotton fabric using supercritical carbon dioxide fluid technology. *Cellulose*, 25, 6247-6267.
- 13- Ghaffar, A., Adeel, S., Habib, N., Jalal, F., Haq, A., Muniir, B., ... & Jamil, Q. (2019). Effects of microwave radiation on cotton dyeing with reactive blue 21 dye. *Polish Journal of Environmental Studies*, 28(3).
- 14- Griffin, W. L., & Hendrix, W. A. (1986). Microwave heating and drying in textile processing-present and future. *IEEE Transactions on Industry Applications*, (1), 115-120.
- 15- Haghi, A. K. (2005). Application of microwave techniques in textile chemistry. *Asian J. of chem*, 17(20), 639-654.
- 16- Hashem, M., Abou Taleb, M., El-Shall, F. N., & Haggag, K. (2014). New prospects in pretreatment of cotton fabrics using microwave heating. *Carbohydrate polymers*, 103, 385-391.
- 17- Kale, M. J., & Bhat, N. V. (2011). Effect of microwave pretreatment on the dyeing behaviour of polyester fabric. *Coloration Technology*, 127(6), 365-371.
- 18- Katović, D., Bischof Vukušić, S., & Flinčec Grgac, S. (2005). Application of microwaves in textile finishing processes. *Tekstil*, 54(7), 313.
- 19- Kiran, S., Adeel, S., Rehman, F. U., Gulzar, T., Jannat, M., & Zuber, M. (2019). Ecofriendly dyeing of microwave treated cotton fabric using reactive violet H3R. *Global Nest Journal*, 21(1), 43-47.
- 20- Komarov, V. V. (2021). A review of radio frequency and microwave sustainability-oriented technologies. *Sustainable Materials and Technologies*, 28, e00234.
- 21- Lara, L., Cabral, I., & Cunha, J. (2022). Ecological approaches to textile dyeing: a review. *Sustainability*, 14(14), 8353.
- 22- Lei, N. N., Gong, D. L., Ling, X. R., & Shi, Y. D. (2013). Researches on microwave dyeing cotton fabrics. *Advanced Materials Research*, 627, 343-347.
- 23- Mahltig, B., & Miao, H. (2017). Microwave-assisted preparation of photoactive TiO₂ on textile substrates. *Journal of Coatings Technology and Research*, 14(3), 721-733.
- 24- Mirabedini, S. M., Rahimi, H., Hamedifar, S., & Mohseni, S. M. (2004). Microwave irradiation of polypropylene surface: a study on wettability and adhesion. *International Journal of Adhesion and Adhesives*, 24(2), 163-170.
- 25- Mohammad, F. (2014). Emerging green technologies and environment friendly products for sustainable textiles. *Roadmap to Sustainable Textiles and Clothing: Environmental and Social Aspects of Textiles and Clothing Supply Chain*, 63-82.
- 26- Panda, S. K. B. C., Sen, K., & Mukhopadhyay, S. (2021). Sustainable pretreatments in textile wet processing. *Journal of Cleaner Production*, 329, 129725.
- 27- Pendergrass, J. E., Hatcher, J. D., & Lyons, D. W. (1972). Deposition of finishes and dyes in materials dried using microwave heating. *Journal of Microwave Power*, 7(3), 207-213.
- 28- Rehman, F. U., Adeel, S., Haddar, W., Bibi, R., Azeem, M., Mia, R., & Ahmed, B. (2022). Microwave-assisted exploration of yellow natural dyes for nylon fabric. *Sustainability*, 14(9), 5599.
- 29- Samanta, K. K., Pandit, P., Samanta, P., & Basak, S. (2019). Water consumption in textile processing and sustainable approaches for its conservation. In *Water in textiles and fashion* (pp. 41-59). Woodhead Publishing.
- 30- Vukusic, S. B., Katovic, D., & Schramm, C. (2003). Influence of microwaves on nonformaldehyde DP finished dyed cotton fabrics. *Textile research journal*, 73(8), 733-738.
- 31- Xue, Z. (2016). Study of dyeing properties of wool fabrics treated with microwave. *The Journal of the Textile Institute*, 107(2), 258-263.
- 32- Yiğit, İ., Eren, S., Özcan, H., Avinc, O., & Eren, H. A. (2021). An investigation of process parameters on colour during the dyeing of polyester in supercritical carbon dioxide media. *Coloration Technology*, 137(6), 625-644.

ADANA VE HATAY BÖLGESİNDEN TOPLANAN TURUNÇ (*Citrus Aurantium*) MEYVE KISIMLARININ ANTIOKSİDAN KAPASİTESİNİN ARAŞTIRILMASI

Fatma ERGÜN

Kırşehir Ahi Evran Üniversitesi, Sağlık Bilimleri Fakültesi, Beslenme ve Diyetetik Bölümü,
Kırşehir, Türkiye

Kırşehir Ahi Evran University, Faculty of Health Sciences, Department of Nutrition and Dietetics,
Kırşehir, Türkiye

ORCID ID: 0000-0001-5587-1581

ÖZET

Bu çalışmada Adana ve Hatay bölgelerinden toplanan Turunç (*Citrus aurantium*) meyvesinin kabuk ve meyve kısımlarından elde edilen ekstraktların toplam fenolik ve flavonoid madde miktarları ve antioksidan potansiyelleri araştırılmıştır. Çalışmada numunelerin kabuk kısımlarında fenolik madde miktarlarının daha yüksek olduğu belirlenmiştir ve Adana Turunç kabuklarında (ATK) 38.35 ± 3.39 mg GAE/g, Hatay Turunç kabuklarında (HTK) 27.28 ± 1.82 mg GAE/g olarak hesaplanmıştır. Benzer şekilde fenolik madde miktarlarının Adana Turunç meyvesinde (ATM) 16.40 ± 2.34 mg GAE/g, Hatay Turunç meyvesinde (HTM) ise 15.88 ± 0.79 mg GAE/g olduğu tespit edilmiştir. Flavonoid madde miktarları ise en yüksek HTK'da 20.55 ± 1.66 mg KE/g en düşük ise HTM'de 4.83 ± 0.60 mg KE/g olarak belirlenmiştir. Ayrıca çalışmada bitki ekstraktlarının radikal giderme ve indirgeme gücü belirlendi. 2,2-difenil-1-pikrilhidrazil (DPPH) radikali kullanılarak yapılan çalışmada ekstraktların IC₅₀ değerleri hesaplandı ve HTK'nın radikal giderme aktivitesinin diğerlerinden daha yüksek olduğu görüldü. Çalışma sonucunda numuneler arasında anlamlı nicel farklılıklar tespit edilmiş olsa bile turunç meyve ve kabuklarının antioksidan potansiyeline sahip olduğu kanaatine varılmıştır. Kabuk kısımlarındaki değerlerin yüksek olmasının sebebi ise dış ortam ile direk ilişkili olmaları şeklinde açıklanabilir. Ayrıca farklı bölgelerden alınan numunelerdeki değer farklılıklarının iklim ve toprak yapısından kaynaklanmış olabileceği düşünülmektedir.

Anahtar Kelimeler: Flavonoid madde, Fenolik bileşikler, *Citrus aurantium*, DPPH, FRAP

ANTIOXIDANT CAPACITIES OF ORANGE (*Citrus Aurantium*) FRUIT PARTS COLLECTED FROM ADANA AND HATAY REGIONS

ABSTRACT

In this study, the total phenolic and flavonoid contents and antioxidant potentials of extracts obtained from the peel and fruit parts of Citrus (*Citrus aurantium*) fruits collected from Adana and Hatay regions were investigated. In the study, it was determined that the amounts of phenolic substances were higher in the peel parts of the samples and were calculated as 38.35 ± 3.39 mg GAE/g in Adana citrus peel (ATK) and 27.28 ± 1.82 mg GAE/g in Hatay Citrus

peel (HTK). Similarly, the amounts of phenolic substances were 16.40 ± 2.34 mg GAE/g in Adana Citrus fruit (ATM) and 15.88 ± 0.79 mg GAE/g in Hatay Citrus fruit (HTM). The highest flavonoid content was 20.55 ± 1.66 mg KE/g in ATM and the lowest was 4.83 ± 0.60 mg KE/g in HTM. In addition, radical scavenging and reducing power of plant extracts were determined in the study. In the study using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical, IC50 values of the extracts were calculated and it was observed that the radical scavenging activity of HTK was higher than the others. As a result of the study, it was concluded that citrus fruits and peels have antioxidant potential even if significant quantitative differences were detected between the samples. The reason for the high values in the peel parts can be explained by the fact that they are directly related to the external environment. In addition, it is thought that the value differences in the samples taken from different regions may be due to climate and soil structure.

Keywords: Flavonoids, Phenolic compounds, *Citrus aurantium*, DPPH, FRAP

1. Giriş

Beslenmeye bağlı bozukluklar insanları erken yaşta çalışamaz duruma gelmelerine hatta ölmelerine neden olmaktadır. Bu olumsuzlukların oluşmasında beslenme şekli ve tüketilen besinler önemli rol oynamaktadır. Son yıllarda beslenme bilincinin yükselmesi tüketilen besinlere karşı ilginin artmasına ve tüketilen besinlerin sorgulanır hale gelmesine neden olmuştur. Bu durum üretimde ve tüketimde doğal besinlere ve doğal kaynaklara olan ilgiyi artırmıştır. Bu kaynakların en önemlilerinden birisi bitkilerdir. Bitkilerin yapısında proteinler, karbohidratlar, yağlar, vitaminler ve mineraller gibi birçok önemli kimyasal gruplar bulunmaktadır. Bu grupların yaşamsal faaliyetlerin devamlılığının sağlanmasının yanında çeşitli hastalık ve bozukluklara karşı koruyucu etkileri de vardır. Antioksidanlar bunlar arasında yer alan önemli bir gruptur.

Antioksidanlar tahıllarda, baklagillerde, meyvelerde ve şifalı bitkilerde bol miktarlarda bulunurlar (Cao, Sofic ve Prior, 1996; Foo ve Porter, 1981). Önemlileri arasında tokoferoller, flavonoidler, fenolik bileşikler, alkaloid, klorofil, protein, amin grubu içeren azotlu bileşikler gelmektedir (Larson, 1998). Bitkiler bu yapıları çoğalmak, yaşamlarını devam ettirmek ve birtakım zararlılara karşı kendilerini korumak amacıyla sentezlerler (Özkan ve Açıkgöz, 2007). Ayrıca bu yapıların antimikrobiyal, karminatif, koloretik, sedatif, diüretik, antispazmodik ayrıca kanser, kolesterol, diyabet gibi birçok hastalığa karşı etkili olduğu bildirilmiştir (Maksimovic, Dordevic ve Mraovic, 2005; Erlund, Koli, Alfthan, Marniemi, Puukka, Mustonen, Mattila ve Jula, 2008). İlave olarak bitkisel kaynaklı doğal antioksidanlar son

yıllarda gıda sanayisinde gıdaların raf ömürlerinin uzatılması için sentetik antioksidanlara karşı alternatif olarak kullanılmaktadır (Şahin, 2019).

Turunçgillerin atası olan turunç (*C. aurantium*) antioksidan potansiyele sahip bir meyvedir. Meyvelerinin tadı acı olduğundan yiyecekleri tatlandırıcı ve asitlendirici olarak kullanılır (Karabıyıklı, Değirmenci ve Karapınar, 2014). Uçucu yağ bileşenlerince zengin ve hoş bir kokusu vardır (Moraes, Kushima, Moleiro, Santos, Rocha, Marques, Vilegas ve Hiruma-Lima, 2009; Barceloux, 2008). Uzun zamandır tıbbi olarak kullanılmaktadır (Periyanyagam, Dhanalakshmi, Karthikeyan ve Jegadeesan, 2013). Meyvesi geleneksel olarak mide ağrısı, öksürük, soğuk algınlığı, dizanteri, ishal gibi hastalıkların tedavisi için kullanılmaktadır. Kabuklarının ise idrar yolu enfeksiyonlarında yararlı olduğu bilinmektedir (Karthikeyan ve Karthikeyan, 2014). Ayrıca gövdesinden beyzbol sopası, soyulmuş gövde kabuklarında sabun, mobilya cilası ve evcil hayvan şampuan yapılmaktadır (Çavuş, 2020).

Bu çalışmada Adana ve Hatay bölgelerinden toplanan Turunç (*Citrus aurantium*) meyvesinin kabuk ve meyve kısımlarından elde edilen ekstraktların toplam fenolik, flavonoid madde miktarlarını belirlenip radikal giderme potansiyelleri ve indirgeme gücü araştırılmıştır.

2. ARAŞTIRMA VE BULGULAR

2.1. Deneysel Çalışmalar

Örneklerinin Toplanması

Çalışmamızda kullandığımız Turunç (*Citrus aurantium L.*) örnekleri Adana Ceyhan ve Hatay İskenderun bölgelerinde bulunan özel mülklerden aynı tarihte toplanmıştır. Toplanan numuneler daha sonra destile su ile yıkanarak üzerlerindeki fiziksel kirler uzaklaştırılmıştır. Numunelerin kabukları soyularak kabuk ve meyve kısımları gölgede kurutulmuştur. Kurutma işlemine numunelerin sabit ağırlığa ulaştıklarında son verildi ve kurutulmuş numuneler karanlık ortamda +4 °C'de çalışma gününe kadar saklanmıştır.

Grupların Oluşturulması ve Meyve Ekstraktların Hazırlanması

Çalışmada her meyve grubu toplandıkları bölge, meyve ve kabuk numunesi birer grup olarak planlanmıştır

Tablo 2.1. Meyve ekstraktlarının kodlanması

Örnekler	Kod
Adana Ceyhan bölgesinden toplana turunç meyve örnekleri	ATM
Adana Ceyhan bölgesinden toplana turunç meyve kabuğu örnekleri	ATK
Hatay İskenderun bölgesinden toplana turunç meyve örnekleri	HTM
Hatay İskenderun bölgesinden toplana turunç meyve kabuğu örnekleri	HTK

Gruplara ait numuneler fiziksel parçalama işleminden sonra her örnekten 10 gr ağız kapalı dört erlene ayrı ayrı konuldu. Üzerlerine 200 mL metanol ilave edilerek manyetik karıştırıcıda karıştırıldı. Süzme işleminin ardından ekstraktlardan metanol evaporatör yardımıyla 45°C’de uzaklaştırıldı ve +4°C’de muhafaza edilmiştir.

Stok Çözeltilerin Hazırlanması

Her bir örnek için ayrı ayrı metanol kullanılarak 1000 ppm konsantrasyonda stok çözelti hazırlandı. Hazırlanan dört stok çözelti çalışma için +4°C’de muhafaza edilmiştir.

Kimyasal Analizler

Çalışmada her bir örnek için ayrı ayrı olmak üzere kimyasal analizler yapılmıştır (Tablo 2.2)

Tablo 2.2. Çalışma kimyasal analiz tablosu

No	Kimyasal Analiz Presedürü	Kaynak
1	Toplam fenolik madde miktar tayini	<i>Slinkard and Singleton., 1977</i>
2	Toplam flavonoid madde miktar tayini	<i>Nieva Moreno et al.,2000</i>
3	DPPH• serbest radikal giderme aktivitesi tayini	<i>Blois.,1958</i>
4	Fe ³⁺ -Fe ²⁺ kapasite azaltma (FRAP) gücü tayini	<i>Oyaizu., 1986</i>

İstatiksel Analiz

Çalışmanın istatistiksel değerlendirilmesinde SPSS 22 V[®] istatistik paket programı kullanılmıştır. Başlangıçta tek yönlü kullanılmış, farklılıkların önemli olarak belirlendiği durumlarda ise çoklu karşılaştırma testlerden olan Duncan testi kullanılmıştır (Duggan ve ark., 2017). Çalışmada önemlilik düzeyi P<0,05 seviyesinde belirlenmiştir.

2.2. Deneysel Sonuçlar

Turunç (*Citrus aurantium L.*) bitkisi meyveleri yıllarca şifa amaçlı kullanılmaktadır. Çalışmamızda farklı bölgelerde toplanan turunç meyve ve kabuklarının toplam fenolik madde miktarları belirlendi ve sonuçlara göre gruplar arasında farklılıklar anlamlı idi (P< 0,05) (Tablo 2.3). Numunelerin fenolik madde miktarları sırasıyla ATK’ da 38.85±3.39 mg GAE/g, HTK’ da

27.28±1.82 mg GAE/g, ATM' de 16.40±2.34 mg GAE/g ve HTM grubunda ise 15.88±0.79 mg GAE/g olarak tespit edilmiştir. Benzer bir çalışmada toplam fenolik madde miktarının meyvelerde 31,62 ± 0,88 mg GAE/g ve kabuklarında ise 44,41±0,49 mg GAE/g olduğu bildirilmiştir (Lagha-Benamrouche ve Madani, 2013). Farklı ekstraksiyon yöntemleri kullanılarak yapılmış başka bir çalışmada Turunç kabukları toplam fenolik madde miktarının 41,88±1,6 mg GAE/g ve 46,49±1,49 mg GAE/g olduğu bildirilmiştir (Temiz, 2020). Bulduğumuz değerler bu değerlere yakındır.

Tablo 2.3. Toplam fenolik madde ve toplam flavonoid miktarları

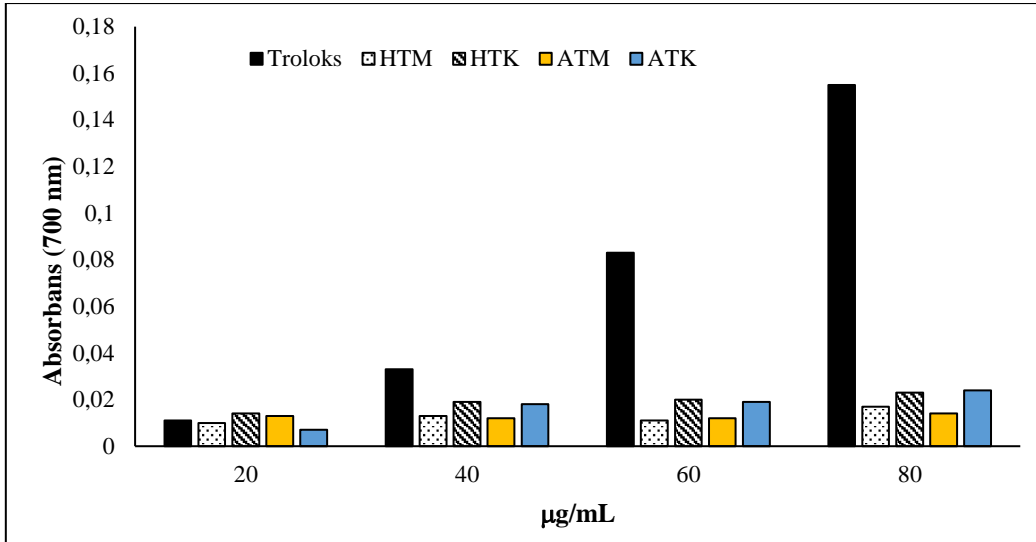
Gruplar	Toplam Fenolik Madde Miktarı (µg GAE/ml)	Toplam Flavonoid Madde Miktarı (µg KE/ml)
<i>ATM</i>	16.40±2.34 ^c	4.83±0.60 ^c
<i>ATK</i>	38.85±3.39 ^a	20.55±1.66 ^a
<i>HTM</i>	15.88±0.79 ^c	4.83±1.07 ^c
<i>HTK</i>	27.28±1.82 ^b	16.92±1.07 ^b

*: Aynı harfle gösterilen ortalamalar arasındaki farklar P<0.05 düzeyinde önemsizdir.

*: **ATM** (Adana Turunç Meyvesi), **ATK** (Adana Turunç Kabuğu), **HTM** (Hatay Turunç Meyvesi), **HTK** (Hatay Turunç Kabuğu)

Toplam flavonoid madde miktarı bakımından da gruplar arasında anlamlı farklılıklar vardı (P<0,05) (Şekil tablo 2.3). En yüksek değer 20.55±1.66 mg KE/g olarak ATK'da en düşük değer ise ATM'de 4.83±0.60 mg KE/g olarak tespit edilmiştir. Benzer çalışmalarda bu değerlerin meyve ve kabukta sırasıyla 1,17±0,01 - 3,25±0,07 mg KE/g olduğu bildirilmiştir (Lagha-Benamrouche ve Madani, 2013). Bulduğumuz değerler bu değerlerden yüksektir. Bu durumun oluşmasında numunelerin toplandığı ağacın, bölgenin, iklimin, bitki ekstratının elde edilme şeklinin ve çözücü farklılığının etkisinin olabileceği düşünülmektedir (Pietrzak, Nowak, Gawlik-Dziki, Lemieszek, ve Rzeski, 2017).

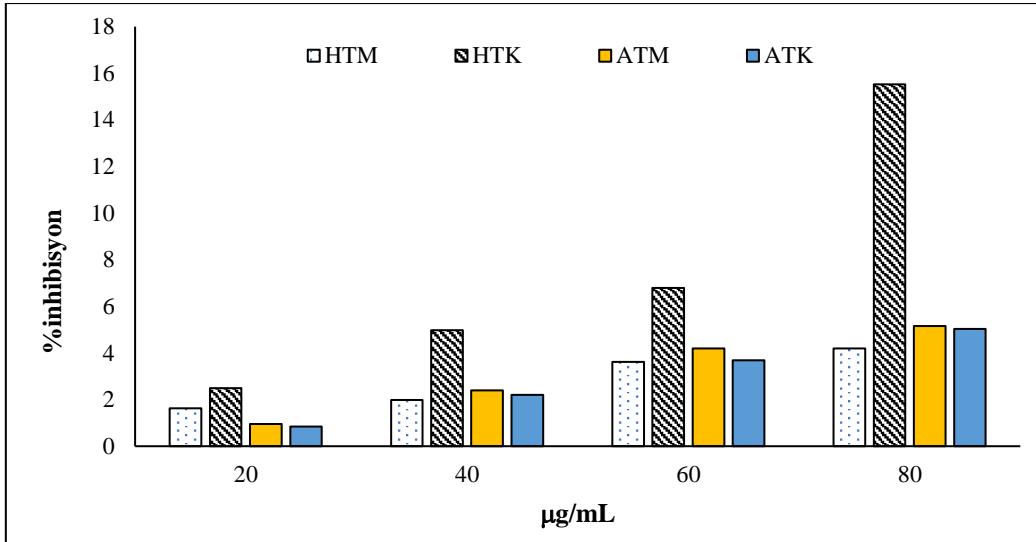
Meyve numunelerinin indirgeme gücünü (FRAP) belirlemek için Oyaizu (1986) metodu kullanılmıştır. Aynı şartlarda standart olarak kullandığımız troloks ve ekstraktlar için hazırlanan stok çözeltilerden farklı konsantrasyonlarda (20-80 µg/mL) alınarak literatüre göre çalışıldı. Fe³⁺'ün Fe²⁺'ye indirgenmesi ile meydana gelen renk değişimi 700 nm'de takip edildi. Elde edilen absorbans değerleri konsantrasyona karşı grafik edildi (Şekil 2.1).



Şekil 2.1. Ekstraktların ve Troloks standardının Fe^{3+} - Fe^{2+} indirgeme gücünün karşılaştırılması

Konsantrasyon arttıkça absorbansın artma eğiliminde olması indirgeme gücünün olduğunun göstergesidir. Numunelerin tamamında indirgeme gücünde artış olmasına rağmen 80 µg/mL konsantrasyonda HTK ve ATK örneklerinde daha fazla artış gözlenmiştir. 700 nm’de absorbans değerlerinin artmış olması bütün örneklerin Fe^{3+} - Fe^{2+} indirgeme gücünün olduğunu göstermektedir. Lagha-Benamrouche ve Madani 2013 yılında yaptıkları çalışmada *C. aurantium* L türünde indirgeme gücünün olduğunu tespit etmişlerdir. Ayrıca yapılan başka bir çalışmada turunçgillerin farklı türlerinin kabuklarında Fe^{3+} indirgeme potansiyelinin olduğunu bildirmişlerdir (Güzel ve Akpınar, 2017). Bu sonuç çalışmada bulduğumuz sonucu desteklemektedir.

Serbest radikal giderme aktivitesinin belirlenmesi için 1,1-Difenil-2-pikrilhidrazil radikali kullanılarak farklı ekstrakt konsantrasyonlarının literatürde belirtildiği gibi çalışılarak 517 nm’de absorbans ölçümü yapıldı. Artan konsantrasyona paralel olarak absorbanslardaki düşüş aktivitenin arttığının göstergesidir. Absorbansın azalma sebebi ekstraktın serbest radikali yakalaması ve giderek ortamda kalan DPPH konsantrasyonunun düşmesidir. 517 nm’de ölçülen absorbanslarda yararlanılarak %inhibisyon değerleri hesaplandı. Şekil 2.2’de görüldüğü gibi ekstrakt konsantrasyonu arttıkça % inhibisyon değeri artmaktadır. ATM ve ATK numunelerine artış hemen hemen birbirine paralelken HTK numunesi hem kendi meyvesi olan HTM den hemde diğer numunelerden çok daha fazla radikal giderme aktivitesi göstermiştir.



Şekil 2.2. Numunelere ait ekstraktlarının DPPH• radikal giderme aktiviteleri

Numunelerin artan konsantrasyonlarına karşılık % inhibisyon değerleri kullanılarak çizilen grafiklerin denklemlerinden yararlanılarak IC_{50} değerleride hesaplandı. IC_{50} değerleri ne kadar küçük olursa radikal yakalama aktiviteleride o kadar büyük olmaktadır. IC_{50} değeri HTM'de $1,057 \mu\text{g/mL}$, HTK'da $257.86 \mu\text{g/mL}$, ATM'de $700.41 \mu\text{g/mL}$ ve ATK'da $721.32 \mu\text{g/mL}$ olarak hesaplanmıştır. Bu sonuçlara göre HTK diğer numunelerden daha fazla antioksidan aktiviteye sahiptir.

Çalışma sonucunda elde edilen bütün sonuçlar dikkate alındığında Turunç örneklerinin hem meyve hem de kabuk kısımları antioksidan özellik göstermektedir. Fakat meyvelerin kabul kısımlarından elde edilen ekstraktların fenolik ve flavonoid madde bakımından daha zengin olduğu ve buna paralel olarak daha yüksek antioksidan aktiviteye sahip olduğu görülmektedir.

3. SONUÇ

Turunçta kabuk-meyve oranının %15 olduğu bilinmektedir (Deveci, 2008). Türkiye'de 2022 yılında turunç üretimi 2615 bin ton olduğunun düşündüğümüzde çöpe gidecek kısımları büyük miktarlarla ifade edilmesi düşündürücüdür (TUİK, 2022). Her ne kadar turunç kabukları bitkisel çay, reçel, uçucu yağ, hayvan yemi, pektin, sitrik asit üretiminde kullanılıyor olsa bile yeterli değildir. Sonuç olarak çalışmamızda bulduğumuz sonuçlar turunç meyve ve kabuklarının antioksidan potansiyeline sahip olduğu ve meyve kabuklarının değerlendirilme şekillerine alternatif olarak, çeşitli işlemlerden geçirildikten sonra günlük diyetin antioksidan ihtiyacını karşılamak ve gıda üretiminde gıda raf ömrünün uzatılması amaçlı kullanılan sentetiklerin yerine kullanılabileceği kanaatine varılmıştır. Bu amaçla yeni çalışmalara ihtiyaç vardır.

KAYNAKÇA

- Barceloux, D.G. 2008. "Citrus Oil and Limonene" in Medical Toxicology of Natural Substances, pp. 635-643, John Wiley & Sons, Inc, Hoboken, NJ, USA.
- Blois M.S. 1958. Antioxidant determinations by the use of a stable free radical, Nature, 181: 1199- 1200.
- Cao, G., Sofic, E., Prior, R.L. (1996). Antioxidant capacity of tea and common vegetables. Journal of Agricultural and Food Chemistry, 44; 3426–3431.
- Çavuş, V. (2020). "Turunç (*Citrus aurantium L.*) odununun bazı mekanik özelliklerinin belirlenmesi ve bazı odun türleri karşılaştırılması," Mobilya ve Ahşap Malzeme Araştırmaları Dergisi 3(2), 101-109.
- Deveci, E. Ü. 2008. Portakal Atıklarından *Aspergillus niger* Filamentli Fungusu Kullanılarak Sitrik Asit Üretiminde Değerlendirilmesi, Yüksek Lisans Tezi, Mersin Üniversitesi. Fen Bilimleri Enstitüsü. Mersin
- Duggan M.R, Lee-Soety J.Y and Anderson M.J. 2017. Personality types in Budgerigars, *Melopsittacus undulatus*. Behav Processes. 138:34-40.
- Erlund I, Koli R, Alfthan G, Marniemi J, Puukka P, Mustonen P, Mattila P, Jula A. 2008. Favorable effects of berry consumption on platelet function, blood pressure, and HDL cholesterol. The Am. J. of Clin. Nutrition. 87(2): 323-331.
- Foo, L.Y., Porter, L.J., 1981. The structure of tannins of some edible fruits. Journal Science Food Agricultural, 32: 711–716.
- Güzel, M., Akpınar, Ö. 2017. Turunçgil kabuklarının biyoaktif bileşenleri ve antioksidan aktivitelerinin belirlenmesi. *Güfbed/Gustij*, 7(2): 153-167.
- Karabiyıklı, Ş., Değirmenci, H., and Karapınar, M. 2014. Inhibitory effect of sour orange (*Citrus aurantium*) juice on *Salmonella Typhimurium* and *Listeria monocytogenes*, *LWT - Food Science and Technology*, 55(2), 421-425.
- Karthikeyan, V., and Karthikeyan, J. 2014. *Citrus aurantium* (Bitter Orange): A review of its traditional uses, phytochemistry and pharmacology, *International Journal of Drug Discovery and Herbal Research (IJDDHR)*, 4(4): 766-772.
- Lagha-Benamrouche, S., & Madani, K. 2013. Phenolic contents and antioxidant activity of orange varieties (*Citrus sinensis L.* and *Citrus aurantium L.*) cultivated in Algeria: Peels and leaves. *Industrial Crops and Products*, 50: 723-730.
- Larson, R.A. (1988). The antioxidants of higher plants. *Phytochemistry*, 27; 969–978.
- Maksimovic Z.A, Dordevic S, Mraovic M. 2005. Antimicrobial Activity of *Chenopodium botrys* Essential Oils. *Fitoterapia*, 76: 112-114.
- Moraes, T.M., Kushima, H., Moleiro, F.C., Santos, R.C., Rocha, L.R.M., Marques, M.O., Vilegas, W., and Hiruma-Lima, C.A. 2009). Effects of limonene and essential oil from *Citrus aurantium* on gastric mucosa: role of prostaglandins and gastric mucus secretion, *Chemico-Biological Interactions*, 180(3), 499-505.
- Nieva Moreno M.I, Isla M.I, Sampieto A.R, Vattuone M.A. 2000. Comparison of the free radical-scavenging activity of propolis from several regions of Argentina *Journal of Ethnopharmacology*. 71: 109-114.
- Oyaizu M. 1986. Study on products of Browning reactions: antioxidative activities of products of browning reaction prepared from glucosamine. *Jpn. J. Nutr*, 44: 307-315.
- Özkan K, Açıkgöz Z. 2007. Kanatlı kümes hayvanlarının beslenmesi. 1.Baskı, Hasad Yayıncılık, İstanbul.
- Periyanyagam, K., Dhanalakshmi, S., Karthikeyan, V., and Jegadeesan, S., 2013. Phytochemical studies and GC/MS analysis on the isolated essential oil from the leaves of *Citrus aurantium* Linn, *Journal of Natural products Plant Resources*, 3(6), 19-23.
- Pietrzak, W., Nowak, R., Gawlik-Dziki, U., Lemieszek, M., and Rzeski, W. 2017. LC-ESI-MS/MS Identification of Biologically Active Phenolic Compounds in Mistletoe Berry Extracts from Different Host Trees. *MDPI Molecules* 22 (4), 624 doi:10.3390 / molecules22040624
- Slinkard K, Singleton V.L. 1977. Total phenol analyses: Automation and comparison with manual methods. *American Journal of Enology and Viticulture*. 28: 49-55.

- Şahin S. 2019. Doğal Katkı Maddelerinin Bitkisel Yağların Stabilitelerine Etkileri Çukurova J. Agric. Food Sci. 34(1): 69-78,
- Temiz B. 2020. Ülkemizde Yetiştirilen Bazı citrus L. Türleri Üzerine Fitokimyasal ve Biyolojik Aktivite Çalışmaları. Yüksek Lisans Tezi, Anadolu Üniversitesi, Sağlık Bilimleri Enstitüsü. Eskişehir.
- TUİK, 2022. Statistical database. <https://biruni.tuik.gov.tr/bitkiselapp/bitkisel.zul>. Erişim Tarihi: 27.09.2023.

ANALYSIS OF HIGHER ORDER BOUNDARY VALUE PROBLEM**Khelef BOUICH***

Teacher's Higher College-Mostaganem, Algeria

ABSTRACT

The pseudoinverse (generalized inverse) of bounded linear operators or bounded nonlinear operators on a Banach space can be split into subsets in many different ways, depending on the purpose one has in mind. We refer to [1].

The present work concerns a kind of higher-order differential equation which can be written in abstract form as $Lu = Nu$, where L is a linear Fredholm operator of index zero, and N is a nonlinear operator. It is well known that if the kernel of the linear part contains only zero, the corresponding boundary value problem is called non-resonant. In this case, L is invertible, the equation can be reduced to a fixed point problem for the inverse operator. Otherwise, if L is a noninvertible, i.e., $\dim \text{Ker} L \geq 1$, then the problem is said to be at resonance, and then the problem can be solved by using the coincidence degree theory [2,3]. In this work, the Pseudoinverse matrix concepts combining with the coincidence degree theory of Mawhin is used to obtain the solution existence of solution to a class of nonlinear boundary value problem at resonance.

Keywords: Pseudoinverse matrix, Mawhin's coincidence degree theory, Nonlinear boundary value problem

REFERENCES

- [1] A. Ben-Israel and Thomas N. E. Greville, Generalized Inverses Theory and Applications, Springer-Verlag, New York, 2003.
 - [2] J. Mawhin, Theorems for nonlinear operator equations and coincidence degree theory for some mappings in locally convex topological vector spaces, *J. Differential Equations*. 12 (1972), 610-636.
 - [3] J. Mawhin, Topological Degree Methods in Nonlinear Boundary Value Problems, CBMS Series No.40, American Math. Soc. Providence, 1979.
- the 2nd Int. Conference on Mathematics and Applications, Sep 26-27 2023, Blida

IMPACT OF FLOURIDE LEVELS ON DENTAL HEALTH

Javeria SHEIKH

Lecturer, Faculty of Pharmacy, Jinnah University for Women, Karachi. Pakistan

Dr. Amber NAWAB

Professor, Faculty of Pharmacy, Jinnah University for Women, Karachi, Pakistan

Sobia KAMRAN

Lecturer, Faculty of Pharmacy, Jinnah University for Women, Karachi. Pakistan

Asra MANSOOR

Lecturer, Faculty of Pharmacy, Jinnah University for Women, Karachi. Pakistan

Touba WAQAR

Student, Faculty of Pharmacy, Jinnah University for Women. Karachi. Pakistan

Iqra SAJJAD

Student, Faculty of Pharmacy, Jinnah University for Women. Karachi. Pakistan

Syeda Noor ZEHRA

Student, Faculty of Pharmacy, Jinnah University for Women. Karachi. Pakistan

Sumaiya MOHSIN

Student, Faculty of Pharmacy, Jinnah University for Women. Karachi. Pakistan

ABSTRACT

OBJECTIVE

The core objective of this study is to determine fluoride levels in different brands of toothpaste available in market and to determine if the fluoride content is in accordance with the information provided on the packaging and if the brands are following the standards from evidence based dentistry regulations.

METHODOLOGY

For this study five different brands of toothpastes like CG, SSN, CU, DR, PD were selected. 1g toothpaste from each brand was suspended in distilled water with other chemical reagents and buffer like TISAB Solution to amplify the ionic strength of the solution. The total fluoride and the total soluble fluoride concentration were determined by using Spectrophotometer analysis. The technique followed in this study might not be the same as that employed by other laboratories.

RESULT

From the analysis of various toothpaste brand samples, it was found that the level of fluoride shows variation. CU label claims 1450ppm of fluoride and the result obtained is 1520ppm. The other brands like SSN, PD, CG, Doctors toothpaste were also analyzed, their label claims 1450ppm, 1400ppm, 1100ppm and 2800ppm of fluoride level respectively and the results obtained are 13300, 0.285ppm, 3800ppm, 7600ppm respectively which is not in range.

CONCLUSION

To calculate toothpaste's quality and strength, it is essential to find out its total and free fluoride concentration. There are various toothpastes available in the market with varying levels of fluoride. The top toothpastes are those that contain 1,350-1,500 ppm of fluoride. The results showed that CU had almost matched the label claim. While the other brands like SSN, PD, CG, DR had shown the total fluoride content either higher or lower than the label claim. The total soluble fluoride produces an anti-caries action. It is beneficial to use a fluoride containing toothpaste.

INTRODUCTION

Fluoride is basically a mineral which is present in bone and teeth. It can also be naturally obtained from Water, Soil, Plants, Rocks, Air.

Fluoride is used in dentistry to strengthen enamel which is basically the outer layer of your teeth. It helps in preventing cavities. Small amount of it also added in public water the process is called Water Fluoridation. It can also find and used as cleaning agent, pesticides, making of steel, medical imaging scan and in many OTC products including:

1. Toothpaste
2. Mouth rinses
3. Supplements. [1]

LEVEL OF FLUORIDE

EPA set maximum acceptable concentration of fluoride in drinking water is at 2ppm to prevent enamel fluorosis and 4ppm for preventing skeletal fluorosis.

The U.S. Public Health Service recommended 0.7 ppm optimum fluoride level in drinking water for preventing the tooth decay risk.

Most effective way of preventing tooth decay is to brush teeth with fluoride toothpaste. Different toothpaste is available in the market having various levels of fluoride. The quantity of fluoride in toothpaste is mentioned on the side of the tube and measured in parts per million (ppm).

Toothpastes that contain 1,350 to 1,500ppm fluoride are the most effective. Dentist might advise their patients to have higher strength of toothpaste if they are at risk of tooth decay.

- Children that are under 3 years old should brush their teeth twice day, contain at least 1,000ppm fluoride.
- Children between 3 and 6 years old should brush two times daily with a pea-sized amount of toothpaste having more than 1,000ppm fluoride.

- Children over 7 and adults should brush at least two times a day, toothpastes containing 1,350-1,500ppm fluoride. [2]

PROBLEMS ASSOCIATED WITH FLUORIDE LEVELS

High fluoride levels can lead to serious health problems.

1. DENTAL FLUOROSIS

Dental fluorosis is the change appears on tooth enamel. During childhood when teeth are developing Exposure to high fluoride concentration can cause mild dental fluorosis. There will be small white streaks or spots on the tooth enamel.

2. SKELETAL FLUOROSIS:

Exposure to high concentration of fluoride can cause bone diseases known as skeletal fluorosis. It may result in bones and joints injury. The bone may lose their elasticity and becomes hard increasing the chances of fractures. As bone tissue accumulates and bones thicken it leads to impaired joint mobility [2,3].

3. THYROID PROBLEMS

High fluoride level can also damage the parathyroid gland results in hyperparathyroidism which is the uncontrolled parathyroid hormone secretions. This reduces the amount of calcium in the bone structure and can lead to an increase in the concentration of calcium in the blood. A low concentration of calcium in the bones is more likely to cause fractures.

4. NEUROLOGICAL PROBLEMS

According to a report excess fluoride level before birth may lead to deficient cognitive outcome in future. Researchers measured fluoride levels in 299 women during pregnancy, as well as in their 6- to 12-year-old children. They tested cognitive abilities at age 4 and between ages 6 and

12. High levels of fluoride are associated with lower IQ test scores. In 2014, fluoride was considered a neurotoxin that can be a source of developmental risks to children [2,4].

OTHER HEALTH PROBLEMS

- Excess fluoride levels can cause acne and other skin problems
- Exposure to high fluoride levels can lead to Heart problems, arterial sclerosis and arterial calcification, high blood pressure, myocardial damage and heart failure.

- Excess fluoride concentration can cause Reproductive problems such as low fertility and early puberty in girls.
- Neurological problems that may cause ADHD can also occur by high fluoride concentration [1,5].

FLUORIDE POISONING:

High fluoride levels can lead to:

- Stomach ache
- Excessive salivation
- Nausea and vomiting
- Cramps and muscle spasms

It is important to remember that many substances are harmful in high doses but beneficial in low doses. [3,5]

ROLE OF FLUORIDE IN TOOTHPASTE:

Fluoride can greatly help tooth health by strengthening tooth enamel and making it more resistant to cavities. In addition, reduce the amount of acid produced by the bacteria on teeth. Toothpaste containing fluoride is very effective in preventing caries. The amount of fluoride in toothpaste is usually enough to reduce decay. Fluoride toothpaste provides extra protection. Studies have shown that adding fluoride to water is the best way to reduce "dental imbalances" [1]

REASON FOR DETERMINATION OF FLUORIDE IN TOOTHPASTE:

This raised the relevance of the need for soluble fluoride content in toothpaste. It is necessary to determine the concentration of total and free fluoride in toothpaste in order to evaluate the quality and stability of toothpaste. This raised the relevance of the need for soluble fluoride content in toothpaste. The aim of this study was to analyze the concentration of total and free fluoride in commercial toothpastes available in Pakistan. [1,6]

METHODS AND MATERIALS:

Aim of this study was to find the fluoride content of different toothpaste and to compare the efficacy of different toothpaste. For this purpose, we had taken 5 samples of toothpastes. CG, SSN, CU, DR, and PD. [4,7]

CHEMICAL AND REAGENT:

TISAB solution, concentrated HCL (38%), TRIS (hydroxymethyl), aminomethane, sodium tartrate ($\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$), Distilled water.

SPECTROPHOTOMETRY CONDITION:

Spectrophotometer was equipped with UV visible detector to check the absorbance of sample with cuvette dimensions 45 mm x 12.5 mm x 12.5 mm. TISAB solution diluted with water used as blank UV detector set at 544nm [8].

TISAB SOLUTION:

Total ionic strength adjustment buffer (TISAB) is a buffer solution which increases the ionic strength of solution to a relatively high level.

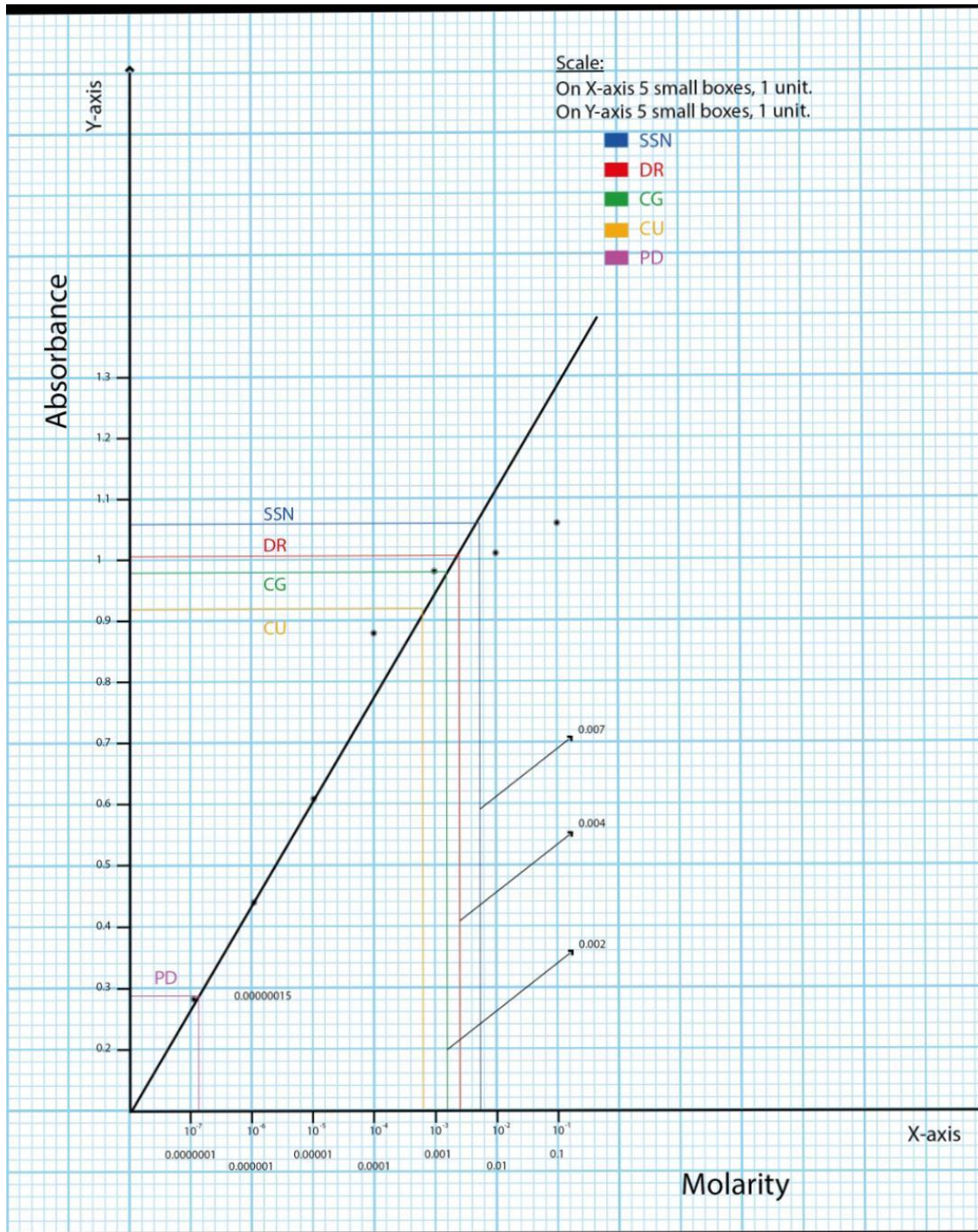
PREPARATION:

TISAB solution was prepared by dissolving 84ml concentrated HCL (38%), 242g TRIS (hydroxymethyl) amino methane, 230g sodium Tartrate ($\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$) with 50ml distilled water in 1L volumetric flask at room at room temperature [9].

PREPARATION OF SAMPLE SOLUTION:

Take 5 toothpaste sample, CG, SN, CU, DR and PD in 5 beakers. Add 25ml TISAB solution each container and place all beakers in water for 5 minutes. After that add 25 ml distilled water in each beaker and stir them continuously until they cool down. 50ml solution was ready of all 5 samples from which the dilutions were made to record the absorbance of each toothpaste sample to check the level of fluoride in them. [4,10]

STATISTICAL ANALYSIS:



CALCULATION:

$$\%F = \frac{\text{Molarity of F} \times \text{Volume (L)} \times 19g \text{ mol of F} \times 100}{\text{Mass of toothpaste}}$$

For SSN:

$$\%F = \frac{0.007 \times 0.1 \times 19 \times 100}{1}$$

$$\%F = 1.33\%$$

$$PPM F = \%F \times 10,000$$

$$PPM F = 1.33 \times 10,000$$

$$PPM F = 13300ppm$$

For CU:

$$\%F = \frac{0.008 \times 0.1 \times 19 \times 100}{1}$$

$$\%F = 0.152\%$$

$$PPM F = \%F \times 10,000$$

$$PPM F = 0.152 \times 10,000$$

$$PPM F = 1520ppm$$

For PD:

$$\%F = \frac{1.5 \times 10^{-7} \times 0.1 \times 19 \times 100}{1}$$

$$\%F = 28.5 \times 10^{-6}\%$$

$$PPM F = \%F \times 10,000$$

$$PPM F = 28.5 \times 10^{-6} \times 10,000$$

$$PPM F = 0.285ppm$$

For CG:

$$\%F = \frac{0.002 \times 0.1 \times 19 \times 100}{1}$$

$$\%F = 0.38\%$$

$$PPM F = \%F \times 10,000$$

$$PPM F = 0.38 \times 10,000$$

$$PPM F = 3800ppm$$

For DR:

$$\%F = \frac{0.004 \times 0.1 \times 19 \times 100}{1}$$

$$\%F = 0.76\%$$

$$PPM F = \%F \times 10,000$$

$$PPM F = 0.76 \times 10,000$$

$$PPM F = 7600ppm$$

Toothpaste	Mass of Toothpaste	PPM Fluoride	LabelClaim	Label Claim Match Or Mismatch	In Range
SSN	50g m	13300ppm	1450ppm	Mismatch	Not in range
CU	160g m	1520ppm	1450ppm	Almost Match	In range
PD	90g m	0.285ppm	1400ppm	Mismatch	Not in range
CG	150g m	3800ppm	1100ppm	Mismatch	Not in range
DR	70g m	7600ppm	2800ppm	Mismatch	Not in range

RESULT

The fluoride level has been checked in the different brands of toothpaste (SSN, CU, PD, CG and DR) as fluoride is used in dentistry to strengthen enamel which is basically the outer layer of our teeth. The spectrophotometry technique was used, and the end results were obtained. CU label claims 1450ppm of fluoride level the results obtained for this brand is 1520ppm which lies within the range. The other brands PD, CG, SSN and DR were also analyzed, there label claims 1400ppm, 1100ppm, 1450ppm and 2800ppm of fluoride level respectively. According to analysis the fluoride level of these brands obtained were 0.285ppm, 3800ppm, 13300ppm and 7600ppm respectively which not lies in range.

LIMITATIONS:

This study conducted has several limitations. These limitations include:

I. SAMPLING:

The samples of toothpaste used in this investigation were not gathered in a methodical way. Although we list the relevant brand names in the result tables, we do not imply that other samples of these brands or the brand as a whole would show the same results in further analysis. This is due to the small sample size, which makes it impossible to consider the results to be representative of the fluoride content or labelling quality of any specific brand.

II. ANALYSIS METHODOLOGY:

To assess the amounts of free accessible fluoride in toothpaste, there is currently no established methodology. The methodology utilized in this investigation might not be the same as that employed by other laboratories.

III. GENUINE AND FAKE PRODUCTS:

It has become increasingly difficult to distinguish between an original and fake product. Labelling and packaging are all too often copied so accurately that even expert has difficulty in clearly identifying fake products. It is thus possible that some of the samples included in the study are fake products. [5,11]

DISCUSSION:

The widespread use of fluorides in both systemic and topical forms has been associated with the substantial reduction in dental caries over the past few decades. The use of fluoride toothpaste as a topical delivery vehicle is currently the most common. Using fluoride toothpaste to brush your teeth has become an important public health measure to prevent dental caries. To evaluate toothpaste's quality and stability, it is necessary to determine its total and free fluoride concentrations. It is essential that enough soluble fluoride be present for fluoridated toothpaste to be effective against dental caries because some forms of fluoride may be linked to the abrasive that is included in the formulation of the toothpaste therefore it is necessary to determine the total amount of fluoride that is present in the toothpaste [10-12].

According to the EPA and the United States, the level of fluoride in each toothpaste is different. There are a lot of toothpastes on the market with varying levels of fluoride. The best toothpastes are those that contain between 1,350 and 1,500 ppm of fluoride. We are aware that fluoride improves dental health by strengthening tooth enamel and making it more resistant to decay.

However, it also causes dental fluorosis, which is a condition in which changes appear in tooth enamel, skeletal fluorosis, which is a condition in which a high concentration of fluoride can cause bone diseases, thyroid problems, and neurological issues. A high fluoride level can cause stomach pain, excessive salivation, cramps, and muscle spasms. Therefore, for some substances to be effective, they must be taken in small amounts.

The purpose of this study was to determine the total and free fluoride concentrations in Pakistani commercial toothpastes. For this purpose, we had chosen five different commonly

used toothpaste brands in Pakistan which includes SSN, CG, CU, DR, and PD. After testing, we compared the results of each sample to its label claim to see if our values agreed or disagreed with that claim.

To begin testing, we prepared TISAB solution, which served as a buffer and significantly increased the solution's ionic strength. Then take small amount of toothpaste sample of each brand in separate beakers and add 25 ml of TISAB solution to each, place it in a water bath for five minutes, add 25 ml of distilled water, and stir it continuously until it cools. Finally, 50 ml of each solution were made for all five samples, from which we made additional dilutions and measure the absorbance of each diluted toothpaste sample by UV spectrophotometer. An absorbance vs molarity graph was plotted on a simple graph paper and unknown molarities of each sample was determined by calibration curve. By putting the value of molarities obtained from the graph, volume, and mass of each toothpaste sample taken in the formula, % fluoride and ppm (parts per million) fluoride was calculated for each sample.

The results were then compared to the fluoride levels claimed on the toothpaste labels and we also checked if they fell within the standard fluoride range in toothpaste of 1350ppm to 1500ppm or not.

The results showed that only one brand i.e., CU among five chosen brands had measured the fluoride content of 1520ppm that almost matched the label claim of 1450ppm, and it also lies within the standard range. This indicates that users were able to properly protect their teeth while minimizing the risks associated with fluoride in the body because the accuracy of the specified fluoride content on the toothpastes that were labeled was maintained.

While the other brands i.e., SSN, PD, CG and DR had shown the total fluoride content of 13300ppm, 0.285ppm, 3800ppm and 7600ppm respectively which either higher or lower than their respective label claims. Their fluoride levels also do not lie within the standard fluoride range in toothpaste. Fluoride concentrations can vary for a variety of reasons, including but not restricted to:

- 1) Global manufacturers produce toothpastes locally through sub-contracted companies. These products might not have been made correctly or with inferior quality.
- 2) Cheaper ingredients, particularly abrasives, may be used in toothpaste to boost profit margins.

- 3) In our country, dishonest distributors may sell vast quantities of toothpaste that is about to expire.
- 4) Poor quality imitations of well-known brands are possible.
- 5) Toothpastes may have a low turnover rate, depending on the store, the area, the time of year, etc. Longer shelf life and sales close to or after the expiration date will result from this.
- 6) The stability of toothpaste will be negatively impacted by high storage temperatures.

Commercial toothpaste labels only indicate the total fluoride content and not the total soluble fluoride concentration. The only source of fluoride that can produce an anti-caries action when brushing your teeth is total soluble fluoride. To ensure their efficiency, fluoride toothpastes must contain enough freely available fluoride. Our work has demonstrated that some toothpaste samples contain insufficient fluoride concentrations, which may affect how effective they are at preventing dental cavities. This will put our people at risk for a disease of the public health, especially in locations where the intake of fluoride is not balanced through drinking water.

National regulatory agencies for drugs and consumer goods should be established in our country to address the poor-quality control and noncompliance on the behalf of toothpaste manufacturers. These organizations should also oversee making sure that fluoride products sold on the market adhere to minimal labelling and packaging standards.

RECOMMENDATIONS:

The extensive use of fluorides in both systemic and topical forms has been linked to a significant drop in dental caries in industrialized nations over the past few decades. The most common topical application of fluoride is through toothpaste, which is one of the topical delivery systems.

Fluoride toothpaste use has grown in importance as a public health tool to prevent dental cavities. Fluoride toothpaste is the most significant topical fluoride delivery technique because it is used by over 500 million individuals worldwide. As we know that fluoride improves dental health by strengthening tooth enamel and making it more resistant and provide protection against decay.

1. Before buying toothpaste, check the expiration date.
2. In our country, cheating vendors may also promote great portions of toothpaste which is about to expire so don't buy toothpaste that does not appear an expiry date.
3. Silica-primarily based totally fluoride toothpaste with none calcium containing abrasives is probably to have extra anti-caries efficacy.
4. The oral cavity must contain an appropriate concentration of soluble fluoride for fluoridated toothpaste to be effective in preventing dental caries.
5. Poor quality counterfeit of well-known brands is possible. So be aware of these imitations.
6. Use toothpaste containing fluoride as we know toothpastes which contain 1,350 to 1,500ppm fluoride are the most effective Specifically, fluoride slows down the demineralization method and may re-mineralize the enamel, decreasing small quantities of early-degree decay. Fluoride additionally decreases the quantity of plaque occur to your teeth – a clean precursor to teeth decay and gum disease.

CONCLUSION:

The motive of this study was to determine the total and free fluoride concentrations in Pakistani commercial toothpastes. And for this purpose, we had selected five different commonly used toothpaste brands which claim fluoride presence includes SSN, CG, CU, DR, and PD. After testing, we compared the results of unknown molarities of each sample was determined by the graph and the % fluoride and ppm (parts per million) fluoride were calculated by using the formula. And by the use of Spectrophotometry technique, the end results we obtained is SSN and CU label claims 1450ppm of fluoride level the results obtained for these brands are 1330ppm and 1520ppm which is in range and matched with the label claim. The other brands PD, CG, DR3 were also analyzed, there label claims 1400ppm, 1100ppm and 2800ppm of fluoride level so according to our testing the fluoride level of these brands obtained were 0.285ppm, 3800ppm, 7600ppm respectively which is not in range.

So we got to conclude that the TF content material in the toothpastes analyzed changed into now no longer constant with the quantity declared with the aid of using the manufacturers, and a few samples contained better concentrations of TF than advocated with the aid of using the country's regulations. It is vital to check the law approximately the quantity of soluble

fluoride in toothpaste to offer the most anti-caries impact and hold the first-rate of toothpaste production.

As we know sometimes substances give worse and harmful results in high doses while beneficial in low doses so there are advantages of the usage of fluoride toothpaste at sure strengths in order to prevent enamel decay. The more potent the fluoride concentration, the extra decay is prevented. And disadvantage is that it may cause dental fluorosis, skeletal fluorosis, thyroid problems, and neurological issues. A high fluoride level can cause fluoride poisoning, stomach pain, excessive salivation, cramps, and muscle spasms. Therefore, in order for some material to be effective, they must use in small quantity.

It was concluded that proper use of fluoridated toothpaste maximizes the benefits and minimizes the risks of fluorosis. Appropriate oral wellness care is essential for any individual's health.

Dental caries continues to be one of the predominant public health problems. The handiest manner of caries prevention is using fluoride.

Reference:

1. Jacquelyn Cafasso. What is fluoride?its uses,benefits,safety. July 3, 2019.
2. Fluoride level in drinking water. Published on 2009.
3. Karen Cross, FNP, MSN, Yvette Brazier . Why do we have fluoride in our water? Published on February 21, 2018.
4. Imran Farooq, Saqib Ali, Khalifa Sulaiman Al-Khalifa, Khalid Alhooshani. Total and soluble fluoride concentration present in various commercial brands of children toothpastes available in Saudi Arabia – A pilot study. Published online 2018 Jan 31.
5. Benzian H, Holmgren C, Buijs M, van Loveren C, van der Weijden F, van Palenstein Helderma W. Total and free available fluoride in toothpastes in Brunei, Cambodia, Laos, the Netherlands and Suriname. *Int Dent J*. 2012.
6. Thakkar VP, Rao A, Rajesh G, Shenoy R, Pai M. Fluoride content and labelling of toothpastes marketed in India. *Community Dent Health*. 2015 Sep 1;32(3):170-3.
7. Sebastian ST, Siddanna S. Total and free fluoride concentration in various brands of toothpaste marketed in India. *Journal of clinical and diagnostic research: JCDR*. 2015 Oct;9(10):ZC09.
8. Chávez BA, Vergel GB, Cáceres CP, Perazzo MF, Vieira-Andrade RG, Cury JA. Fluoride content in children's dentifrices marketed in Lima, Peru. *Brazilian oral research*. 2019 Jul 1;33.
9. Pillai DD, Vijayaraghavan R, Kumar R, Prasad KB, Pandya K, Nagappan N. Spectrophotometric analysis of fluoride concentration in dentifrices for children in India. *Journal of Pharmacy & Bioallied Sciences*. 2022 Jul;14(Suppl 1):S943.

- 10.** Agha Y, Kowash M, Hussein I, AlSalami A, Al-Halabi M. Fluoride concentration of commercially available infant formulae in the United Arab Emirates. *European Archives of Paediatric Dentistry*. 2020 Dec;21:657-66.
- 11.** Jairoun AA, Al-Hemyari SS, Shahwan M, Jairoun O, Zyoud SE. Analysis of Fluoride concentration in toothpastes in the United Arab Emirates: Closing the Gap between local regulation and practice. *Cosmetics*. 2021 Nov 30;8(4):113.
- 12.** Benzian H, Holmgren C, Buijs M, van Loveren C, van der Weijden F, van Palenstein Helderma W. Total and free available fluoride in toothpastes in Brunei, Cambodia, Laos, the Netherlands and Suriname. *International Dental Journal*. 2012 Aug 1;62(4):213-21

FLUORIDE AND DENTAL HEALTH: A BALANCE BETWEEN PREVENTION AND SIDE EFFECTS

Lecturer, Javeria SHEIKH
Lecturer, Asra MANSOOR
Lecturer, Sobia KAMRAN
Student Syeda Noor Zehra NAQVI
Student Toubha WAQAR
Student Iqra SAJJAD
Student Sumaiya MOHSIN

Faculty of Pharmacy, Jinnah University for Women, Karachi, Pakistan

ABSTRACT

OBJECTIVE:

The core objective of this study is to determine fluoride levels in different brands of toothpaste available in market and to determine if the fluoride content is in accordance with the information provided on the packaging and if the brands are following the standards from evidence based dentistry regulations.

METHODOLOGY:

For this study five different brands of toothpastes like CG, SSN, CU, DR, PD were selected. 1g toothpaste from each brand was suspended in distilled water with other chemical reagents and buffer like TISAB Solution to amplify the ionic strength of the solution. The total fluoride and the total soluble fluoride concentration were determined by using Spectrophotometer analysis. The technique followed in this study might not be the same as that employed by other laboratories.

RESULT:

From the analysis of various toothpaste brand samples, it was found that the level of fluoride shows variation. CU label claims 1450ppm of fluoride and the result obtained is 1520ppm. The other brands like SSN, PD, CG, DR were also analysed, their label claims 1450ppm, 1400ppm, 1100ppm and 2800ppm of fluoride level respectively and the results obtained are 13300, 0.285ppm, 3800ppm, 7600ppm respectively which is not in range.

CONCLUSION:

To calculate toothpaste's quality and strength, it is essential to find out its total and free fluoride concentration. There are various toothpastes available in the market with varying levels of fluoride. The top toothpastes are those that contain 1,350-1,500 ppm of fluoride. The results showed that CU had almost matched the label claim. While the other brands like SSN, PD, CG, DR had shown the total fluoride content either higher or lower than the label claim. The total soluble fluoride produces an anti-caries action. It is beneficial to use a fluoride containing toothpaste.

STRONG MOMS, FRAGILE BONES: OSTEOPOROSIS IN PREGNANCY

Prof. Dr. Amber NAWAB

Lect. Dr. Javeria Rafiq SHEIKH

Prof. Dr. Subia JAMIL

Student Fakhra MEHAR

Student Nuzhat NAIMATULLAH

Faculty of Pharmacy, Jinnah University for Women, Karachi, Pakistan

ABSTRACT

Background:

Osteoporosis is a common disease characterized by a systemic impairment of bone mass due to the deficiency of Vitamin-D those results in fragility fractures. With an aging population, the medical and socioeconomic effect of osteoporosis, particularly Osteoporosis poses unique challenges for pregnant individuals, necessitating specialized care to ensure maternal and fetal well-being.

Aim:

The study focuses on the development of osteoporosis in women which can be a silent killer especially in Pregnant women and worsens the life style of their wellbeing. The conduct study is representing the idea in comprehensive literature research and evidence-based interventions, to reduce the risk of fracture and improve bone health during pregnancy.

Methodology:

This study analyzes the complex relations between pregnancy and osteoporosis, highlighting the demand for individualized treatment strategies. The factors examined were physiological alterations, hormonal swings, and probable side effects of this dual diagnosis. The conducted research was divided in two parts in which detailed review of the literature of last 5 years and using those evidence the cross-sectional survey was implemented. The study offers evidence-based therapies such as dietary supplements, exercise advice, and medication.

Result:

The evaluated results show that 60% of the random women who participated in survey were found to be deficient in vitamin D. This was comparable to the percentages of pregnant women (53%) and nursing moms (58%), respectively, who were vitamin D deficient. Additionally, our study revealed that vitamin D shortage in mothers increases the likelihood of neonatal vitamin D deficit and puts nursing moms at a higher risk of developing osteoporosis. We advise frequent supplementation with calcium and vitamin D, as well as monthly monitoring of vitamin D levels, for all women, including those who are expecting or nursing.

Conclusion:

By addressing this under-researched intersection, healthcare providers can enhance the quality of care for pregnant individuals with osteoporosis, safeguarding both maternal and fetal health.

Keywords: Osteoporosis, Pregnancy, Vitamin-D deficiency, Women Health.

THE INTERACTION OF ETHICS AND AESTHETICS IN HUMAN DECISION- MAKING

Fenti FEBRIANI

Faculty of Islamic economics and business, UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0009-0009-3114-0202

Khorisatul AMANAH

Faculty of Islamic economics and business, UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0009-0004-2353-6454

Sulis SAPUTRA

Faculty of Islamic economics and business, UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0009-0009-2871-9520

ABSTRACT

This research aims to explore the interaction of ethics and aesthetics in human decision-making, with a focus on the importance of values and perceptions. This research uses a literature study approach sourced from books and journals related to the journal title. This research shows that ethics and aesthetics are two important aspects of human decision-making. Ethics relates to the concept of good and bad, while aesthetics relates to the concept of beauty and ugliness. Both ethics and aesthetics are subjective and depend on individual perception. In various areas of life, such as business, politics, and the arts, ethics, and aesthetics play an important role in shaping human behavior and decision-making. The principles of autonomy, responsibility, and honesty are important in ethical decision-making, while the perception of beauty and artistic creation are important in aesthetic decision-making. This research will provide insight into how ethics and aesthetics influence human decision-making, and how values and perceptions play a role in this process. This study will contribute to the understanding of the complex relationship between ethics and aesthetics, as well as provide practical implications for decision-making in various areas of life.

Keywords: ethics, aesthetics, human decision-making, values, and perception.

ISLAMIC MUTUAL FUNDS IN INDONESIA

Fani ALVIYANTO

UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0009-0008-4811-111X

Metti Rahma SANIAGI

UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0009-0008-5557-2686

Istikomah Dwi LESTARI

UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0000-0002-5343-5150

Ade GUNAWAN

UIN K.H. Abdurrahman Wahid Pekalongan, Indonesia

ORCID ID: 0000-0001-8479-0641

ABSTRACT

Investment can simply be interpreted as an activity of investing capital or assets that aims to gain profits. More practically, investment is a commitment to a number of funds or other resources made at the present time in the hope of obtaining future profits. The purpose of this research is to find out about Islamic mutual funds in Indonesia. The method used in this research is a literature approach sourced from books and scientific journals in accordance with the topic and focus of research. The results of this study indicate that sharia mutual funds are investment vehicles that follow Islamic sharia principles in their placement and investment policies. This means that the funds are only invested in companies that comply with Islamic sharia principles. Islamic mutual funds have several functions, including helping investors with limited funds to diversify their investments, simplifying investment in the capital market, and time efficiency. The aim is to fulfill the needs of investors who want to generate returns from sharia-compliant investments. Islamic mutual funds are regulated by various regulations and laws, such as the Financial Services Authority (OJK) Regulation and the National Sharia Council fatwa. There are different types of Islamic mutual funds, including money market, fixed income, equity and mixed funds. With a better understanding of Islamic mutual funds, we can make smarter investment decisions that comply with Islamic sharia values if that is an important consideration for investors.

Keyword: Investment, Islamic Mutual Funds, Islam

INTRODUCTION

Investment can simply be interpreted as an activity of investing capital or assets that aims to gain profits. More practically, investment is a commitment to a number of funds or other resources made at the present time in the hope of obtaining future profits. Based on this understanding, it can be understood that investment is an economic activity that cannot be

separated from human life or what is often referred to as homo economicus. The activity of developing or investing assets requires a commitment to sacrifice a number of funds to obtain future profits. The expected profit certainly cannot be ascertained, it could even be that investors experience losses or lose their funds (Warde, 2014).

The assessment of investment success is not only determined by a high rate of return, but must also consider spiritual satisfaction. This investment trend is called ethical investment, which is an investment that has a social responsibility by using ethical considerations in the investment or called ethical screening (Irkhami, 2016).

In a modern economy, the capital market is one of the forums for everyone who wants to invest, the capital market is also the most important part of the representation of a country's economic conditions, the better the performance shown by the capital market, the better the economic performance. Because the capital market is a market for various types of long-term financial instruments. The role of the capital market is very large in the economy because this market performs two functions, namely economic functions and financial functions. The economic function of the capital market is to provide facilities that bring together parties with excess funds (investors / mumawwilan) with parties who need funds (issuers). Meanwhile, the capital market is said to have a financial function because it provides the possibility of obtaining returns for the owner in accordance with the characteristics of the investment chosen (Mawardi, 2016).

The capital market is known as the stock exchange. The stock exchange according to article 1 paragraph (4) of Law No. 8 of 1995 concerning the Capital Market is a party that organizes and provides systems and / or facilities to bring together the securities buying and selling offers of other parties with the aim of trading securities between them. In the capital market structure, there is one of them, namely the issuer, which is a company that will sell securities or make emissions on the stock exchange. The container used to collect funds from the investor community to be invested in securities portfolios by investment managers is mutual funds. This paper will discuss sharia mutual funds which include understanding, history of sharia mutual funds, functions, objectives and business activities of legal entities / laws / regulations profile of one of the relevant institutions.

RESEARCH METHODS

The method used in this research is to use a literature approach sourced from books and scientific journals that are relevant to the topic and focus of the research. This research uses a descriptive qualitative approach in the form of a literature review that is explicitly studied. This research approach relies on literacy and understanding of the literature relevant to the

topic under study. Qualitative research is a research method used to research on the conditions of natural objects, and the researcher himself as the key instrument, the data collection techniques used by triangulation, the data obtained tend to be qualitative data, the data analysis is inductive or qualitative, and the results of qualitative research are to understand meaning, understand uniqueness, construct phenomena and find hypotheses.

DISCUSSION

A. Definition of Islamic Mutual Fund

The definition of Islamic mutual funds is related to mutual funds. Mutual funds in the UK are known as unit trusts which means trust units (shares) and in America are known as *mutual funds* which means joint funds and in Japan are known as *investment funds* which means fund management for investment based on trust. In language, mutual funds are composed of two concepts, namely *reksa* which means also or maintain and the concept of funds which means (set of) money. Thus, the language concept of mutual fund means a collection of money that is maintained. A mutual fund is a joint fund operated by an investment company that collects money from shareholders and invests it in stocks, bonds, options, commodities or money market securities. In terms of Law No. 8 of 1995 concerning Capital Markets, mutual funds are containers used to raise funds from the investor community to continue to be invested in securities portfolios by investment managers.

Islamic mutual funds are mutual funds that operate according to the provisions and principles of Islamic sharia, both in the form of contracts between investors as owners of assets (*sahib al-mal /rab al-mal*) and investment managers as representatives of *sahib al-mal*, as well as between investment managers as representatives of *sahib al-mal* and investment users. Thus, sharia mutual funds are mutual funds whose management and investment policies refer to Islamic law. Islamic mutual funds are intermediary institutions that help surplus units place funds to be invested. One of the objectives of Islamic mutual funds is to fulfil the needs of this group of investors who obtain investment income from sources and methods that are clean and religiously accountable and in line with sharia principles. (Andriani, 2020).

B. History of Islamic Mutual Funds

Given the importance of mutual fund instruments that continue to grow until now, mutual funds have a long history of development, mutual funds were first known in 1970, when Robert Fleming was assigned to America by the head of the company where he worked, he saw a new investment that emerged after the civil war. When he returned to the UK he intended to open the new investment but he did not have enough capital to open his business.

This prompted him to raise money from friends and form The Scottish American Investment Trust in 1873. This company was similar to what is now known as a closed-end-fund.

Internationally, the development of Islamic mutual funds began with the birth of the first Sharia Equity Fund in the form of the Amanah funds issued by the North American Islamic Trust in 1986, then the FTSE International was formed followed by the Finance Corporation Index formed by the IFC-World Bank together with ANZ bank which later became the Benchmark for Islamic leasing funds, then the Dow Jones Islamic Market Index (DJIMI) was formed, then Malaysia issued Malaysia Global Suumkok (MGS) of US 100 million published on the Bahrain Stock Exchange all of this encouraged the development of Islamic mutual funds globally. Islamic mutual funds were first introduced in 1995 by National Bank Saudi Arabia under the name Global Trade Equity with a capitalisation of 150 million.

In Indonesia, mutual funds have been around since 1997 through PT Danareksa. In just one semester, by the end of 1996, 24 mutual funds were born. 6 The name Danareksa Syariah was ratified by Bapepam on 12 June 1997. The sharia mutual fund was established in the form of a Collective Investment Contract (CIC) based on Law No. 8 of 1995 concerning Capital Markets, as outlined in Deed No. 24 dated 12 June 1997 made before Notary Djedjem wijaya, S.H. in Jakarta between PT Danareksa Fund Management as investment manager and Citibank N.A. Jakarta as Custodian Bank. Then PT Nasional Madani (PNM) through PNM Investment Management, issued PNM Syariah and PNM Dana Sejahtera, both of which are sharia mutual funds. August 2004 Investment Manager PT Andalan Artha Advisindo (AAA) securities in cooperation with Mandiri Sekuritas as investment manager and Deutsche Bank as custodian bank. December 2004 PT Bhakti Asset Management (BAM) issued BIG Dana Syariah, an open-ended mutual fund in the form of KIK.

C. Functions and Objectives of Islamic Mutual Funds

The most important thing that distinguishes Islamic mutual funds from other mutual funds is the placement or investment of funds. Islamic mutual funds place funds in companies whose line of business does not conflict with sharia principles. Islamic mutual fund investments are suitable for the long term, as they minimise the volatility of investors' returns.

According to (Sutedi, 2011) the benefits that will be obtained if investors invest in Islamic mutual funds include:

1. Investors who do not have enough funds to invest can diversify their investments in securities to minimise risk. Islamic mutual funds aim to support instruments in the money market and capital market.

2. Make it easier for investors to freely invest in the capital market. Investors who understand investment better will find it easier to decide which stocks are good to buy.
3. Time efficiency. Investors do not need to monitor the performance of their investments at all times. Because, it is transferred to the investment manager.

Islamic mutual funds are often also referred to as Islamic Investment Fund or Sharia Mutual Fund which is an intermediary institution that helps surplus units place funds to be reinvested. (Farid, 2014). In addition to providing convenience for potential investors to invest in the capital market, the purpose of Islamic mutual funds is to meet the needs of investors who want the benefits of a clean and religiously accountable investment mechanism that does not conflict with sharia principles, for example, not invested in stocks or bonds from companies whose management or products are contrary to Islamic law. Such as food or beverage factories that contain alcohol, pork, cigarettes or tobacco, conventional financial services, and entertainment businesses that contain immorality. (Kurniawan, 2019).

D. Business Activities Legal Entity/Law/Regulations Sharia Mutual Funds

Law Number 8 Year 1995 on Capital Market article 18 paragraph (1) explains that the legal form of mutual funds in Indonesia is generally divided into two forms, namely the Company (*Investment companies*) and Collective Investment Contract (*Unit Investment Trust*). The Company is a company whose legal form is not much different from other companies but only differs in terms of the type of business in the form of securities portfolio management in investment (Soemitra, 2009). While the Collective Investment Contract is a contract made between the Investment Manager and the Custodian Bank which is also binding on the Unit Participation holders as Investors.

Islamic mutual funds are designed to raise funds from people or investors who have limited time, knowledge and capital so as to increase the role of their local capital. The existence of various types of Islamic mutual funds, investors are free to choose which type of Islamic mutual fund can be profitable, because each type of Islamic mutual fund has advantages and disadvantages. (Kandarisa, 2014).

There are several types of mutual fund business activities, including (Sutedi, 2011):

1. Money Market Funds

Money market funds are a type of mutual fund that only invests in debt securities with maturities of less than 1 year. This type of mutual fund has a fairly small level of risk, but the benefits that will be generated are also quite limited. The goal is nothing more than to protect

capital and to provide high liquidity, so that when needed it can be withdrawn every working day with almost no risk of decline in investment value. (Ariswanto, 2020).

2. Fixed Income Funds

Fixed income mutual funds are one of the best ways to invest in the medium or long term with medium risk. (Ariswanto, 2020). *Fixed income funds* are a type of mutual fund that invests at least 80% of its assets in debt securities. Investing with fixed income funds has a relatively large risk compared to money market funds. The goal is to generate a stable rate of return.

3. Equity Funds

Equity funds are a type of mutual fund that invests at least 80% of its assets in equity securities. The nature of investment of equity funds is higher risk than the two types of equity funds and fixed income funds, but produces a high rate of return.

4. Mix Funds

This type of mutual fund invests in equity and debt securities. This mixed mutual fund is orientated to be more flexible in carrying out its investments, this flexibility is defined as investment management that can be used randomly / moving from stocks to bonds or to deposits. (Ariswanto, 2020).

The operations in Islamic mutual funds are formed from several activities, including:

- a. Activities between investors and Investment Managers are carried out with the wakalah system

The use of the wakalah contract in the contract between the investor and the investment manager is an agreement to grant power to the investment manager to carry out the management of funds that have been entrusted, which aims to benefit from the invested funds. The investment manager uses a wakalah contract, which is intended to be a representative for the benefit and on behalf of investors.

- b. Activities between investment managers and investment users are carried out using a mudharabah contract

In this case, the investment manager acts as a mudharib in a mudharabah contract, but not as a pure mudharib because Islamic mutual funds place funds back into the activities of issuers through the purchase of Islamic securities. (Ariswanto, 2020).

There are several legal bases that regulate the activities of Islamic mutual funds, including:

1. Financial Services Authority Regulation No. 19/POJK.04/2015 on the Issuance and Requirements of Sharia Mutual Funds.

2. National Sharia Council Fatwa No.20/DSN-MUI/IV/2001

3. Financial Services Authority Regulation Number 33/POJK.04/2019 of 2019 concerning the Issuance and Requirements of Sharia Mutual Funds.

E. Profile of One Islamic Mutual Fund Institution

PT PNM Investment Management (PNM-IM)



a. Overview

PT PNM Investment Management (PNM-IM) is an investment manager company engaged in the management of mutual funds and investment advisory services in the capital market industry. PNM-IM is licensed as an Investment Manager based on BAPEPAM Decree No. Kep-01/PM/MI/1998 dated 27 January 1998. The Company is also licensed as an Investment Advisor based on the Decree of the Board of Commissioners of the Financial Services Authority Number: KEP-16/D.04/2019 dated 2 April 2019.

As a subsidiary with the majority of its shares (99.98%) owned by PT Permodalan Nasional Madani (PNM), the Company also carries a special mission to support PT PNM's mission in empowering the micro, small and medium enterprises and cooperatives (UMKMK) sector in Indonesia. PT Permodalan Nasional Madani is a company established by the Government on 1 June 1999 through Government Regulation No.38/1999 dated 29 May 1999. In 2021 PNM changed its status to become a subsidiary of PT Bank Rakyat Indonesia Tbk (Persero) as the Ultra Micro BUMN Holding.

“A sense of security as a guarantee to grow together”. The trust and security of investors is the basic value and the most important factor that is always held firmly in the business activities of fund management and investment services. This value has proven to be able to provide a strong foundation for building a track record and long experience of more than 20 years as a leading investment manager in Indonesia.

Supported by an experienced and professional investment team in the capital market, the Company is able to prove itself as a reliable and trusted investment manager and become a leading investment manager in Indonesia.

b. Vision and Mission

Vision

To become a leading investment management company in supporting people's economic programmes, real sector development and financial sector.

Mission

1. Provide competitive investment products for customers.
2. Support fund raising efforts from the capital market and money market to support the real sector including MSMEs.
3. To be a healthy and highly competitive company that can provide optimal benefits to stakeholders.

c. Products and Services

In accordance with its business licence as an Investment Manager, the Company focuses its business on mutual fund investment management services. The Company manages a complete range of mutual fund investment products such as *open-end mutual funds* and *closed-end mutual funds*. All of these mutual fund products are both conventional and sharia types. In fact, the Company is known as the pioneer of the sharia mutual fund industry in Indonesia.

The Company also continues to develop alternative investment products such as *Exchange Traded Fund* (ETF) or mutual funds traded on the stock exchange and individual customer fund management products, namely Fund Management Contracts (KPD).

As a manifestation of its founding mandate, the Company also continues to focus on providing services to assist capital market financing to the real sector by developing other alternative products.

In carrying out a special mission to support the development of the real sector, especially the mission of empowering MSMEs, the Company also develops other alternative investment products such as Limited Participation Mutual Funds (RDPT), KIK-EBA, DINFRA and others.

So far, the Company is known as a major player in the real sector mutual fund industry, namely Limited Participation Mutual Funds to bridge capital market funding to the real sector, especially foreign exchange-producing state-owned companies, the infrastructure sector, the creative economy sector and micro, small and medium enterprises (MSMEs) carried out through business synergies with PT Permodalan Nasional Madani (PNM), a subsidiary of Holding BUMN Ultra Micro.

In addition to focusing on the Investment Manager business, the Company also has Investment Advisory services with a business license based on the Decree of the Board of Commissioners of the Financial Services Authority Number: KEP-16/D.04/2019 dated 2 April 2019.

CONCLUSION

Islamic mutual funds are investment vehicles that follow Islamic sharia principles in their investment placement and policies. This means that the funds are only invested in companies that comply with Islamic sharia principles. The history of Islamic mutual funds began in 1986 with the emergence of the first Sharia Equity Fund. Then, Islamic mutual funds developed globally, and in Indonesia, Islamic mutual funds were first introduced in 1997. Islamic mutual funds have several functions, including helping investors with limited funds to diversify their investments, simplifying investment in the capital market, and time efficiency. The aim is to fulfill the needs of investors who want to generate returns from investments that are in accordance with sharia principles. Islamic mutual funds are regulated by various regulations and laws, such as the Financial Services Authority (OJK) Regulation and the National Sharia Council fatwa. There are various types of sharia mutual funds, including money market, fixed income, equity, and mixed funds.

Profile of One Sharia Mutual Fund Institution (PT PNM Investment Management). PT PNM Investment Management is an investment management company that focuses on mutual fund management and investment advisory services. The company's main mission is to support the development of the real sector and the financial sector, and to provide competitive investment products for customers. With a better understanding of Islamic mutual funds, we can make smarter investment decisions that are in line with Islamic sharia values if that is an important consideration for investors.

REFERENCE

- Andriani, F. (2020). Investasi Reksadana Syariah di Indonesia. *Jurnal Penelitian Keuangan dan Perbankan Syariah*, 44-65.
- Ariswanto, D. (2020). Investasi pada Reksadana Syariah di Indonesia. *Jurnal Ilmu Akuntansi dan Bisnis Islam Volume II*.
- Farid, M. (2014). Mekanisme dan Perkembangan Reksadana Syariah. *Iqtishoduna*, 69.
- Irkhami, N. (2016). Islamic Ethical Investment Membincang Aspek Hukum dan Ekonomi Syariah.
- Kandarisa, N. A. (2014). Perkembangan dan Hambatan Reksadana Syariah di Indonesia : Suatu Kajian Teori. *Jurnal Mahasiswa Universitas Negeri Surabaya*, 1-18.
- Kurniawan, E. (2019). Pengaruh Inflasi, Jakarta Islamic Index, Bagi Hasil Bank Syariah terhadap Investasi Reksa Dana Syariah. *Jurnal Ekonomi dan Bisnis*, 114.

- Mawardi, B. P. (2016). Perbandingan Kinerja Reksadana Syariah di Indonesia menggunakan Metode Sharpe.
- Soemitra, A. (2009). *Bank dan Lembaga Keuangan Syariah*. Kencana.
- Sutedi, A. (2011). *Pasar Modal Syariah Sarana Investasi Keuangan berdasarkan Prinsip-prinsip Syariah*. Jakarta: Sinar Grafika.
- Warde, I. (2014). Islamic Finance in the Global Economy: Second Edition. *Islamic Finance in the Global Economy: Second Edition*, 1-228.

BENEFITS AND OBJECTIVES OF ISLAMIC ECONOMIC PHILOSOPHY

Fatma Azzahra Puspita SARI

ORCID ID: 0009-0000-5741-5299

Qonita FITRIANI

ORCID ID: 0009-0003-8098-0597

Riska Naila ZULFA

ORCID ID: 0000-0002-1533-8149

Muhammad Sultan MUBAROK

ORCID ID: 0000-0002-6168-0439

Ade GUNAWAN

ORCID ID: 0000-0001-8479-0641

Ria Anisatus SHOLIHAH

ORCID ID: 0000-0003-4113-7284

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid
Pekalongan Indonesia

ABSTRACT

This paper aims to explain the benefits and objectives of Islamic economic philosophy by formulating the following questions: First, what are the benefits of studying Islamic economic philosophy? Second, are there any philosophical benefits of Islamic economic philosophy? Third, what are the main objectives of Islamic economic philosophy?. This paper uses a qualitative approach, because the data sources and research results are in the form of literature research, inductive data analysis, grounded theory (towards theory building based on data). Findings: First, the main benefit of studying the Philosophy of Islamic Economics is to get a comprehensive picture of Islamic economics so that the building will be solid and steady. Likewise with the application process in everyday life. As for some of the benefits and uses of studying the philosophy of Islamic economics other is to achieve the perfection of the integrity of a Muslim so that berislam no longer halfway, for example in aqidah according to Islam but in the economy is still ribawi, Apply Islamic economic philosophy in the economic activities of society, and Apply Islamic economic activity is part of worship in Islam. Second, as for the philosophical benefits that we can feel after studying the philosophy of Islamic economics, namely by studying the Philosophy of Islamic Economics we will find the basis and core values of economic activity in Islam. This is not easy to do, because it must involve deep thought and continuous study. However, with the belief that Allah SWT revealed His sharia not to trouble people, then efforts to explore the basic values of Islamic economics will certainly be easy to implement. Theoretically, the study of Islamic economic philosophy will be a stimulus for economists, especially Muslims, to continue to develop various economic theories both on a micro and macro scale based on Islamic beliefs. Third, the main purpose of Islamic economic philosophy is to explore the basic values of Islamic economic theory and

practice, so that the value of kemashlahlah that exists in it can be explored. So that the purpose of Islamic economics as a mercy for all nature can be explored properly. In addition, it is also the development of science, especially related to the discipline of philosophy with the object of Islamic economics so that this discipline will be as solid as the other sciences.

Keywords: Benefits, Objectives, Islamic Economic Philosophy

**ABDURRAHMAN WAHID (GUSDUR) THOUGHTS: ISLAMIC STUDIES AND
PEOPLE'S ECONOMICS**

Adhi Riza AULIA

ORCID ID: 0009-0003-6154-3279

Shafa Nissa AUDIA

ORCID ID: 0000-0002-3297-4825

Asmitiya MEILINDA

ORCID ID: 0000-0003-0405-9256

Karomatul IZZAH

ORCID ID: 0009-0002-7395-3788

Muhammad Sultan MUBAROK

ORCID ID: 0000-0002-6168-0439

Ade GUNAWAN

ORCID ID: 0000-0001-8479-0641

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman
Wahid Pekalongan Indonesia

ABSTRACT

This research aims to determine Abdurrahman Wahid's basic thought concepts regarding Islam and people's economics. Community economy is an economic system carried out by local communities. The implementation of people's economics also aims to realize social justice in society through controlling economic activities. This research is a literature study with a qualitative approach. The data sources in this research were obtained through studying various references such as books, journal articles, the internet, and other sources relevant to the research topic. The data analysis in this research uses content analysis techniques from existing reference sources. The research results show that Abdurrahman Wahid's thoughts on economics are established into five pillars and also become an implementation. The five pillars are, namely, the people's economy which is an economic movement controlled and implemented by the (small) people. Then, the economy must be based on local resources and establish consistent food prices to support increased purchasing power. Furthermore, economic growth and equality must also go hand in hand and maintain relations between countries to be able to develop together. Apart from that, Gus Dur also had ideas about social Islam in the form of Islamic economics, namely the values of justice, equality, liberation, simplicity, humanity, brotherhood and local wisdom.

Keywords: Economics, Populist, Islam, Gus Dur.

LOCAL GOVERNMENT AND SOCIO-ECONOMIC DEVELOPMENT IN NIGERIA: CASE STUDY OF IFEDAYO LOCAL GOVERNMENT

Afolabi Tunde OWOLABI

Faculty of Social Science, Department of Political Science, Osun State University, Osogbo, Nigeria.

ORCID ID: 0009-0008-7259-3593

Seyi Samuel FATOLA

Oriental Institute - School of Regional and International Studies, Far Eastern Federal University, Vladivostok, Russia

ORCID ID: 0009-0000-6318-9929

Moradeyo Oluwatobi ADEOYE

Faculty of Social Science, Department of Political Science, Osun State University, Osogbo, Nigeria.

ORCID ID: 0009-0002-5707-6367

ABSTRACT

This paper examined local government and socio-economic development in Nigeria: a case study of Ifedayo local government, Osun state. The objective of the study seeks to investigate the relevance of the local government administration to socio-economic development with emphasis on Ifedayo local government council and identify and proffer solutions to some of the fundamental problems challenging the development of rural areas. The study adopted the system theory approach. The study adopted descriptive research design and used primary data to gather information through structured questionnaires covering 79 respondents using simple random sampling technique. This study adopted descriptive statistics which includes the use of simple frequencies percentages tables in analyzing the response of the questionnaire. Firstly, the findings revealed that local government takes preliminary social survey for community identified needs. Secondly, the findings also showed that local government has proficiently used the revenue available to them. Thirdly, the findings discovered that financial and economic autonomy of local government is a prospect on rural development. Lastly, the findings revealed that improvement on agricultural programmes and strategy can help in solving the problem of agricultural production on the part of rural dwellers. From the research conducted the study concludes that local government has in no little way impacted the lives of the rural populace and this has essentially been through the social, economic, and political activities of the government at the lowest level. This research recommends that the Nigerian economy and infrastructures must be improved upon to empower the grass root dwellers economically as well as a comfortable standard of living.

Keywords: Local government, development, autonomy, federalism, Nigeria

1. Introduction

This study examines existing literatures on local government and socio-economic development in Nigeria. This chapter begins with an analysis of key discussions in this study

which includes conceptualization of local government, the historical overview of local government in Nigeria, constitutional roles and responsibilities of local government, defining socio-economic development as well as local government and socio-economic development in Nigeria.

1.1 Conceptualization Of Local Government

Local government as a concept has been conceptualized by various scholars. The concept has been centered on the transfer of political powers to local areas by involving the inhabitants in the provision of basic needs. Ikelegbe (2005) defines local government as “a segment of a constituent state or origin of a nation state established by law to provide public services and regulate public affairs within its jurisdiction”. Fajobi (2010) defines local government “as a unit of government to maintain law and order based on range of social amenities and to encourage cooperation and participation of people at the grassroots to improve their living conditions”. For the purpose of this study, different issues raised from the definitions above are extracted to form a broad conceptualization of local government as follows:

- Local government is a political authority with elected officials which has the political powers to make decisions.
- Local government is a subdivision of the central government established by the law.
- Local government is a unit of government closest to the people to provide basic social and economic amenities.
- Local government is an entity that has substantial autonomy to make laws, rules, and regulations. Also, the autonomy to formulate and execute programs.
- Local government is expected to facilitate the existence of democratic self-government close to the grassroot levels of the society, and to encourage initiatives for leadership potentials.
- Local government is expected to mobilize human and material resources through the involvement of members of the public.
- Local government is expected to provide a two-way channel of communication between the local communities and central government.

1.2. Structure Of Local Government In Nigeria

The 1999 constitution of Nigeria recognizes the existence of 774 Local Government Areas (LGAs). Each local government area is administered by a Local Government Council consisting of a chairman who is the Chief Executive of the LGA, and other elected members who are referred to as “Councillors”. Each of the areas is further sub-divided into wards with

a minimum of ten and a maximum of fifteen (FRN, 1999). There are two distinctive marks of Nigeria's public administration system that have implications on the country's local governments. One is the federal practice and the other is the presidential system (Osaghae, 2005).

1.3 Constitutional Roles And Responsibilities Of Local Government In Nigeria

Local Government as the third tier of Government in Nigeria is the closest government to the people as it deals with the people at the grassroots level. It is therefore imperative to emphasize its importance as significant in the socio-economic and political life of Nigeria. This is because majority of the teeming populace resides in rural communities. The functions of local government administration cannot be overemphasized and are clearly spelt out in the 1999 Constitution:

- The consideration and the making of recommendations to a State Commission on Economic Planning or any similar body on:
- The economic development of the State, particularly in so far as the areas of authority of the Council of the State are affected, and
- Proposal made by the said Commission;
- Collection of rates, radio, and television licenses.
- Establishment and maintenance of cemeteries, burial grounds, and homes for the destitute or infirm.
- Licensing of bicycles, trucks (other than mechanically propelled trucks), canoes, wheelbarrows, and carts.
- Establishment, maintenance and regulation of slaughterhouses, slaughter slabs, markets, motor parks and public conveniences.
- Construction and maintenance of roads, streets, streets lightings, drains and other public highways, parks, gardens, open spaces, or such public facilities as may be prescribed from time to time by the House of Assembly of a state.
- Naming of roads and streets, and numbering of houses.
- Provision and maintenance of public conveniences, sewage and refuse disposal.
- Registration of all birth, death, and marriages.

1.4 The Nature And Challenges Of Local Government Administration In Nigeria

Local government is the system of political decentralization in which the power base of decision-making is, to a great extent, not national but local. Within this system, functions are locally and directly executed by elected officials who have direct control over local affairs. It

constitutes the most critical level of government at which the momentum to sustain national development can be created. To some countries in the third world, it is the only semblance of authority known beyond the traditional institution (Bello-Imam, 1996:2).

According to Lawal (in Khalil, 2011), local government is that tier of government closest to the people and which is vested with certain powers to exercise control over the affairs of people in its domain. A local government council is expected to play the role of promoting the democratic ideals of a society and coordinating development programmes at the local level. It is also expected to serve as the basis of socioeconomic development in the locality.

According to Appadorai (1975), local government is defined as government by popularly elected bodies charged with administration and executive duties in matters concerning the inhabitants of a particular district or place. The need to catalyze table development, boost citizens involvement, and stimulate government responsiveness compels the conception of local governments (Lawal and Oladunjoye, 2010). The local government assists as a form of political and governmental edifice aiding decentralization, national integration, competence in governance, and a sense of belonging at the grassroots. The local government is a unit of government all over the world (Agagu, 2004)

1.5 What Is Socio-Economic Development

Within the socio-economic framework, development is referred to improvement within the lifestyles of the individual through improved education, incomes, skill development and employment. It is the process of economic and social transformation based on cultural and environmental factors. Therefore, it can be understood as the process of social and economic development within the society. It is measured with indicators such as, gross domestic product, life expectancy, literacy, and levels of employment. Social development is a process, which results in the transformation of the social institutions in a manner, which improves the capability of the society to meet the objectives. Economic development is the development of economic wealth and resources of the nations or regions for the well-being of the individuals.

1.5.1 Major Component Of Socio-Economic Development

Socio-economic development of any region depends on various factors of different parameters, and it is an arduous task to discuss every component of socio-economic development in detail. However, some major components of socio-economic development are worked out. The following are the major components of socio-economic development:

- Per capita Income
- Level of Agriculture Development

- Level of Industrial Development
- Level of Urbanization
- Occupational Structure
- Level of Educational Development
- Primary Healthcare Services
- Transport and Communication
- Population Characteristics

1.6 Local Government And Socio-Economic Development In Nigeria

Local government administration in Nigeria is an offshoot of the federal political arrangement which is basically characterized by decentralization of functions. Decentralization in this context is regarded as a process through which powers, functions, responsibilities, and resources are transferred from central to local governments and/or to other decentralized entities (United Nations, 2006). In a federal system like Nigeria, decentralization shares both political and economic justifications (Diejomaoh and Eboh, 2010). The economic side emphasizes the advantages in terms of promoting inclusive and broad-based growth by the optimal use of local and national resources for economic development, while the political side sees local government as a valid tool for managing in-country heterogeneities, reduce power-sharing tensions and cater for divergent needs of the different nationalities and societies within a country. As such, by devolving functions to local governments, peculiar socio-political and economic needs in the localities are identified and appropriate responses sought. The United Nations Office for Public Administration defines local government as the political subdivision of a nation-state (or in a federal system), which is constituted by law and has substantial control of local affairs, including the powers to impose taxes or to exert labour for prescribed purposes (Adetoritse 2011). Adetoritse (2011) argues this definition shows that local government is a multi-dimensional concept. These dimensions are social, economic, geographical, legal, political, and administrative. The key parameters here are that local governments exist for the purpose of delivering goods and services to the people and to mobilize local resources and identify specific areas of needs and how they can be solved. Ismail et al (1997) wrote in similar vein that local governments exist for both utilitarian (service rendering) and democracy (civic) considerations. According to Ahmed (2012), the function of local government involves the philosophical commitment to participation in the growing process at the grassroots level.

2. Study Objective

The Nigerian state has continued to wallow in the mire of asymmetric national development. In a democratic federal state like Nigeria, the third tier of government has been reduced to a mere ceremonial and figurehead government, and this equally accounts for the low quality of life in various rural areas in Nigeria. In appraising this anomaly, this study underscored the roles the third tier undertake in ensuring balanced socio-economic development particularly in areas where the federal and state tiers do not immediately function. For the purpose of this study, inference was made from the case study of Ifedayo local government council. Additionally, this study identified and gave recommendations to fix some of the challenges impeding socio-economic development in rural areas.

3. Methodology

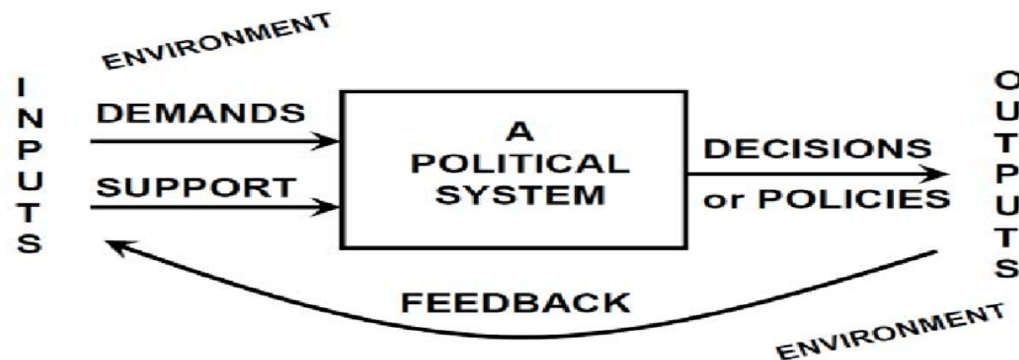
This study drew information from both quantitative and qualitative sources and data were analyzed descriptively and quantitatively to arrive at a logical conclusion. Qualitatively, analysis of existing literature and contribution of scholars to this field was sourced from textbooks, dictionaries, newspapers, magazines, journals and reports. For data collection, the mechanism adopted for the planning and implementation of this scientific study was the use of questionnaires, the technique of data collection was the use of primary source of data and statistical instrument in data analysis and interpretation.

4. Theoretical Discussion

The theory which informs this study is the general systems theory. The proponent of this theory, David Easton (1965) sees the political system as a set of interrelated and reciprocally regulated patterns of actions and orientation, pattern that cluster together in equilibrium and that have certain needs of maintenance and survival. It is a phenomenon of whatever type, including physical, biological, social, political, etc., which is an organized whole with identifiable, interrelated structures delineating it from the environment (supra system) in which it is located and with which it interacts, processing the inputs from it into outputs for it.

The general systems theory argues that every system, including political system, has sub-systems which make up the entire system. They are assigned functions and provided with enabling empowerment, including resources, appropriate authority etc. to enable them to discharge their responsibilities optimally. Where this is the case, there is said to be stability in the political system. On the other hand, instability reigns in the political system where the contrary is the case, and the sub-systems and entire system are also unable to function optimally.

Input and output analysis of a political system is very important. A political system is said to obtain its inputs (demands, supports, liberty or autonomy, cooperation, criticisms, resources, information, direct labour, etc.) from the environment. These inputs are what the sub-systems employ to discharge their responsibilities, so that the political system can send out its outputs into the environment and obtain further inputs for its operation.



Diagrammatic representation of David Easton's System Analysis (David Easton, 1957)

5. Research Gap

The inconsistency of the Nigeria system of administration has posed a barrier to the inherent obligation of local government in enhancing socio-economic development in Nigeria. This issue has not been properly developed by existing studies. To fill this gap, this study seeks to draw the attention of the Nigeria government to enable the political and administrative system become more consistent with its nature by giving autonomy, and decentralizing power and functions.

Overdependency on the central government and the ineffectiveness of local government in enhancing rural development requires optimum attention. Over-reliance of local government on the federal and state governments in Nigeria impedes the efficiency of local government in discharging their constitutional functions. Although, there have been various agitations for local government reform and autonomy since 1976, to intensify the utilization of local government in achieving economic, social, and political objectives. On this note, this study emphasizes the overarching need for the decentralization of power and functions from the center to the local government as the Nigerian state continues to aim towards inclusive socioeconomic development.

6. Data Analysis

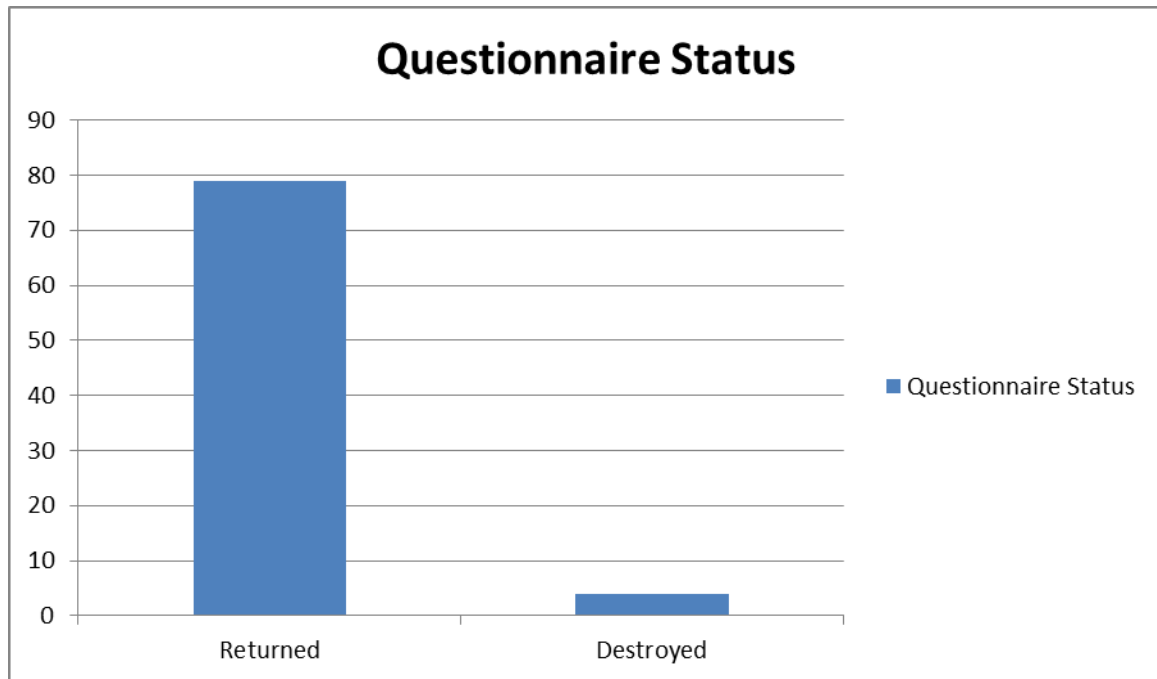


Fig 1.1 showing the status of the questionnaire distributed at Ifedayo Local Government

6.1 Presentation, Interpretation And Analysis Of Results

6.1.1 Socio-Demographic Background of Respondents (Ifedayo LGA)

Table 6.1

Status	Variable	Frequency	Percentage (%)
Gender	Male	43	54.4
	Female	36	45.6
	Total	79	100
Age (in years)	18-29	32	40.5
	30-39	19	24.0
	40-49	14	17.7
	50-59	8	10.1
	60& above	6	7.5
	Total	79	100
Qualification	Tertiary Education	37	46.8
	Secondary Education	34	43.0
	Primary Education	5	6.3
	None of the above	3	3.7
	Total	79	100
Occupation	Farming	10	12.6
	Civil Servant	16	20.2
	Trader Artisan	28	35.4
	Student	22	27.8

	Unemployed	3	3.7
	Total	79	100
Income (₦)	No response	24	30.3
	Below 5,000	2	2.5
	6,000-10,000	16	20.2
	11,000-15,000	13	16.4
	16,000-20,000	11	13.9
	21,000 & above	13	16.4
	Total	79	100
Housing Facility	No response	17	21.5
	Round hut	2	2.5
	Two rooms roofed with grass	8	10.1
	Two rooms roofed with zinc	19	24.0
	Three-bedroom flat	23	29.1
	Four-bedroom flat	10	12.6
	Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

6.1.2 Role Of Local Government On Socio-Economic Development

Table 6.2: Impact of the Local Government's activities (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Yes	50	63.3
No	13	16.4
Maybe	16	20.3
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

Table 6.3: Provision of School Facilities by the Local Government (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Strongly Agree	25	31.6
Agree	23	29.1
Neither Agree	7	8.8
Disagree	7	8.8
Strongly Disagree	15	18.9
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

Table 6.4: Absence of Financial and Economic Autonomy (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Strongly Agree	27	34.1
Agree	27	34.1

Neither Agree	14	17.7
Disagree	5	6.3
Strongly Disagree	5	6.3
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

Table 6.5: Availability of Financial Resources to Local Government (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Strongly Agree	14	17.7
Agree	19	24.0
Neither Agree	15	18.9
Disagree	17	21.5
Strongly Disagree	14	17.7
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

Table 6.6: Proficient Usage of Revenue (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Strongly Agree	14	17.7
Agree	25	31.6
Neither Agree	18	22.7
Disagree	11	13.9
Strongly Disagree	11	13.9
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

Table 6.7: Absence of Local Government Autonomy (Ifedayo LGA)

Variables	Frequency	Percentage (%)
Strongly Agree	30	37.9
Agree	27	34.1
Neither Agree	14	17.7
Disagree	4	5.1
Strongly Disagree	4	5.1
Total	79	100

Source: Researcher's Fieldwork (Ifedayo LGA)

7. Discussion Of Findings

From conducting this study, the results revealed that there is an interplay between local government administration and socio-economic development. It was discovered that the people of Ifedayo local government are confident in the activities of local government

authority in the area. Also, the findings revealed that local government takes preliminary social survey for community identified needs. Furthermore, the study revealed that the local government has built health care facilities and services in the community. Another finding revealed the state of roads, culverts and bridges in Ifedayo locality are good. Findings also showed the extent to which local government has made efforts to ensure stable electricity in the community. One discovery was the initiation of major rural development projects by the local government authority, thereby making prudent use of allocations and generated revenues. As revealed in this study, lack of financial autonomy from the state government continues to hamper the effectiveness of Ifedayo local government authority.

8. Conclusion

It is without doubt that the prevalent cause of local government ineffectiveness extends beyond absence of financial and economic autonomy. From data gotten and analyzed in this study, local government has impacted the quality of lives at the grassroots, and this has essentially been through the social, economic, and political initiatives of local government at this level. Local government initiates major rural and community development projects, provision of public education at the local level, pipe-borne water, primary health care centers and other services. However, the lack of local autonomy and perpetual dependency on the central and state governments has reduced local government to a pawn within the Nigerian political landscape. The absence of preliminary social survey to identify rural needs in Nigeria has strengthened the status quo and continues to keep the whims of power between the center and the state. The implementation of the policy options as suggested in the recommendation can be of help in creating a system where the local government will be an independent tier of government saddled with the responsibility of developing rural areas in Nigeria.

9. Recommendations

From the analysis and findings of this study, several recommendations can be put forward to address the lack of local government autonomy and the consequent under-performance in Nigeria. First, the inclusiveness of local government financial and economic activities as well as operation of joint account by both the state and local government should be discouraged to increase transparency on the allocation received by the local government for rural development. Therefore, a state government failing to grant its local governments financial and economic autonomy should be sanctioned to discourage the continuity of this practice by other states.

There is the need for ethical codes and transparency by local government officials to prohibit them accruing wealth thereby sending the wrong signals to the rural dwellers and

other tiers of government. There should be a restrictive mechanism to deter embezzlement of funds by local government officials. Autonomous local government should be made responsible for inclusive development at the grassroots. Transparent and effective preliminary social survey for rural identified needs must be developed by local government officials. This will ensure good governance and people-oriented grassroots administration.

REFERENCES

- Adetoritse, T. D. (2011). Conceptualizing Local Government from a multidimensional perspective, *Journal of Higher Education of Social Science*, Vol. 1 No. 1 pp. 66-71. www.cscanadar.org.
- Agagu, A. (2004). Continuity and change in local government administration and the politics of underdevelopment. In Agagu, A. & Ola, R. (Eds.) *Development agenda of Nigeria state*. Ibadan: Flag Publishers.
- Ahmed, A. A. (2012). Local Government Authority and its Effectiveness in Nigeria, www.jaaiga.net/journal/index
- Appadorai, A. (1975). *The substance of politics*, New Delhi: Oxford University Press.
- Bello-Imam IB (1996) *Local government in Nigeria: evolving a third tier of government*. Heinemann Educational Books Nig. Plc. & French Institute for Research in Africa (IFRA), Ibadan.
- Diejomaoh, I. Eboh, E. (2010). Local Government in Nigeria: Relevance and Effectiveness in Poverty Reduction and Economic Development. *Journal of Economics and Sustainable Development*, Vol. 1, No 1
- Easton D., 1957, An Approach to the Analysis of Political Systems, in: *World Politics*, vol. 9, No.3, pp. 383-400.
- Easton, D., (1965). *A Framework for Political Analysis*, Englewood Cliffs, New Jersey: Prentice Hall.
- Fajobi, O.F (2010). *X-ray of Local Government Administration in Nigeria*. Crehill Publisher Ltd.
- FRN (1979, 1999). *Constitution of the Federal Republic of Nigeria 1979, 1999*. Lagos: Federal Government Printer.
- Ikelegbe, A. O. (2005). *The Local Government System and Grassroots Development in Nigeria: Issues, Problems and Challenges*.
- Ismail, I, Bayat, S. & Meyer, I. (1997). *Local Government Management*. Boston: Houghton Mifflin.
- Lawal (in Khalil 2011). *Local Government Administration in Nigeria and Localist Theory*, Covenant University Repository.
- Lawal, T. and Oladunjoye, A. (2010). Local Government, Corruption and Democracy in Nigeria. *Journal of Sustainable Development in Africa*. Volume 12, No.5.
- Osaghae, E. (2005). *Federal Character and Federalism in Nigeria*. Ibadan: Heinemann Educational Book.
- United Nations (2006). *Definition of basic concepts and terminologies of governance and public administration*. <http://unpaul.un.org>.

IMPROVING THE IMPACT OF SHADOW EDUCATION IN ASSISTING STUDENTS WITH AUTISM SPECTRUM DISORDERS THRIVE IN CONTEMPORARY EDUCATIONAL SETTINGS

Research Scholar Fr. Baiju THOMAS

Ramakrishna Mission Vivekananda Educational and Research Institute, Faculty of Disability Management and Special Education, Vidyalaya Campus, SRKV Post, Coimbatore

ABSTRACT

The current study on improving the impact of shadow education (SE) in assisting students with autism spectrum disorder (SwASD) thrive in contemporary educational settings. Considering the widespread enthusiasm for SE among many social groups, the area is fast developing in many parts of the world. It will attempt to provide academics with a summary of after-school tutoring by integrating the outcomes of current work on the history, modern environment, functioning trends, causes, impacts, and regulation of SE to assist students with ASD to succeed in contemporary educational settings. It has become increasingly usual in recent years for students on the autism spectrum to receive SE outside of a school setting, usually from a private tutor and coach who works with the student individually to supplement their regular classroom learning and prepare for forthcoming assessments. Since many children on the autism spectrum need additional educational services, SE is currently very popular. Students with ASD who are simultaneously enrolled in mainstream classrooms benefit by receiving SE, according to the available evidence. Recent studies have switched their focus from the SE providers' point of view to that of the autistic kids', teachers, and families.' However, there needs to be more study on the best teaching SE. This directly affects Students' academic performance, making it a significant problem to solve. Therefore, it focuses mainly on SE teaching strategies. Using a task cycle with children who have autism spectrum disorder has been found to improve their educational outcomes. A stricter approach might improve the quality of SE education. These outcomes could be a springboard for further study into SE education methods. Although the motivations behind this change remain murky, educational leaders everywhere are growing increasingly concerned about the threat that "shadow" and informal education pose to academic quality and equity. Students with ASD from affluent homes can use the same curriculum covered in public schools and more through SE, contributing to its rising popularity. Teachers of teenagers with ASD have differing perspectives on the benefits of shadow schools. Although there is an increasing body of literature, more needs to be understood about the effects of SE on formal education. The term SE is widely utilized, yet people have differing views on what it means. Therefore, it is critical to define the scope and limitations of this research from the outset.

After-school academic tutoring for the opportunity is the main focus. Recreational activities and musical learning are outside the area of this study unless they are used as measures of progress for children with ASD in contemporary educational settings.

Keywords: Improving, Impact, Shadow Education, Assisting, Students with Autism Spectrum Disorders, Thrive, Contemporary, and Educational Settings

A CONTENT REVIEW ON THE ROLE AND USE OF GLOBAL POSITIONING SYSTEM (GPS) IN THE DEVELOPMENT OF REVOLUTIONIZED SOCIETY

Moses Adeolu AGOI

Lagos State University of Education, Lagos Nigeria

ORCID ID: 0000-0002-8910-2876

Solomon Abraham UKPANA

Lagos State University of Education, Lagos Nigeria

Oluwanifemi Opeyemi AGOI

Obafemi Awolowo University, Osun Nigeria

ABSTRACT

The role and use of computing technologies in the development of modern society cannot be undermined. Global Positioning System (GPS) is a subset of computing technologies that use satellite based navigation system to locate specified positions. In simple terminology, GPS is a worldwide radio-navigation system that uses satellites as reference points to acquire the accurate position of an object. According to Kaplan (1996), the Global Positioning System (GPS) is successfully being used in a wide variety of navigation and timing applications across the globe. This paper discussion is focused on the Global Positioning System (GPS). The paper clearly described how the amazing GPS system works. The various applications of the GPS were discussed in the paper write-up. The paper also highlighted some of the advantages and disadvantages of GPS. In order to collect useful information for the paper work, online Google form questionnaire instrument was used to collect vital information from respondents. The responses gathered were subjected to reliability analysis. Conclusively, the paper inferred that navigation in three dimensions is the primary function of GPS and its receivers have been miniaturized into few integrated circuits, therefore becoming very economical to acquire.

Keywords: Global Positioning System, GPS Technology, Revolutionized Society.

Introduction

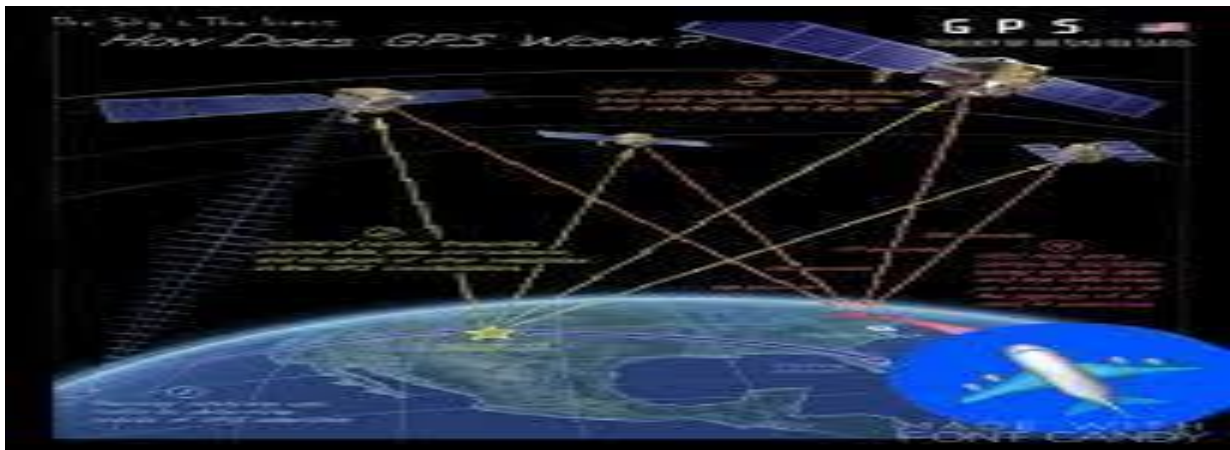
The Global Positioning System (GPS) is a worldwide network of satellites and monitoring stations. This global radio-navigation system uses satellites as reference points to track their position in three dimensions; longitude, latitude and attitude when there is a reasonable clear view of the sky. A GPS tracking system uses the GNSS (Global navigation satellite system) network. This network make incorporate several satellite that use microwave signals which are transmitted to tracking units to determine precise location, speed, time and direction of an object. The operation of the GPS relies on signals received from 24 orbiting satellites in space about 11,000 miles above the earth's surface. These satellites revolve around the earth once every 12 hours and transmit signals to GPS receivers

located on or above the earth's surface. The GPS receivers then process the data emitted from GPS satellites and determine its precise distance of the particular object. This paper discussion evaluates the various applications of the GPS and highlights some of its advantages and disadvantages.

Related Literature

TomTom (2015) defined GPS (Global Positioning System) as a satellite-based radio navigation system. According to Catherine (2008), GPS tracking system has the potentials that show both real-time and historic navigation data on different types of journey. Kaplan (1996) earlier posits that GPS is successfully being used in a wide range of navigation and timing applications across the globe. Navstar (1996) noted that the tracking sequence of any satellite begins with the receiver which determines the satellites visibly available for it to track. TomTom (2015) state that GPS are used only outdoors and might perform less well within forested areas or near tall buildings because the receiver require an unobstructed view of the sky. Hoffmann, et al. (1994) reveals that orbits are arranged in such a way that, at least four satellites are visible in the sky. Fiedler (2015), reports that AllSport GPS route and mapping program are usable for tracking and mapping of sporting and other outdoor activities such as bike race, distance travels, average speed, etc.

Applications of GPS tracking system



GPS is widely deployed and used in so many areas of life. Viz:-

1. Environmental:

Environmental trends and patterns are efficiently recognized by GPS/GIS data collection systems thereby it will be easy to create thematic maps which are useful for the comprehensive analysis of environmental parameters.

2. Agriculture:

GPS equipments are deployed for use by farmers and agribusinesses because of the various benefits which including the ability to work through low visibility field conditions and the elimination of the need for human "flaggers".

3. Aviation:

GPS offers seamless satellite navigation services which guarantees absolute safety and efficiency of flight for aviation users. GPS provides aviation with reliable, accurate and continuous positioning information for all the phases of flight on global basis.

4. Marine:

GPS is essentially in the management of maritime port facilities as it help to provide access to the information on the position and its course thereby saving navigators' fuel and time through fast traffic routing.

5. Military:

GPS is primarily used by the military to improve the control and command of forces through its enhanced ability to accurately locate targeted areas for cruise missiles or troops. It is also be used to carry out nuclear detonation detection.

6. Public safety and Disaster Relief:

GPS is useful as it help to provide positional information about individuals and vehicles using mobile mapping. GPS can as well provide positional information that can be used to map disaster regions where little or no information is available.

Advantages of GPS

1. Improved navigation and route planning:

Individuals and businesses are able to navigate and plan their routes using GPS signal. This helps to save time and reduce the chances of getting lost or late arrival.

2. Real-time location tracking:

GPS technology can essentially be very useful in real-time tracking of the location of specific objects including vehicles, assets and even people. This helps businesses to reduce downtime, optimize routes and improve their overall efficiency.

3. Emergency assistance and tracking:

GPS technology can be used in emergency situations to quickly track specific assets or people. This helps to monitor the safety of workers in remote places.

4. Reduced need for manual labor:

GPS technology can be used to automatically carryout many tasks including asset tracking and route planning. This helps to reduce the need for manual labor.

5. Increased individualized ability to perform tasks:

GPS technology can be used by individuals to remotely perform tasks such as controlling and monitoring of equipments in real-time. This helps to save time, money and increase individual efficiency.

6. Increased efficiency in resource management:

GPS technology can be used to optimize schedules, routes and the use of resources. This helps to reduce overall costs and increase efficiency.

Disadvantages of GPS

1. Limited functionality in specific areas:

GPS technology relies on regular interconnectivity of satellites orbiting the Earth, therefore, instances where the signals from the satellites are blocked or weak could limit the functionality of GPS devices.

2. High possibility of signal interference or disruption:

Factors such as atmospheric conditions, solar flares or human-made interference could also disrupt the signals from the satellites thereby resulting to temporary loss of service or errors in location data.

3. Security and Privacy Issues:

GPS technology can be unlawfully used to breach personal data or track individuals and assets. This has raised concerns on safety and privacy.

4. Initial investment in equipment and infrastructure:

GPS technology requires a huge amount of money for initial investment in equipment and infrastructure. The cost of installation and configuration of GPS receivers and antennas is relatively expensive.

5. High cost of maintenance and updates:

The running cost for maintenance and updates of GPS technology is very high. Most times, huge money is needed for the repair of damages, replacement of failed components and software upgrades

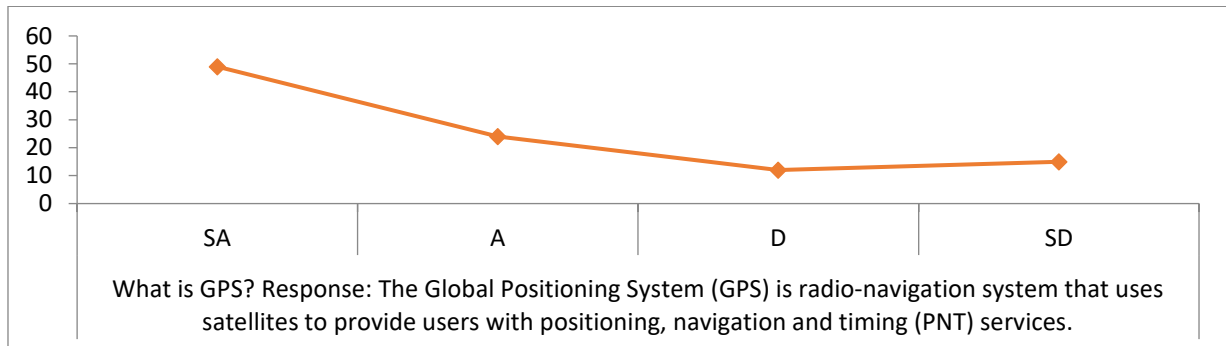
Materials And Methods

This paper adopts a descriptive review approach on the Global Positioning System (GPS). The principles on how the GPS system works were described by the researcher. Magazines and useful literatures were consulted for data collection purposes. In order to further gather important information considered useful for the paper work, online Google form questionnaire instrument was used to collect information from respondents. The collated information were subjected to reliability analysis. The result of 0.92 gave a good reliability

index of the instrument. The entire exercise took place within thirty nine (39) days before completion.

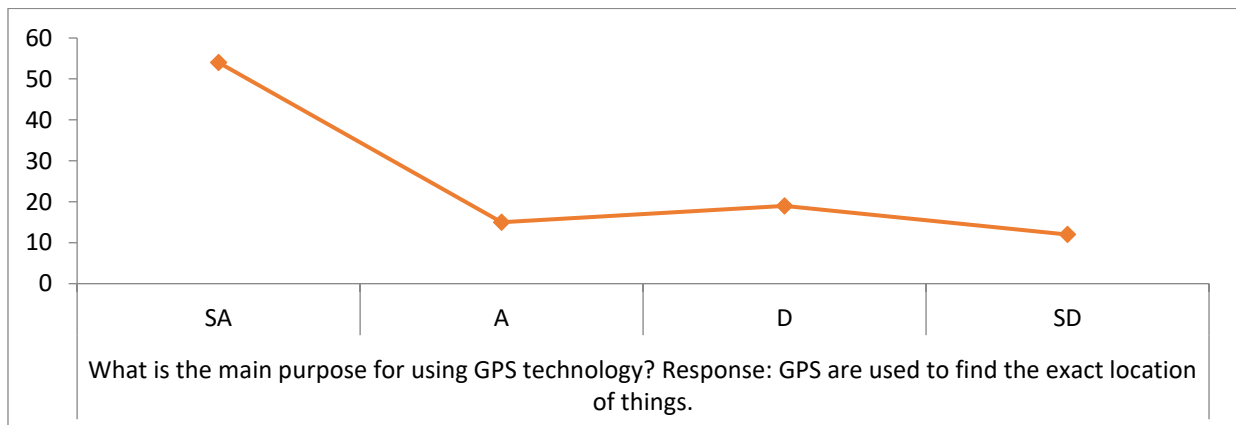
Result And Discussion

Fig.1: Chat Analysis



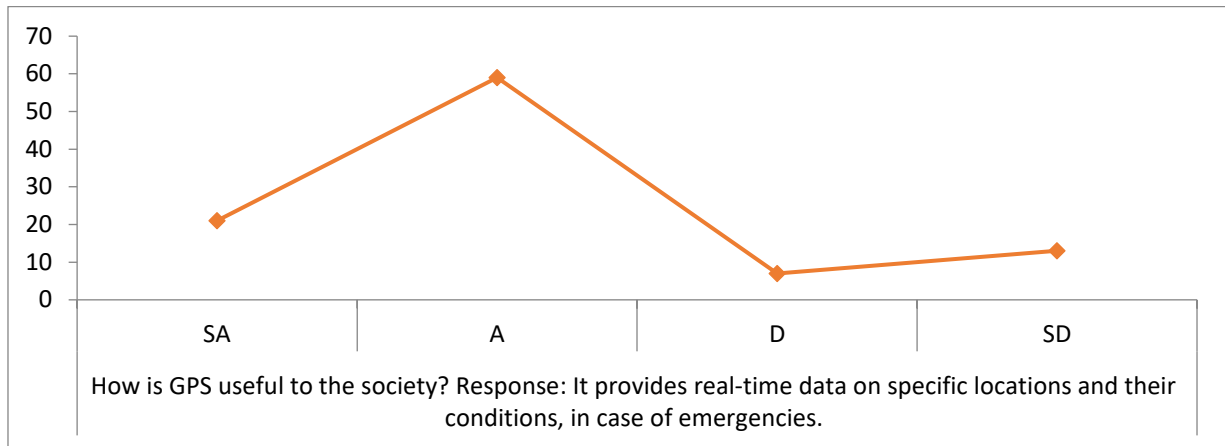
The graph plotted in figure 1 shows that majority of the respondents are duly aware of GPS technology. According to the respondents, the global positioning system (GPS) is a radio-navigation system that uses satellites to provide users with positioning, navigation and timing (PNT) services. Respondents mentioned that GPS system consists of three segments: the space segment, the user segment and the control segment. The respondents also noted that GPS is freely accessible to anyone with a GPS receiver, although the United States government created, controls and maintains the GPS system.

Fig.2: Chat Analysis



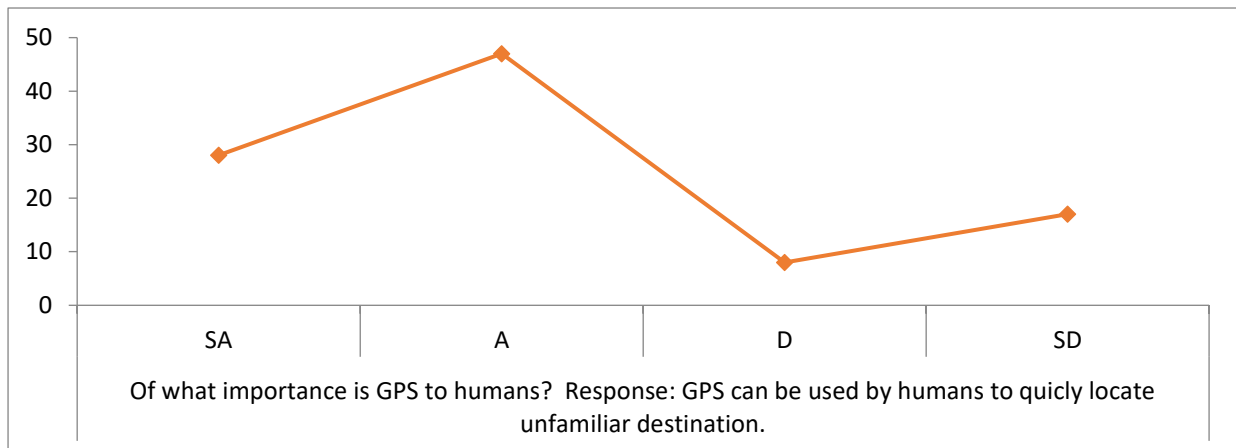
The graph seen in figure 2 depicts that a very high number of respondents supports the statement that GPS are used to find the exact location of things. Some of the respondents also stressed that GPS could also be use for managing land in high countries.

Fig.3: Chat Analysis



The chat analysis shown in figure 3 suggests that a greater number of respondents agree that GPS can be very useful to human society. According to the respondents, GPS provides real-time data on specific locations and their conditions, in case of emergencies. The respondents further mentioned that GPS could also be essentially used for monitoring roads across the country thereby ensuring a high level of road safety. In addition to road safety, GPS helps drivers to avoid traffic congestion as this will go a very long way to reduce the number of car accidents and injuries.

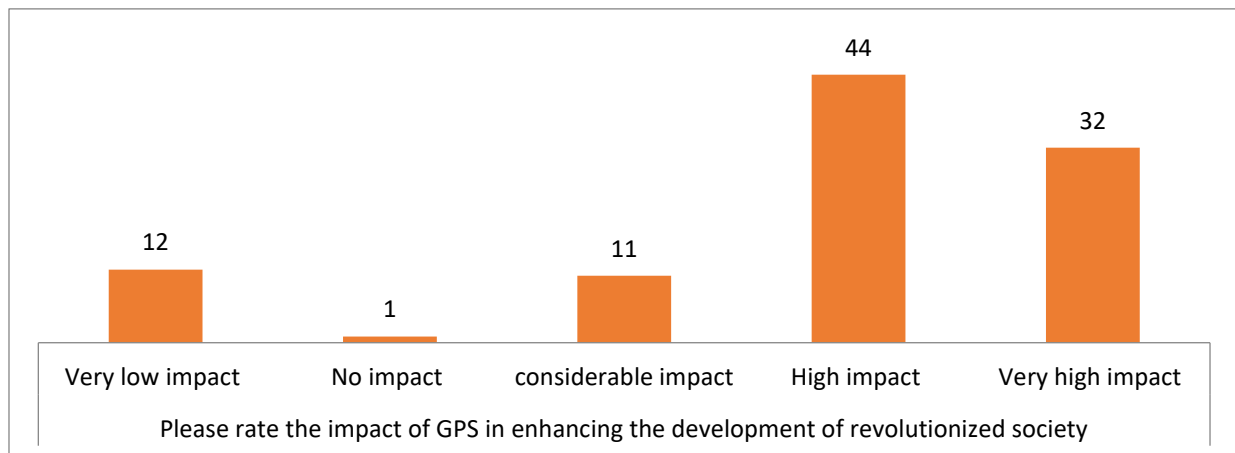
Fig.4: Chat Analysis



The graph plotted in figure 4 indicates that a huge some of respondents opine that the importance of GPS to human cannot be quantified. The respondents noted that GPS can be used for the quick location of unfamiliar destination. as quick as possible. According to the respondents, this could be life saving to individuals traveling to unknown places. In summary, GPS is used for navigation purpose (moving from one location to another), for tracking

purpose (monitoring object or persons movement)., for mapping purpose (creating maps of the world)., for timing purpose (bringing precise timing to the world).

Fig.5: Chat Analysis



The table seen in figure 5 signifies that GPS plays a significant role revolutionizing human society. From the graph plotted it can be inferred that a great number of respondents indicated that GPS have a high impact in enhancing the development of revolutionized society. According to the respondents, GPS has dynamically become the most popular choice for making transportation businesses highly productive. It allows for the effective tracking of vehicles locations.

Conclusion

This paper has carefully discussed the fundamental operations of the Global Positioning System (GPS). The paper described the concepts behind GPS system. Various applications of the GPS were also mentioned in the paper work alongside with the advantages and disadvantages. Conclusively, the paper inferred that navigation in three dimensions is the primary function of GPS and its receivers have been miniaturized into few integrated circuits, therefore becoming very economical to acquire.

REFERNCE LIST

- Catherine, A. (2008). The Story of GPS. Archive from the Origin on February 24, 2013.
- Fiedler D (2015). Review of the AllSport GPS Mapping and Route Planning Tool. Retrieved on May 24, 2015.
- Hoffman-Wellenhof, B., Lichtenegger, H. & Collins, J. (1994). Global Positioning System: Theory and Practice. New York, Springer-Verlag. 3rd Edition. Pp. 382.
- Kaplan (1996). Understanding GPS: Principles and Applications. Edited by Elliott D. Kaplan. Boston: Artech House Publishers. Pp. 554.
- Navstar (1996). Navstar GPS User Equipment Instruction. Public Release Version.
- TomTom (2015). What is GPS? TomTom International BV.
- Srivastava, I. (2014). How Kargil Spurred India to Design Own GPS. The Times of India. Retrieved on December 9, 2014.

SHARIA VENTURE CAPITAL

Niken Ning TIYAS

ORCID ID: 0000-0003-3286-6469

Muhammad Zidan MAULANA

ORCID ID: 0000-0003-3032-6848

Muhammad Taufiq ABADI

ORCID ID: 0000-0001-9705-7756

Etika Alina PUTRI

ORCID ID: 0009-0008-7484-1140

Laeni KHAZIMAH

ORCID ID: 0009-0008-7968-771X

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid Pekalongan Indonesia

ABSTRACT

Financial institutions are one type of business whose role is very important in the economy, especially in the financial sector. In accordance with Presidential Regulation Number 9 of 2009 concerning Financial Institutions in the form of business entities carrying out financial activities in the form of providing capital or capital. In principle, financial institutions are only engaged in providing capital, in contrast to financial institutions, money can be withdrawn in the form of savings, current accounts and deposits. There are 3 (three) fields of activity in the financial institution sector, namely Financing Companies, Venture Capital Companies, and Infrastructure Financing Companies. The existence of financial institutions is an important alternative in supporting the national economy. The form of financial institution trading area chosen by the community and the business world to conduct business is venture capital financing. Based on the Financial Services Authority Regulation (POJK) No.35/PJOK.05/2015. relating to the business activities of venture capital companies and venture capital companies (PMV) are business entities that carry out venture capital activities, venture capital fund management, paid service operations and other business activities with the approval of the Financial Services Authority (OJK). Venture capital in Indonesia today is needed to help businesses that are constrained by capital or internal funds for business development. The existence of venture capital is thought to be an alternative source of financing for micro, small and medium enterprises that do not have the ability to make bank payments because in terms of business forms that have not been incorporated, therefore their scope and accessibility are limited to the financial sector such as banking. The existence of venture capital companies in Indonesia, institutionally and formally, is a relatively new legal and business institution. This practice was only introduced through the regulatory policy

package on December 20, 1988, which was followed by the promulgation of Presidential Decree Number 61 of 1988. However, this venture capital activity has

However, this venture capital activity has a very good future prospect because its existence plays a very important role in the business world, especially for small businesses in Indonesia. Common constraints faced by small businesses, such as limited capital, management capabilities, and technology, will be eliminated through the existence of venture capital funding organizations. This paper will systematically explain the information regarding venture capital as a form of financial institution business. Through this paper, we hope that readers will gain a thorough understanding of the existence and operations of venture capital companies.

Keywords: Venture Capital, Financial Institutions, Business Activities, Company Operations

1. Introduction

Financial institutions are one type of business whose role is very important in the economy, especially in the financial sector. In accordance with Presidential Regulation Number 9 of 2009 concerning Financial Institutions in the form of business entities carrying out financial activities in the form of providing capital or capital. In principle, financial institutions are only engaged in providing capital, in contrast to financial institutions, money can be withdrawn in the form of savings, current accounts and deposits. There are 3 (three) fields of activity in the financial institution sector, namely Financing Companies, Venture Capital Companies, and Infrastructure Financing Companies.

The existence of financial institutions is an important alternative in supporting the national economy. The form of financial institution trade area chosen by the community and the business world to conduct business is venture capital financing. Based on the Financial Services Authority Regulation (POJK) No.35/PJOK.05/2015. relating to the business activities of venture capital companies and venture capital companies (PMV) are business entities that carry out venture capital activities, venture capital fund management, paid service operations and other business activities with the approval of the Financial Services Authority (OJK). Venture capital in Indonesia today is needed to help businesses that are constrained by capital or internal funds for business development.

The existence of venture capital is thought to be an alternative source of financing for micro, small and medium enterprises that do not have the ability to make bank payments because in terms of business forms that have not been incorporated, therefore their scope and accessibility are limited to the financial sector such as banks.

The existence of venture capital companies in Indonesia, institutionally and formally, is a relatively new legal and business institution. This practice was only introduced through the regulatory policy package on December 20, 1988, which was followed by the promulgation of Presidential Decree Number 61 of 1988. However, this venture capital activity has a very good future prospect because its existence plays a very important role in the business world, especially for small businesses in Indonesia. Common constraints faced by small businesses, such as limited capital, management capabilities, and technology, will be eliminated through the existence of venture capital funding organizations. This paper will systematically explain the information about venture capital as a form of financial institution business. Through this paper, we hope that readers will gain a thorough understanding of the existence and operations of venture capital companies.

2. Research Method

The method used in this research is the literature review method, which is a summary, analysis and synthesis of the literature relevant to the Venture Capital model and Sharia Venture Capital.

3. Results And Discussion

3.1. Understanding Venture Capital Sharia

The term venture comes from the word venture, which linguistically can mean something that contains risk or can also be interpreted as a business. Thus, in language, venture capital is capital invested in businesses that contain risk. The definition of a venture capital company according to Presidential Decree No. 61 of 1988 is a financing business in the form of equity participation in a company that receives financing assistance for a certain period of time (Soemitra, 2009).

Thus it can be understood that venture capital is a financing that has a high risk. Venture capital financing is different from banks that provide financing in the form of loans or credit, because venture capital provides financing by making direct investment in the company it finances. The company that obtains venture capital financing is called a Business Partner Company (PPU) or investee company. Other instruments that can be used in the framework of venture capital are convertible bonds that have the option to be exchanged for PPU shares. Generally, venture capital financing is almost always accompanied by a requirement for involvement in the management of the PPU, which is usually agreed in the venture capital agreement (Robert & Brown, 2004).

The term of venture capital equity participation is temporary. In some countries, the term of venture capital financing is between 3 - 10 years. In Indonesia, according to Presidential

Decree No. 61/1988, the maximum period of 10 years must have been invested. This feature makes venture capital different from ordinary investment.

Meanwhile, Islamic venture capital is a financing business in the form of equity participation in a company that receives assistance financing for a certain period of time based on sharia principles. Venture capital practices carried out based on sharia contracts and engaged in businesses that are not contrary to sharia principles are recognized. According to POJK No. 35/POJK.05/2015, a sharia venture capital company is a business entity that conducts sharia venture capital business activities, venture fund management, and other business activities with the approval of the Financial Services Authority, all of which are carried out based on sharia principles (Sunaryo, 2022).

The business activities carried out by venture capital are in the form of financing in the following forms:

- a. Equity participation
- b. Participation through purchase of convertible bonds
- c. Financing through the purchase of debt securities (bonds) issued by business partner companies at the start-up and business development stages.
- d. Productive business financing

3.2. History of Venture Capital Sharia

The development of venture capital in Indonesia began in 1973 with the establishment of PT Bahana Pembinaan Usaha Indonesia (BPUI), whose institutional status at that time was included in Non-Bank Financial Institutions whose activities were mainly to finance business development. PT. BPUI was formed based on Government Regulation No. 18 of 1973 engaged in capital participation (Soemitra, 2009).

In contrast to Islamic finance companies that have grown rapidly, there are still relatively few Islamic venture capital companies. Since its development in 2012 until 2015, only 4 Islamic venture capital companies have been established. Judging from the development of total assets, the Islamic venture capital industry experienced an average growth of 31.01 per year. Meanwhile, the assets of the Islamic venture capital industry compared to the total assets of the venture capital industry amounted to 4%. (Sharia IKNB Roadmap 2015-2019). When looking at the development of the Islamic financial industry globally, Islamic venture capital companies have the opportunity to develop further in the future. However, government support is still needed, especially from the additional capital of Islamic venture capital companies which is still considered very limited. In addition, there is

a need for intensive socialization and education to the public about the urgency of developing Islamic venture capital companies to support the birth of new entrepreneurs and companies that carry out their activities based on sharia principles (ABDUL RASYID, 2016).

Meanwhile, shariah venture capital has recently been present in a very small number. In principle, shariah venture capital follows the legal basis of existing venture capital. However, shariah venture capital is enriched with principles that are in accordance with shariah. Furthermore, the development of venture capital in terms of its legal basis in Indonesia can be sorted chronologically as follows: (Siamat, 2004)

1. Presidential Decree No. 61 of 1988 concerning Financing Institutions. Venture capital business is legally part of the activities that can be carried out by financing institutions.
2. The provisions for the implementation of the first point are regulated by Minister of Finance Decree No. 1251/KMK.013/1988 dated December 20, 1988 concerning Provisions and Procedures for the Implementation of Financial Institutions. And enhanced by Minister of Finance Decree No. 1251/KMK.013/1989 dated November 18, 1989.
3. Government Regulation No. 62 of 1992 on Business Sectors of Venture Capital Companies followed up by Minister of Finance Decree No. 227/KMK.01/1994 dated June 9, 1994 on Business Sectors of Venture Capital Companies.
4. Government Regulation No. 4 Year 1995 on Income Tax of Venture Capital Company.
5. Minister of Finance Decree No. 469/KMK.17/1995 dated October 3, 1995 on the Establishment and Development of Venture Capital Companies.
6. Law No. 7 of 1991 concerning Income Tax.
7. Government Regulation No. 4 Year 1995 on Income Tax of Venture Capital Company.

Based on Minister of Finance Decree No. 469/KMK.17/1995 dated October 3, 1995 on the Establishment and Development of Venture Capital Companies, venture capital is no longer part of financing activities. And since then, venture capital is carried out separately with its own legal entity. This has resulted in venture capital developing in the regions. The objectives of venture capital development in the provinces are as follows: (Soemitra, 2009)

1. To provide a means of financing in order to help SMEs that find it difficult to fulfill bank loans.
2. The establishment of a Regional Venture Capital Company (PMVD) facilitates the supervision and guidance of Business Partner Companies (PPU).

This objective is based on Government Regulation No. 4 Year 1995 above, that the income of Venture Capital Company which is part of the profit received from the investment in PPU within a period of 10 years, is not an income tax object.

Theoretically, venture capital has great potential to contribute to business development. Companies that have good prospects but do not have enough capital and do not have access to banks can develop by obtaining capital support from venture capital (Hamid, 2015).

3.3. Function and Purpose of Venture Capital

There are many benefits of venture capital or funds that are not widely known, even though this funding or financing is very useful especially for new companies (startups). Here are some of the functions that Venture Capital can provide that are important to know: (OJK, 2015)

1.Improving Business Activities and Potential

This venture capital company not only acts as an investor but they will also be involved in management and make the company given the funds as a partner. Companies that become partners are usually small businesses or startups that certainly require considerable capital and funds to be able to increase their business. Venture fund investors will become partners who help in product development, idea development, and business to become even bigger. Therefore, it is certain that with the involvement of venture funders, business activities and potential will be much more increased.

2.More Efficient Product Marketing

Small companies or MSMEs generally face marketing constraints that are not maximized, but with venture funds, the company's credibility will increase, then the MSME production process will become even bigger so that with abundant products, marketing will be maximized and easier.

3.Gain the trust of the Bank

Start-up companies will find it difficult to gain the trust of banks because their management is still not effective and stable. Banks also do not want to take the risk if the company does not have the ability to pay debts or installments due to bankruptcy due to unstable management. In contrast to venture funds, which will be involved in management so that when a problem occurs, they will also help solve it. By joining a venture fund, this is a plus

for the company in gaining the trust of banks that also play a role in providing potential business capital.

4.Improved Liquidity

Start-up companies that will receive funding from venture capital do not have to pay interest expenses and debt i n s t a l l m e n t s . Therefore, the additional capital can be directly used to increase the company's liquidity.

5.Improved Rentability

Venture capital companies not only help from the funding side but also help from the management side, so that marketing costs and production costs can be more efficient so that the ability for companies to be able to get profits or profitability will increase.

The objectives of the establishment of Venture Capital are as follows: (Dewi Mahrani Rangkyu, 2020)

- a.For the development of specific projects, where the project is not solely about profit.
- b.For the development of new technologies, where investment in these technology projects will only be profitable in the long run.
- c.The takeover of a company, which is done for profit.
- d.Partnership in the context of poverty alleviation, by helping entrepreneurs who are financially weak, but do not have material collateral that makes it very difficult to get a loan from a bank.
- e.Technology transfer from old technology to new technology with the aim of improving quality and production capacity.
- f.Assist in the establishment of new companies, where the company has a high level of risk and a high level of loss.
- g.Helping companies that are lacking liquidity.

3.4. Venture Capital Business Activities and Legal Regulations Sharia

The business activities carried out by venture capital are in the form of financing in the following forms:

a.Equity participation

Investment in shares is carried out by investing in shares through the purchase of shares in Business Partners that are not yet traded on the stock exchange.

The participation of these shares must fulfill 2 elements, namely:

1. The maximum investment period of 10 years can be extended twice with a total extension period of 10 years.

2. Must conduct Divestment with a period of time that has been agreed with the Business Partner in accordance with the provisions. After conducting participation shares, a PMV may divest by:

- a) Public Offering through the capital market;
- b) Selling to PMV, PMVS, and/or new investors through private placement; or
- c) Sell back to the Business Partner (buy back).

b. Participation through purchase of convertible bonds

This method can be done through the purchase of bond certificates as proof of ownership of convertible bonds and or the purchase of convertible bonds as outlined in an agreement with a notarial deed. Convertible Bonds can be converted into equity participation at maturity for a certain period of time based on the agreed agreement.

c. Financing through the purchase of debt securities (bonds) issued by business partner companies at the start-up and business development stages.

Financing through the purchase of debt securities issued by business partners at the start-up stage and / or business development. This business activity is carried out by PMV by purchasing debt securities issued by business partners while in the start- up and or business development stages.

d. Productive business financing

Productive business financing is a financing scheme that must be carried out in the form of channeling financing to Debtors that aims to produce goods and or services that increase income for Debtors. In conducting productive business financing business activities, a PMV can cooperate with other parties in the form of:

- a) Financing forwarding (channeling) the risks that arise are the responsibility of the owner of the funds.
- b) Joint financing is where the risks incurred are borne by each party proportionally.

The parties that can cooperate with PMV in the context of productive business financing include:

- a) Bank;
- b) PMV or PMVS;
- c) Financing Company;
- d) Indonesia Export Financing Agency;
- e) Other Financial Institutions, and/or
- f) Natural person.

The sources of law governing venture capital are divided into two classifications, namely in terms of civil law and in terms of public law. In terms of civil law, agreements are the main source of venture capital law, while in terms of public law, various laws and regulations are the main source of venture capital law.

a. Agreement

Agreements are the main source of civil law in venture capital. All business activity agreements between the Company Venture Capital (PMV) or Sharia Venture Capital Company. The venture capital agreement must reflect the principles relating to the will of the two parties making the agreement. An important principle used in venture capital agreements is the principle of freedom of contract as in Article 1338 Paragraph (1) of the Civil Code which states that "agreements made legally shall apply as laws for those who make them." As in agreements in general, the principle of freedom of contract is the basis for making a financing agreement through venture capital. The provisions in this principle allow each party who wants to make an agreement to be free to make an agreement based on the interests of each party as long as it does not violate or conflict with the provisions of laws and regulations, decency and public order. After that, it is written in an agreement as a valid documentary evidence for the Venture Capital Company and the Business Partner Company (PPU) in accordance with the provisions of the agreement contained in Article 1320 and Article 1338 of the Civil Code.

b. Legislation

Regulations on financing institutions that regulate venture capital businesses can be classified into 2 (two), namely:

1. Laws and regulations on financing institutions that regulate venture capital business prior to the establishment of the Financial Services Authority (OJK):

- a)** Regulation Government Number 18 Year 1973 concerning Capital Participation of the Republic of Indonesia.
- b)** Presidential Decree No. 61 of 1988 on Financing Institutions.
- c)** Presidential Regulation No. 9/2009 on Financing Institutions
- d)** Decree of the Minister of Finance Number 1251/KMK.013/1988 concerning Provisions and Procedures for the Implementation of Financing Institutions.
- e)** Decree of the Minister of Finance Number 468 of 1995 Concerning the Amendment of Decree of the Minister of Finance Number 1251/KMK.013/1988 Dated December 20, 1988 Regarding Provisions and Procedures for the Implementation of Financing Institutions as Amended by Decree of the Minister of Finance Number

1256/KMK.00/1989 Dated November 18, 1989 Minister of Finance of the Republic of Indonesia.

2. Legislation on financing institutions that regulates venture capital business after the establishment of the Financial Services Authority (OJK):

a) Law No. 21 of 2011 on the Financial Services Authority.

b) Minister of Finance Regulation No. 8 /PMK.010/2012 concerning Venture Capital Companies.

c) Financial Services Authority Regulation No.1/POJK.07/2013 on Consumer Protection in the Financial Services Sector.

d) Financial Services Authority Regulation No. 1 /POJK.07/2014 concerning Alternative Dispute Resolution Institutions in the Financial Services Sector.

e) Financial Services Authority Regulation No.35 / POJK. 05/2015 on the Implementation of Venture Capital Company Business.

3.5. Profile of One of the Relevant Venture Capital Institutions Sharia

PT. BAHANA ARTHA VENTURA (BAV)



1. History

PT Bahana Artha Ventura (BAV) was established on March 11, 1991 and is a subsidiary of PT Bahana Pembinaan Usaha Indonesia (Persero) (PT BPUI) or better known as Indonesia Financial Group (IFG), a State-Owned Enterprise (SOE) established on April 17, 1973. Since its inception, BAV has carried out its mission in developing the real sector through financing to Micro, Small and Medium Enterprises (MSMEs) with Venture Capital financing schemes and management assistance through sound business practices and Good Corporate Governance. The shareholding structure of BAV consists of PT BPUI with 84.74%, PT BPUI Employee Cooperative with 0.15% and PT Bank Rakyat Indonesia TBK with 15.10%.

BAV is a pioneer in the development of Micro, Small and Medium Enterprises (MSMEs) in Indonesia which has an extensive network of 27 Regional Venture Capital Companies (PMVDs) which are affiliates of BAV, from Aceh to Papua supported by competent, loyal

and experienced Human Resources (HR) and integrated and comprehensive administrative and financial systems.

2. Vision and Mission

a. Vision

To be the leading Venture Capital Company in Indonesia.

b. Mission

- Providing financing services to support the growth of the MSME segment while maintaining good corporate governance and prudential principles.
- Provide access to capital for start-ups in line with the needs of the Industry and realize financial industry innovation to customers.
- Synergize with related institutions to increase the prosperity of the community.

3. Products and Programs

- a) Equity Participation is direct capital investment in a Business Partner Company (PPU) in the form of a limited liability company for a certain period of time.
- b) Participation in the form of purchase of Convertible Bonds (OK) issued by PPU in the form of a limited liability company.
- c) Productive Business Financing is a form of financing distribution to Business Partner Companies (PPU) which aims to produce goods and/or services that can increase income for Business Partner Companies (PPU).
- d) BAV - UMi (BUMi) Program. In order to increase the number of entrepreneurs facilitated by the government, the Government Investment Center in collaboration with PT BAV provides secondary financing facilities for ultra-micro entrepreneurs. The main objective is to enable ultra-micro entrepreneurs to obtain financing easily and quickly. BAV offers secondary financing facilities for ultra-micro entrepreneurs to Non-Bank Financial Institutions (LKBB) as distributors.
- e) In accordance with the Financial Services Authority Regulation (POJK) Number 35/Pojk.05/2015 on the Implementation of the Company's Business Venture Capital, Venture Capital Company (PMV) organizes other businesses, as for the other businesses are ;
 1. Financing through the purchase of debt securities issued by Business Partners at the start-up stage or in business development.
 2. Fee-based service activities.

- f) Short-term Venture Capital Financing is a short-term receivable or bill settlement transfer service provided by PT Bahana Artha Ventura accompanied by a financing facility.
- g) Sharia Financing is financing with Sharia patterns with the target of financing to productive businesses that are included in the criteria for micro, small and medium enterprises (MSMEs) with financing patterns being Musyarakah and mudharabah.
- h) The Partnership Program is a program to improve the ability of small businesses to become resilient and independent. This program aims to encourage the micro business community to develop through low interest loan facilities. In addition, micro- entrepreneurs also receive coaching facilities to grow and improve their businesses. BAV is the designated institution to channel the BUMN Partnership Program through Regional Venture Capital Companies

4. Conclusions

There are several points that can be taken based on the results of research namely on sharia venture capital namely, Islamic venture capital is a financing business in the form of equity participation in a company that receives financing assistance for a certain period of time based on sharia principles. Venture capital practices that are carried out based on sharia contracts and are engaged in businesses that are not contrary to sharia principles are recognized. The functions that can be obtained from venture capital are; increasing business activities and potential, marketing products more efficiently, gaining trust from banks, improving liquidity, and improving profitability. The business activities carried out by Islamic venture capital are in the form of financing in the following forms: (1) Equity participation, (2) Participation through the purchase of convertible bonds, (3) Financing through the purchase of debt securities (bonds) issued by business partner companies at the start-up and business development stages, and (4) Productive business financing.

The sources of law governing venture capital are divided into two classifications, namely in terms of civil law and in terms of public law. In terms of civil law, agreements are the main source of venture capital law, while in terms of public law, various laws and regulations are the main source of venture capital law.

One of the relevant company profiles is PT Bahana Artha Ventura (BAV) established on March 11, 1991 and is a subsidiary of PT Bahana Pembinaan Usaha Indonesia (Persero) (PT BPUI) or better known as Indonesia Financial Group (IFG), a state-owned enterprise (SOE) established on April 17, 1973.

5. Acknowledgments

Based on the conclusions above, With the completion of this paper, we would like to thank the parties who have been involved in making this paper. It is hoped that with this paper, everyone can understand Sharia Venture Capital financing. We realize that in the preparation of this paper there are still many shortcomings in both the writing and the language presented. Therefore, constructive criticism and suggestions from readers are highly expected as material for our future evaluation. The author hopes that with this paper, hopefully it can provide scientific benefits for all of us.

6. References

- ABDUL RASYID. (2016). SEKILAS TENTANG PERUSAHAAN MODAL VENTURA SYARIAH. BINUS UNIVERSITY. <https://business-law.binus.ac.id/2016/01/30/perusahaan-modal-ventura/>
- Dewi Mahrani Rangkuty, A. Z. (2020). Perbandingan Modal Ventura Konvensional dan Syariah : Studi Literatur Model Pembiayaan Startup dan UMKM di Provinsi Sumatera Barat. *Ekonomi, Keuangan, Investasi dan Syariah (EKUITAS)*, 75.
- Hamid, A. (2015). Modal Ventura Syari'Ah. *Jurnal Ekonomi dan Keislaman*, 3(1), 144–145.
- OJK. (2015, November 4). *Modal Ventura,, Solusi Berbisnis bagi Calon Pengusaha*. Retrieved November 4, 2015, from Sikapi: <http://sikapiuangmu.ojk.go.id/FrontEnd/CMS/Article/20611>
- OJK. (2019, Juli), *Literasi Perguruan Tinggi, Buku V Lembaga Pembiayaan*. Retrieved Juli, 2019 from Sikapi : <https://sikapiuangmu.ojk.go.id/FrontEnd/LiterasiPerguruanTinggi/book/book5/reader.html>
- Robert, B., & Brown, E. B. (2004). *Modal Ventura*. 1, 1–14.
- Siamat, D. (2004). *Manajemen Lembaga Keuangan* (4 ed.). Lembaga Penerbit Fakultas Ekonomi Universitas Indonesia.
- Soemitra, A. (2009). *Bank dan Lembaga Keuangan Syariah* (Edisi 2). KENCANA.
- Sunaryo, D. (2022). *Model Pembiayaan Dengan Pola Penyertaan Pada Modal Ventura*. In Repository.Lppm.Unila.Ac.Id.

**UNDERSTANDING ISLAMIC INSURANCE IN ISLAMIC FINANCE
(THEORITICAL FOUNDATIONS AND LITERATURE ANALYSIS)**

Diana ZALFANUR

ORCID ID: 0000-0003-0026-7656

Erna WIJAYANTI

ORCID ID: 0000-0002-9505-5826

Ega Vivia FATIKHAH

ORCID ID: 0000-0002-4413-3820

Ade GUNAWAN

ORCID ID: 0000-0001-8479-0641

UIN KH. Abdurrahman Wahid Pekalongan, Indonesia

ABSTRACT

This research aims to find out more about Islamic insurance. This research uses a qualitative approach with in-depth analysis of secondary data from various literature sources, to understand the perspectives and concepts underlying Islamic insurance. The data collection technique in this research is a literature study technique to obtain a theoretical basis in the form of opinions or writings of legal experts, scholars, and other authorized parties, regarding Islamic insurance guidelines in Indonesia. This research is descriptive analytical to describe a research result but not used to make broader conclusions. The result of this research is that sharia insurance is an insurance product that is managed sharia and supervised by DSN-MUI. The functions of sharia insurance are managed according to sharia principles, transparent fund management, investment returns shared with participants, ownership of funds by two parties, namely the company and participants, contribution funds are not forfeited even though there are no claims, and underwriting surplus benefits. The main purpose of sharia insurance is to improve the welfare and struggle of the people. Sharia insurance business activities are regulated in Undang-Undang Nomor 2 Tahun 1992. One of the relevant company profiles is PT. JMA Sharia Insurance.

Keywords: Sharia Insurance, Financial Institution

Introduction

The advancement of science and technology today makes humans appear to be progressing in life and the world's sophisticated and modern economic life. Apparently, the progress that has been considered advanced is still experiencing setbacks. This is characterized by uneven economic growth enjoyed by every citizen. European and American countries, for example, dictate Asian countries, especially the Middle East, to implement conventional interest-based economies (Mardianto & Dkk, 2022). Almost all civil laws are colored by conventional

interest-based systems, including the application of conventional insurance that has created unrest and injustice to its customers (Soemitra, 2009).

From the progress of world civilization, it forces humans to continue to produce changes in the way of thinking and acting to face the future related to the possibilities that will occur, because certainty is only in the hands of God's power. However, efforts to predict future events through events (*kauniyah* verses) continue to be made, so that humans are able to take lessons from what has happened so that it is hoped that humans can measure and study in order to determine the best steps with the aim of providing better hope. In fiqh rules, customs or habits that have passed are a legal provision that can be used as a law for the next event (*al-'adah muhakkamah*) (Siddiq, 2017). To determine probability, there is an important concept in insurance, namely *the law of large numbers*. According to this law, the greater the number of observations made of an event, the more likely it is that those observations yield a correct probability estimate. Because the basic purpose of insurance is to make preparations in the face of possible difficulties faced by humans in their lives (Zaini, 2015).

Insurance as one of the financial institutions engaged in the field of coverage is a modern institution resulting from new findings of the western world that was born along with the spirit of enlightenment. This institution along with bank financial institutions became the driving force of the economy in the modern era and continues today. The basis of the operational spirit of modern insurance is oriented towards a capitalist system which essentially only plays in the collection of capital for the benefit of certain individuals or groups and has little or no roots for economic development at a more comprehensive level (Oktayani, 2018).

Research Methods

The object of research is sharia insurance. This topic was chosen because sharia insurance is a public need for financial protection in accordance with sharia principles that seek to minimize risk fairly and in accordance with Islamic religious beliefs. The research method used is a qualitative approach by utilizing in-depth analysis of secondary data from various related literature sources, to understand the perspectives and concepts underlying Islamic insurance. Literature study is applied to obtain the theoretical basis in the form of opinions or writings of legal experts, scholars, and other authorized parties, regarding the guidelines for Islamic insurance in Indonesia. This research is descriptive analytical to describe or analyze a research result but is not used to make broader conclusions.

A. History of the Establishment of Sharia Insurance

The company was first established in 1994, PT Asuransi Takaful Indonesia. (Kartika, 2022). The emergence of Islamic insurance companies has experienced pros and cons in Indonesian society. Islamic insurance law is an association between the understanding of sharia law and the realities that occur. So that in 2001 the Majelis Ulama Indonesia issued a Fatwa regarding the General Guidelines for Islamic Insurance, Fatwa No. 21/DSN-MUI/X/2001 (Umam, 2021). This fatwa was issued to develop Islamic insurance (*takaful*) legal products, the existence of the DSN-MUI fatwa has a fundamental function (B. Burhanudin 2010). The establishment of Islamic insurance in Indonesia was not followed by adequate regulation.

The existence of Islamic insurance in Indonesia is constitutionally weak and still needs political policies that support the Indonesian government at that time. For 20 years a regulation governing Islamic insurance was issued, namely yaitu Undang-undang No. 40 Tahun 2014 concerning Insurance. The issuance of Undang-undang No. 40 Tahun 2014 concerning Insurance is clearly stated in the explanation of the Law in the General Provisions (Kartika, 2022). Efforts to create a healthier, more reliable, trustworthy and competitive insurance industry are generally carried out, both in determining new provisions and improving existing provisions. One of the manifestations of these efforts is in the form of establishing a legal basis for the implementation of sharia insurance business and sharia reinsurance business. This is encouraging news for Muslims in Indonesia who contribute to insurance finance without bearing the burden of its positive legal basis.

The development of Islamic insurance lately is considered quite happy. The number of sharia insurance companies, whether business units or not, has opened people's eyes to easier facilities. Even foreign companies are targeting Indonesia as the largest market because it has a large number of Muslims.

1. Origin of Insurance

At the beginning of the emergence of insurance, insurance was needed by people when there was no longer any help from existing tribes. People in the past lived in colonies or tribes. Where in the group help each other when there is distress, but when human life has changed, and the risk is borne alone, then that is where the origin of insurance is.

The first insurance known in 2250 BC was known in the Babylonian community known as the Hamurabi agreement (Amrin, 2006). The Babylonian society ensured the payment of interest for people in debt to be protected from any unexpected accidents during trade by paying a premium. In ancient times, people started trading, then to secure their merchandise from various risks, such as robbery, looting, or natural disasters, these traders made premium

payments to others, so there were other people who were ready to bear the risks of these traders.

2. History of Sharia Insurance

The practice of insurance has existed since the time before the Prophet Muhammad. Insurance is a culture that originated in ancient Arabia. The practice of insurance is called *âqilah* (Sula, 2004). The word *âqilah* can simply be interpreted as mutual responsibility and responsibility for the family (Ali, 2023). This can illustrate that Arab tribes at that time had to be ready to make financial contributions in the name of murder to pay a sum of money to the victim's family or heirs. In *âqilah*, each tribe member makes a contribution whose function is to pay blood money when one tribe member kills another tribe member. The practice of *âqilah* is similar to the practice of insurance in that the contribution made to the victim's heirs is equal to the sum insured. Thus, the Arab tribes in ancient times had practiced insurance by protecting their tribe members against the risk of murder that could occur at any time without prior knowledge.

The discussion of insurance in the study of Islamic sciences only appeared in the phase of the birth of contemporary scholars. Recorded in the literature, a series of names that pursue insurance studies include Ibn Abidin (1784-1836), Muhammad Nejatullah al Shiddiqi, Muhammad Muslehuddin, Fazlur Rahman, Mannan, Yusud al Qardhawi, Mohd. Ma'shum Billah, are some of the famous scholars who lived in the modern era (Thohari, 2023). Here, the study of insurance is a package of Islamic economic studies which are usually always studied together with the discussion of banking in Islam. So, Islamic insurance or sharia insurance is the result of the thinking of contemporary scholars.

The history of the formation of Islamic insurance began in 1979 which was marked by the establishment of an insurance company in Sudan called Sudanese Islamic Insurance (Suparmin, 2019). The company was the first to introduce Islamic insurance. In the same year a life insurance company in the United Arab Emirates also introduced Islamic insurance in the Arab region. Then, Islamic insurance was also recognized in Switzerland which was marked by the establishment of Islamic insurance called *Dar al Mâl al Islâmi* in 1981 which then introduced Islamic insurance to Geneva. (Suhawan, 2020). In Europe, the second Islamic insurance called Islamic Takafol Company (ITC) was established in Luxembourg in 1983, and was followed by several other countries. (Amrin, 2006).

In principle, Islamic economic studies always prioritize the principles of justice, help, avoid injustice, the prohibition of usury, the principle of profit and loss sharing and the elimination of the element of *gharar*, so from here a parallel line is drawn to the principles that must exist

in an Islamic insurance institution. This is because Islamic insurance theoretically still refers to the study of Islamic economics in general. In addition to the above basic principles that must be fulfilled by Islamic insurance institutions, Islamic insurance must also develop an independent, integrated, professional insurance management, and not violate the basic rules outlined in Islamic law.

For the purpose of keeping it always in accordance with Islamic law, then in every insurance there must be a Subsatansi Council of insurance activities is protection against risk. Human life is inseparable from risk, for example an earthquake, or other events that cause protection, where then the potential risk is not too great.

As a Muslim, we have the Quran and Hadith and other agreed sources of Islamic law. Then when we examine the Qur'an only some of the practices that have been carried out by the prophets, in Islam the concept of insurance is not a new thing because it has existed since the time of the Prophet Sallallahu alaihi wasallam which is often known as *Aqillah*. *Aqillah* means *ashobah* which indicates the father's relationship with the murderer (Syadali & Mudzakir, 1997). In ancient times in Arabia if there was one member of the tribe killed by another member of the tribe the heirs of the victim would be paid from the killer of the killer's closest relatives called *aqillah* who had to pay a blood debt (*diyat*) on behalf of the killer. to pay this financial contribution is the same as the premium in insurance practice. while the compensation paid under *aqillah* may be equal to the value of coverage in current insurance practice.

As such, it was a form of financial protection for the heir against the untimely death of the victim. This payment system was retained after the advent of Islam because of its benefits, including firstly reducing bloodshed, secondly replacing individual responsibility with shared responsibility for individual financial burdens and developing smart cooperation and brotherhood. At the time of the caliphs Abu Bakr, Uthaman and Ali, the concept of *aqillah* was then regulated by a special body, and this has led to modern practices, where today insurance is managed by a special body, and in the era of Khulafaur Rashidin it was also held by a special body, called Diwan Mujahidin. The Diwan Mujahidin was a specially selected person to manage the practice of *aqillah*. In the 14th and 17th centuries, there was the practice of marine insurance. In conventional insurance, the first insurance was marine insurance or maritime insurance which at that time for any shipment of goods was done by sending goods by sea transportation.

The existence of Islamic insurance business has been around for a long time and cannot be separated from the existence of conventional insurance business as well. Before the insurance

business became a reality, there were already various types of conventional insurance doing this that developed long ago. Based on the beliefs and interests of the world's Muslims, various companies have been established from the concept of Islamic insurance, insurance companies that operate based on sharia principles. This company is also not only owned by Muslims, but non-Muslims also have various companies. After that, there are parent companies with the concept of conventional companies also opening offices to offer sharia insurance services by creating sharia business unit offices. This shows that the Islamic insurance business is taken seriously in Indonesia. It can be interpreted that the demand for sharia insurance in the local community is growing. Indonesians are accustomed to trading using Islamic law (Muchlis, 2023).

a. Development of Islamic Insurance in Saudi Arabia

By the end of 2014, total contribution receipts are expected to reach US\$B.100 billion, accounting for the total contribution receipts of gulf countries. The annual growth rate of contributions averaged around 12%. In 2015, contribution growth reached 20% with a value of US\$9.7 billion, accounting for 85% of the total contribution receipts of the Gulf States (Milliman, 2017). Islamic insurance development in Indonesia In Indonesia, *takāful* (*Sharī'ah*) grew 8.6% y-o-y to USD 1.1 billion in 2018. Similar to Malaysia, the family *takāful* segment dominated the market, accounting for more than three-quarters of *takāful* contributions. Together with China, the Indonesian market is considered one of the best performing life insurance markets in the world.

b. The Development of Islamic Insurance in Europe

Recently, Germany, Spain, and France have also started to open Islamic insurance markets to meet the demand of the Muslim community in their respective countries. There are currently 16 million Muslims in Europe. In 2017, Germany through INAIA Finance also launched a new life insurance product, in addition to the establishment of the first Islamic bank, KT Bank. Spain through Mussap also cooperated with CoopHalal to offer Islamic insurance products. In addition, 2017 also saw the opening of new branches of brokerage networks offering Islamic insurance products such as Noorassur, Coveris Assurance, Dine Assur, Ethical Capital, MKSS, NCC, Courtifi, and Keen Finance.

B. Function and Purpose of Sharia Insurance

1. Function of Sharia Insurance

Sharia insurance is an insurance product that is managed sharia and supervised by the Dewan Syariah Nasional Majelis Ulama Indonesia (DSN-MUI). This sharia insurance product consists of health insurance, life insurance, and general insurance including car insurance. The

function of Islamic insurance is actually the same as conventional insurance (Muljaningsih & Perdana, 2021). In general, insurance functions are divided into three, namely:

a. The main functions of insurance include:

- 1) Risk transfer
- 2) Collection of funds (common pool)
- 3) Equitable premium

b. Secondary functions include:

- 1) Stimulate business growth.
- 2) Security, so that the insured can concentrate on his business.
- 3) Loss prevention by identifying potential risks.
- 4) Social benefits, namely by accelerating economic recovery and preventing poverty.
- 5) Savings (investment), for example for life insurance: there are unit links, pension funds, insurance savings offered by banks.

c. Additional functions of insurance include:

- 1) As a source of public funds, insurance companies invest the premiums collected through financial instruments.
- 2) Invisible earnings, namely income for insurance companies from reinsurance commissions (Subagiyo & Salviana, 2016).

While the functions of Islamic insurance are as follows.

- a. Managed in accordance with Islamic sharia principles.
- b. Transparent fund management.
- c. Investment profits are distributed to participants.
- d. Ownership of funds by two parties, namely the company and participants.
- e. Contribution funds are not forfeited even if there is no claim.
- f. Benefits of underwriting surplus (Muljaningsih & Perdana, 2021).

2. Purpose of Sharia Insurance

Sharia insurance is a form of insurance based on the principles of Islamic sharia. Sharia insurance aims to provide financial protection for policyholders by helping each other in kindness, sharing risks, and applying the principles of justice and balance. Islamic insurance is a form of financial protection based on sharia principles (Sulaeman et al., 2023). The purpose of the establishment of Islamic insurance is very noble because it has clear objectives, among others:

a. Helping and Cooperating

Wealth owned as a gift from Allah SWT should function socially, especially freeing someone from suffering and dependence. Mutual help and cooperation is one of the praiseworthy traits and is highly recommended by Allah SWT.

b. Maintain Safety and Security

The desire for safety and security in life is a human instinct. Islam recommends that humans strive to make the world free from fear. The initial foundation of Islamic insurance is a sincere intention because of Allah SWT to help others who are suffering. Premiums paid to Islamic insurance must be in accordance with the commands of Allah SWT to get His pleasure based on cooperation and help.

c. Mutual Responsibility

Islam teaches humans to eliminate selfishness. A sense of responsibility is a factor that strengthens the sense of unity and brotherhood among humans. (Siddiq, 2017).

Sharia insurance and conventional insurance have different goals. The main purpose of conventional insurance is purely business, like most other businesses to get a large profit. This can be seen from the funds obtained from customer premiums, all of which belong to the company. While the main purpose of sharia insurance is not to obtain large profits. Rather, the main goal is to seek profits to improve the welfare and struggle of the people. This can be seen from the vision and mission carried out by Islamic insurance, namely: *aqidah* mission, worship mission, *isghtishodi* mission, and ummah mission. (Rosidah, 2010).

C. Business Activities and Legal Arrangements of Sharia Insurance

1. Sharia Insurance Business Activities

Based on Undang-Undang Nomor 2 Tahun 1992 concerning Insurance Business, it includes liability insurance, life insurance, and reinsurance.

a. Non Life Insurance/General Insurance

Loss insurance is a business that provides various services in overcoming the risk of loss and loss of benefits and legal liability to third parties arising from uncertain events (Soemitra, 2009). Examples include fire insurance, transportation insurance, and miscellaneous insurance.

b. Life Insurance

Life insurance is an effort to provide risk management related to life (risk of death, risk of old age, and risk of accidents) or the death of someone who is insured (Nopriansyah, 2016).

c. Reinsurance

Reinsurance is reinsurance or insured coverage, in other words, the insurance of insurance.

In addition, insurance business activities can also be in the form of unit investment insurance (unit linked) which is a form of collective investment offered through insurance policies. In essence, in sharia insurance business activities there is a behavior of mutual responsibility, help, and protection among the participants themselves. The process related to sharia insurance business activities can be described as follows (Soemitra, 2009).

a. Underwriting

Underwriting is a selection process carried out by life insurance companies to determine the level of risk that will be accepted and determine the acceptance or rejection of the application of prospective participants (policyholders).

b. Policy

The insurance policy is a letter of agreement between insurance participants and insurance companies, where in sharia insurance there must be *ijab* and *qabul*.

c. Premium (Contribution)

Premiums or in sharia referred to as contributions are a sum of money that must be paid by insurance participants to bind the manager's obligation to pay compensation for the occurrence of risk. Generally, Islamic insurance premiums are divided into three, namely savings premiums, *tabarru' premiums*, and cost premiums. (Astuti & Rahayu, 2019).

d. Management of Insurance Funds (Premiums)

The management of insurance funds can be carried out with *mudharabah*, *mudharabah musytarakah*, or *wakalah bil ujah* contracts.

e. Sharia Insurance Business Investment

The investment of Islamic insurance companies has the main objective of obtaining high returns with a low level of risk in order to fulfill obligations to policyholders (claim payers) and for company growth (Suparmin, 2019).

f. Claim

Claims are the rights of insurance participants that must be given by insurance companies in accordance with the initial agreement in the contract taken from the *tabarru'* funds of all participants (Amrin, 2006).

g. Insurance Closure

Insurance closure is an insurance agreement that ends because the validity period is completed or canceled before the agreement ends (Soemitra, 2009).

In sharia insurance, generally the contracts that underlie it are *tabarru'* contracts and *tijarah* contracts. *Tabarru'* contracts are all forms of contracts with the purpose of kindness and help, not for commercial purposes. Meanwhile, *tijarah* contracts are all forms of contracts with commercial purposes, such as *mudharabah*, *wadiah*, and *wakalah*.

a. Mudharabah Agreement

In this contract, the insurance company acts as a manager (*mudharib*) and participants as policyholders (*shahibulmal*) based on the principle of profit and loss sharing (Nopriansyah, 2016).

b. Wakalah Agreement

This agreement is the authorization of insurance participants to insurance or reinsurance companies to manage insurance participant funds and / or other activities (Nopriansyah, 2016).

c. Al-Wadiah Agreement

This agreement authorizes the other party to take care of his property by expressing or signaling the meaning of this (Amrin, 2006). In Islamic insurance, this contract is applied to life insurance.

d. Musyarakah Agreement

This is an agreement between two or more parties in carrying out a certain business, where each party contributes to the other (Sula, 2004).

2. Sharia Insurance Legal Regulations

Basically, there are two major categories of the legal basis of Islamic insurance, namely the legal basis in the form of revelation (Al-Quran and Hadith) and various non-revelation legal bases which are *ijtihad*. In Indonesia, the legal basis of Islamic insurance can be sorted as follows.

a. The Quran

The term insurance is not clearly mentioned in the Quran, but the verses in the Quran explain the basic values of insurance, including cooperation, help, and the recommendation to eliminate the difficulties of fellow human beings. (Nopriansyah, 2016).

1) Allah's Command to Help Each Other

- **Surah al-Maidah (5) verse 2**

"And help each other (in doing) righteousness and piety, and do not help each other in sin and transgression, and fear Allah, surely Allah is severe in His punishment."

- **Surah al-Baqarah (2) verse 185**

"...Allah wants ease for you, and does not want hardship for you..."

2) The Command to Trust and Always Try

- **Surah at-Taghaabun (64) verse 11**

"...no calamity befalls a servant except by the permission of Allah..."

- **Surah al-Luqman (31) verse 3**

"Verily, Allah, with Him alone is the knowledge of the Hour; and it is He who sends down the rain, and knows what is in the womb, and no one can know (with certainty) what he will do tomorrow, and no one can know on which earth he will die. Verily, Allah is All-Knowing, All-Knowing."

3) Commandment to Prepare for the Future

- **Surah al-Hasyr (59) verse 18**

"O you who believe, fear Allah and let each one of you consider what he has done for tomorrow (hereafter); and fear Allah ..."

- **Surah Yusuf (12) verses 46-49**

"(When the fisherman met Joseph, he said): "Joseph, O man of great trust, tell us about the seven fat cows which are eaten by seven lean cows and the seven green ears of grain and the seven dry ones, that I may return to the people and they may know. Joseph said: "So that you may endure seven years as is customary, then what you reap you shall leave in the ears except a little for you to eat; then after that there will come seven very hard years, which will consume what you have stored up for them (hard years), except a little of what you have stored up. Then after that will come a year in which it rains (sufficiently) and in which they press wine."

b. Al-Hadis

1) Hadith about the Recommendation to Relieve a Person's Difficulty

"Whoever makes it easy for a person in difficulty (debt), Allah will make it easy for him in this world and the Hereafter." (H.R. Muslim)

2) Hadith about Avoiding Risks

"A man said: "O Messenger of Allah, should I tie it up and put my trust in it, or should I let it go and put my trust in it?" He replied: "Tie it up and put your trust in it." (H.R. Ibn Hibban)

3) Hadith about Covenants

"Making peace with one's fellow Muslims is permissible except for making peace that makes lawful or unlawful. And the Muslims should fulfill the terms they have agreed upon except those which make lawful or forbidden." (H.R. Bukhari)

4) Hadith about the Prophet's recommendation to leave wealth for the heirs

"Indeed, if you leave your heirs rich, it is better than if you leave them poor so that they are forced to beg their fellow human beings." (H.R. Bukhari)

c. Applicable Laws and Regulations

There are a number of other laws and regulations that are directly or indirectly related to insurance in general and Islamic insurance in particular. (Suma & Amin, 2021).

- 1) Undang-Undang RI No. 21 Tahun 2011 on the Financial Services Authority;
- 2) Undang-Undang RI No. 40 Tahun 2014 concerning Insurance;
- 3) POJK No. 56/POJK.05/2017 on the Second Amendment to POJK on Investment in Government Securities for Non-bank Financial Services Institutions;
- 4) POJK No. 55/POJK.05/2017 concerning Periodic Reports of Insurance Companies;
- 5) POJK No. 17/POJK.05/ 2017 concerning Procedures and Procedures for Imposing Administrative Sanctions in the Insurance Sector and Blocking the Assets of Insurance Companies, Sharia Insurance Companies, Reinsurance Companies, and Sharia Reinsurance Companies;
- 6) POJK No. 73/POJK.05/2016 concerning Good Corporate Governance Practices for Insurance Companies;
- 7) POJK No. 72/POJK.05/2016 concerning Financial Health of Insurance Companies and Reinsurance Companies with Sharia Principles;
- 8) POJK No. 70/POJK.05/2016 concerning the Business Implementation of Insurance Brokerage Companies, Reinsurance Brokerage Companies, and Insurance Loss Assessors;
- 9) POJK No. 69/POJK.05/2016 concerning the Business Implementation of Insurance Companies, Sharia Insurance, Reinsurance Companies and Sharia Reinsurance Companies;
- 10) POJK No. 68/POJK.05/2016 concerning Licensing of Companies and Institutions of Insurance Brokerage Companies, and Insurance Loss Assessment Companies;

- 11) POJK No. 67/POJK.05/2016 concerning Business Licensing and Institutionalization of Insurance Companies, Sharia Insurance Companies, Reinsurance Companies, and Sharia Reinsurance Companies;
- 12) UU RI No. 8 Tahun 2019 concerning the Implementation of Hajj and Umrah;
- 13) Peraturan Pemerintah RI No. 79 Tahun 2012 on the Implementation of Law No. 13 of 2008 on the Implementation of Hajj;
- 14) Peraturan Menteri Agama RI No. 8 Tahun 2018 concerning the Implementation of Umrah Worship;
- 15) Keputusan Menteri Agama RI No. 221 Tahun 2018 concerning the Cost of Organizing Umrah; and
- 16) Keputusan Direktur Jenderal Penyelenggaraan Haji dan Umrah Nomor 232 Tahun 2019 concerning Guidelines for Registration of Umrah Pilgrims.

d. Fatwa of the National Sharia Council of the Indonesian Ulema Council (DSN-MUI)

- 1) DSN Fatwa No. 21/DSN-MUI/X/2001 concerning General Guidelines for Sharia Insurance;
- 2) DSN Fatwa No. 39 /DSN-MUI/X/2002 concerning Hajj Insurance;
- 3) Fatwa DSN No. 51/DSN-MUI/X/2006 concerning *Mudharabah Musytarakah* Agreements in Sharia Insurance;
- 4) DSN Fatwa No. 52/DSN-MUI/X/2006 concerning *Akad Wakalah bil-Ujrah* in Sharia Insurance and Reinsurance;
- 5) Fatwa DSN No. 53/DSN-MUI/X/2006 concerning *Tabarru'* Agreements in Sharia Insurance and Reinsurance;
- 6) Fatwa DSN No. 81/DSN-MUI/X/2011 on the Return of *Tabarru'* Contributions for Insurance Participants who Quit Before the Agreement Period Ends;
- 7) Fatwa No. 106/DSN-MUI/III/2016 concerning Waqf of Insurance Benefits and Investment Benefits in Sharia Life Insurance;
- 8) Fatwa Dewan Syariah Nomor 123/DSN-MUI/XI/2018 concerning the Use of Funds that Should Not Be Recognized as Revenue for Sharia Financial Institutions, Sharia Business Institutions, and Sharia Economic Institutions.

e. Religious Regulations and Other Government Regulations

D. Profile of Islamic Insurance Institution

1. Company Profile of PT Asuransi JMA Syariah



PT Asuransi Jiwa Syariah Jasa Mitra Abadi Tbk, or JMA Syariah, is a sharia life insurance company that was established at the initiative of KOSPIN JASA and people who are active in the Indonesian Cooperative economy. The main objective of establishing JMA Syariah is to invite and serve the community in managing their financial aspects through the principles of sharia economy. Their head office is located at Graha Kospin JASA, 5th Floor, Jl. Jend. Gatot Soebroto Kav. 1, South Jakarta, [12870](#), Indonesia.

2. History of PT Asuransi JMA Syariah

On August 15, 2014, JMA Syariah was established based on deed No. 22 issued by a Notary. Subsequently, the company was ratified along with the last amendment deed number 102 on June 26, 2015.

JMA Syariah has also obtained authorization from the Otoritas Jasa Keuangan (OJK) with number KEP-96/D.05/2015 in September 2015, allowing them to operate as a sharia life insurance company.

3. Vision of PT Asuransi JMA Syariah

"Becoming the Pride of Indonesian Sharia Insurance."

4. Mission of PT Asuransi JMA Syariah

- a. Providing All the Needs of the Community in Insurance.
- b. Contributing to the Islamic Insurance Industry in Indonesia.
- c. Providing Better Value Benefits for All Stakeholders.

5. PT Asuransi JMA Syariah Products

a. Individual JMA

This product offers sharia financial planning solutions for individuals through protection and investment products. The goal is to provide peace of mind and create silaturahmi and sharing among customers.

1) JMA Ilma

It is education insurance for children with policyholder compensation in the event of their child's death.

2) JMA Mumtaza

It is an individual life insurance with elements of savings and financial protection.

3) JMA Asyifa

It is an individual health insurance with reimbursement of treatment costs.

4) JMA Salama

It is a simple micro insurance with benefits for beneficiaries.

5) JMA Aghnia

An investment insurance with death benefit.

b. JMA Collection

This product is aimed at companies, government agencies, non-government organizations, and communities. It provides life insurance and medical expenses for employees, officers, organization members, and volunteers.

1) JMA Financing Partner

It is an insurance that gets the remaining loan or financing if the participant dies.

2) JMA Fixed Finance

This is insurance that pays the initial benefit without taking into account installment arrears.

3) JMA MSE Financing

It is an insurance that gets the remaining principal financing with a fixed (proportional) decrease in the remaining principal loan.

4) JMA Karima

Life and accident insurance for educational institutions.

5) JMA Sejahtera

This is pension insurance for employees.

6) JMA Asyifa Care

It is a group health insurance with various benefits.

CONCLUSION

Sharia insurance is an insurance product that is managed sharia and supervised by the National Sharia Council of the Majelis Ulama Indonesia (DSN-MUI). The development of sharia insurance lately is considered quite happy, because the number of sharia insurance companies that have been established, whether business units or not, has opened the view of the community to facilities that are increasingly easy. Even foreign companies are targeting Indonesia as the largest market because it has a large number of Muslims.

The function of Islamic insurance is actually the same as conventional insurance. The functions of Islamic insurance include being managed in accordance with Islamic sharia

principles, transparent fund management, profit from investment shared with participants, ownership of funds by two parties, namely the company and participants, contribution funds are not forfeited even though there are no claims, and underwriting surplus benefits. The main purpose of sharia insurance itself is not to obtain large profits, but to seek profits to improve the welfare and struggle of the people.

Sharia insurance business activities based on Undang-Undang Nomor 2 Tahun 1992 concerning Insurance Business include liability insurance, life insurance, and reinsurance. Islamic insurance law basically has two broad categories, namely the legal basis in the form of revelation (Al-Quran and Hadith) and various non-revelation legal bases which are *ijtihad*. One of the relevant company profiles is PT Asuransi JMA syariah. This bank was established on August 15, 2014. JMA Syariah was established based on deed No. 22 issued by a Notary. Subsequently, the company was authorized along with the last amendment deed with number 102 on June 26, 2015.

REFERENCE

- Ali, Z. (2023). *Hukum Asuransi Syariah*. Sinar Grafika.
- Amrin, A. (2006). *Asuransi Syariah: Keberadaan dan Kelebihannya di Tengah Asuransi Konvensional*. PT Elex Media Komputindo.
- Astuti, Y., & Rahayu, Y. (2019). *Layanan Lembaga Keuangan Syariah*. PT Gramedia Widisiarna Indonesia.
- Kartika, R. F. (2022). *Pengembangan Peraturan Perundang-Undangan Asuransi Syariah dalam Hukum Nasional*. Wawasan Ilmu.
- Mardianto, D., & Dkk. (2022). *Pengantar Ekonomi Islam*. Sada Kurnia Pustaka.
- Muchlis, M. M. (2023). Sejarah Perkembangan Asuransi Syariah Serta Perbedaannya dengan Asuransi Konvensional di Indonesia. *SINOMIKA Journal*, 1(6), 1489–1498.
- Muljaningsih, S., & Perdana, P. (2021). *Bank dan Lembaga Keuangan Lain di Indonesia*. Penerbit Mitra Cendekia Media.
- Nopriansyah, W. (2016). *Asuransi Syariah: Berkah Terakhir yang Tak Terduga*. ANDI Offset.
- Oktayani, D. (2018). Konsep Mohon Bantuannya dalam Asuransi Syariah. *Iqtishaduna: Jurnal Ilmiah Perekonomian Kita*, 7(1), 39–50.
- Profil Perusahaan*. (2023). Published 2023. Accessed September 20, 2023. <https://www.jmasyariah.com/>
- Rosidah, N. H. (2010). Asuransi Konvensional dan Asuransi Syariah: Perbedaan dalam Lingkup Akuntansi. *Universitas Negeri Surabaya*.
- Siddiq, M. (2017). Kedudukan Asuransi dalam Hukum Islam. *Islamic Banking: Jurnal Pemikiran Dan Pengembangan Perbankan Syariah*, 2(2), 44–55.
- Soemitra, A. (2009). *Bank dan Lembaga Keuangan Syariah* (Edisi 2). KENCANA.
- Subagiyo, D. T., & Salviana, F. M. (2016). *Hukum Asuransi*. PT. Revka Petra Media.
- Suhawan. (2020). *Pengetahuan Asuransi di Indonesia*. CV Cendekia Press.
- Sula, M. S. (2004). *Asuransi Syariah (Life and General): Konsep dan Sistem Operasional*. Gema Insani Press.
- Sulaeman, M. M., Wahyudi, I., Cahyono, P., Noval, M., Umah, K. A., Amin, R., Virana, T. A., Haerany, A., & Potton, Z. (2023). *Asuransi Syariah* (D. P. Sari (ed.)). PT. Global Eksekutif Teknologi.
- Suma, M. A., & Amin, I. Q. (2021). *Asuransi Syariah di Indonesia: Telaah Teologis, Historis, Sosiologis, Yuridis, dan Futurologis*. AMZAH.
- Suparmin, A. (2019). *Asuransi Syariah: Konsep Hukum dan Operasionalnya*. Uwais Inspirasi Indonesia.

- Syadali, A., & Mudzakir. (1997). *Filsafat Umum* (M. A. Djaliel (ed.)). CV. Pustaka Setia.
- Thohari, F. (2023). *Islam Prespektif Mu'amalah dan Akhlaq-Tasawuf*. Jejak Pustaka.
- Umam, K. (2021). *Transformasi Lembaga Keuangan Konvensional ke dalam Lembaga Keuangan Syariah*. Gadjah Mada University Press.
- Zaini, M. A. (2015). Aspek Syariah dalam Asuransi Syariah. *Iqtishoduna: Jurnal Ekonomi Islam*, 4(2), 166–188.

SHARIA PENSION FUNDS

Laila KHOLISA
Lizianil AZIZAH
Aulia Nailis SLAMAH
Ria Annisatus SOLIHAH

Faculty of Economics and Islamic Business, State Islamic University K.H. Abdurrahman Wahid
Pekalongan Indonesi

ABSTRACT

A pension fund is a collection of assets managed and operated by an institution to produce a pension benefit, namely a periodic payment that is paid to participants at the time and in the manner specified in the provisions that form the basis for administering the pension program where the payment of the benefit is linked to the attainment of age. certain. Meanwhile, sharia pension funds are pension funds that organize pension programs based on Sharia Principles (DSN MUI Fatwa Number: 88/DSN-MUI/XI/2013). The function of pension funds is as insurance, savings and retirement. The main purpose of pension funds is to provide savings for future retirement. One relevant company profile is DPLK Bank Muamalat. This research aims to find out more about Sharia Pension Funds. This research uses a qualitative approach by utilizing in-depth analysis of secondary data from various related literature sources, to understand the perspectives and concepts underlying sharia insurance. The data collection technique in this research uses literature study techniques to obtain a theoretical basis in the form of opinions or writings of legal experts, ulama and other authorized parties, regarding sharia insurance guidelines in Indonesia. This research is descriptive analytical in nature to describe or analyze research results but is not used to make broader conclusions.

Keywords: pension fund, Financial institutions

INTRODUCTION

Background

As creatures created by Allah SWT, every human being will definitely have an old age. Where in old age we no longer have the strength to work, no longer have an income and most of us only rely on gifts from our children and grandchildren. However, this is not the dream of old age for every human being. Everyone wants prosperity in their life while still actively working or when entering old age or retirement. Retirement is a period when a person stops working because they have reached a certain age or condition, so they must be dismissed or at their own request. A person who has retired will not receive income in the form of wages/salary received every month, but is entitled to the rights he received in the form of

pension funds or severance pay from the company where he last worked. In retirement, everyone wants certainty and assurance that their economic prosperity will continue while they are not working. Pension Fund products are one alternative to overcome this solution. The implementation of the Pension program as a solution to problems in society, whether employees or the community at large, to minimize or reduce the risks that could be faced in the future, such as loss of work, old age, accidents that result in physical disability or death (Johar Arifin, 2007). Law no. 11 of 1992 is the basic law for pension funds in Indonesia. This law is based on the principle of "freedom to make promises and the obligation to fulfill them", that is, even though the establishment of a pension program is voluntary, the rights of the beneficiaries must be guaranteed. The main objective of proposing the Pension Law is to determine the rights of participants, and provide regulatory standards that can guarantee the receipt of pension benefits on time, to ensure that pension benefits are used as a sustainable source of income for retirees, to provide appropriate arrangements for funds. pension, to encourage the mobilization of savings in the form of term pension funds long term, and to ensure that pension funds are not held and used by employers for investments that may be risky and unhealthy, but will flow to financial markets and are subject to requirements regarding risk management. Sharia pension funds need to be introduced massively to the public so that they understand the philosophy of sharia banking in general and sharia pension funds in particular along with the support of the Indonesian people, who are predominantly Muslim. This could be the first step to get people interested in sharia pension fund programs. Sharia pension fund institutions have received legal legality with the issuance of a fatwa from the National Sharia Council of the Indonesian Ulema Council Number 88/DSN-MUI/XI/2013 concerning general guidelines for implementing pension programs based on sharia principles.

DISCUSSION

Understanding Sharia Pension Funds

A pension fund is a collection of assets managed and operated by an institution to produce a pension benefit, namely a periodic payment that is paid to participants at the time and in the manner specified in the provisions that form the basis for administering the pension program where the payment of the benefit is linked to the attainment of age. certain. In other words, pension funds are a form of savings, more specifically savings for retirement (Sanrego, 2015). Meanwhile, sharia pension funds are pension funds that organize pension programs based on Sharia Principles (DSN MUI Fatwa Number: 88/DSN-MUI/XI/2013) (Iqbal, 2020). Sharia pension funds are legal entities that manage and run programs that promise benefits based on sharia principles. The slow but steady growth of Indonesian financial institutions also

encourages the development of pension funds that operate in accordance with sharia principles. Until now, sharia pension funds have developed into Financial Institution pension funds (DPLK) which are implemented by several banks and sharia insurance. Sharia pensions are sharia financial institutions that have the characteristics of being able to be used to maintain the continuity of a person's income when entering retirement. If you look at its function, there is no difference between conventional and sharia pension funds because both have the same aim of maintaining sustainable income when entering retirement. The difference between conventional and sharia pension funds of course lies in the principles used. Sharia pension funds use sharia contracts in their operational activities, such as using contracts when becoming a participant or paying contributions. Apart from that, sharia pension funds also pay close attention to sharia principles such as not containing elements of *maisir*, *gharar* and *usury*. The first sharia pension fund approved by the OJK was the Muamalat Syariah Financial Institution Pension Fund (DPLK) in 2017. In the same year, the sale of sharia investment packages from DPLK Mandiri was also approved. In the following year, OJK authorized the sale of sharia investment packages from DPLK BNI and the Jakarta Islamic Hospital Sharia Pension Fund. Ohhiya friends, apart from the management and supervisory board which handles business operations and supervision, pension funds are also supervised by the Sharia Supervisory Board (DPS). Based on the scheme, sharia pension funds involve four main parties, namely the employer (*wahib*), the investee, participants (*mauhub lah*), and retirees/heirs. In general, there is nothing different between Sharia pension fund schemes and conventional pension funds, but the main difference is that every transaction in Sharia pension funds uses a sharia contract. For example, the *bi syarth grant* and *muqayyadah grant* contracts are contracts used by employers for participants in terms of paying pension contributions. In the context of delegation of authority activities in return for services/fees to a third party, a *wakalah bil ujah* contract or *mudharabah* contract is used, however, if the pension fund uses a third party, the pension fund can use an *ijarah* contract. Based on Law Number 11 of 1992 concerning the administration of pension funds, it is based on the following principles, namely:

1. he principle of separateness of pension fund assets from the assets of the founding legal entity. Pension funds are supported by separate laws and are managed based on statutory provisions. Based on this principle, pension fund wealth which primarily comes from contributions is protected from undesirable things that could happen to the founder.
2. **Basic maintenance in the funding system.** The administration of pension funds based on this Principle, for both employees and self-employed workers, must be managed by

cultivating funds separately from the founder's assets so that they are sufficient to meet the payment of participants' rights. Thus, the formation of reserves within the company to finance the payment of employee pension benefits is not permitted.

3. Basic construction and supervision. In order to ensure that the use of interests can result in not achieving the main purpose of the non-funding community, namely fulfilling the rights of participants, it is necessary to provide guidance and supervision. Guidance and supervision includes the funding system and supervision of pension fund wealth investments.

4. Principle of postponement of benefits

The maintenance of the pension fund program is meant so that the Income that is the right of the participants, then the basis of the deferral of benefits that requires the payment of the rights of successful participants can be done after the participants retire whose payments are made periodically.

5. Basis of Freedom To form or not Form a Pension Fund. The formation of a pension fund is done on the initiative of the employer to promise pension benefits. The consequence of funding and financing is a commitment that must be made until the moment the pension fund has to be liquidated. (Setiawan, 2017).

History of Sharia Pension Funds

Pension funds in Indonesia became known in 1957, when the government established the Civil Servant Pension Fund Foundation (YDPPNS) as an institution that manages pension funds for civil servants. YDPPNS then changed its name to Taspen in 1963. In 1977, the government also formed Asabri as an institution that manages pension funds for members of the TNI and Polri. In 1986, the government issued Presidential Decree No. 29 of 1986 concerning the Old Age Security Program (JHT) which is part of the Social Security Program for Workers (Jamsostek). This JHT program provides pension benefits to private workers who are registered as Jamsostek participants. In 1992, the government passed Law No. 11 of 1992 concerning Pension Funds which regulates in more detail the types, conditions, supervision and sanctions related to pension funds in Indonesia.

According to Law No. 11 of 1992, pension funds in Indonesia are divided into three types, namely:

1. Employer Pension Fund (DPPK),

namely a pension fund established by the employer for the benefit of its employees. DPPK can take the form of defined benefits or defined contributions. A defined benefit is a pension program that guarantees the amount of benefits that participants will receive based on a certain formula that is determined from the start. A defined contribution is a pension program

where the amount of benefits depends on the contributions paid and the results of fund development.

2. Financial Institution Pension Fund (DPLK), namely a pension fund established by financial institutions such as banks, insurance or securities companies to offer pension programs to the general public. DPLK can only take the form of a defined contribution.

3. Profit Based Pension Funds (DPBK), namely pension funds established by parties other than employers or financial institutions to offer pension programs to the general public. DPBK can also only be in the form of defined contributions.

Functions and Objectives of Sharia Pension Funds

The functions of the pension fund program for participants include:

1. Insurance, namely participants who die or become disabled before reaching retirement age can be given liability money for shared expenses from the pension fund

2. Savings, namely the collection of participant contributions and employer contributions which constitute savings for and on behalf of the participants themselves. Contributions paid by employees can be seen every month as savings from the participants.

3. Pension, namely the entire Surakarta association and employer contributions as well as the results of its management, will be paid in the form of benefits for the first month of retirement age for life, and for participant widows/widowers. (Soemitra, 2017)

The objectives of holding a retirement week, both in the interests of the company, participants and pension management institutions, can be:

1) Company

- Moral obligation, where the company has a moral obligation to provide employees with a sense of security for the future because they will still have an income when they reach retirement age.
- Loyalty, employees are expected to have a company and increase employee motivation in carrying out daily tasks
- Labor market competition, where companies will have the power to get qualified and professional employees in the labor market.
- Give appreciation to employees who have served the company.
- So that at retirement age the employee can still enjoy the results obtained after working at his company.
- Improve the company's image in the eyes of the public and government.

2) Participants

- The participants feel secure about the future because they will still have problems when they reach retirement age
- Better compensation, that is, participants have additional compensation, although it can only be enjoyed when they reach retirement age / stop working

3) Administration of pension funds

- Manage pension funds to obtain profits
- Help and support government programs
- As a social service to the participants

Business Continuity and Legal Regulations of Syariah Pension Funds

1. Business Activities Pension fund programs in Indonesia are implemented by government and private institutions. Implementation of government pension funds in Indonesia includes Jamsostek, a mandatory fixed contribution program for private and state-owned employees under the Ministry of Manpower and Transmigration. However, the Ministry of Finance plays a role in its supervision (Law No. 3/1992). Taspen, namely civil servant pension savings and private pension programs which are responsible for the Ministry of Finance (Presidential Decree No. 8/1997). and ASABRI, the armed forces pension fund, is under the Ministry of Defense (Presidential Decree No. 8/1977). These three programs are regulated through different legal provisions. Pension Fund Law no. 11 of 1992 is the basic legal framework for private pension funds in Indonesia. This law is based on the principle of "freedom to make promises and the obligation to fulfill them, namely, although the establishment of a pension program is voluntary, the rights of beneficiaries must be guaranteed. The main purpose of proposing the Pension Law is to determine the rights of participants, provide regulatory standards, which can guarantee the timely receipt of pension benefits, to ensure that pension benefits are used as a sustainable source of income for retirees, to provide appropriate arrangements for pension funds, to encourage the mobilization of savings in the form of long-term pension funds, and to ensure that such funds are not held and used by entrepreneurs for investments that may be risky and unhealthy, but will flow to financial markets and are subject to risk management requirements. Meanwhile, for the operational legal basis for sharia pension funds, in the regulatory context, for example. If banking, insurance, bonds and sharia mutual funds already have many regulations and support from DSN-MUI fatwas, this is different with sharia pension funds, according to a Sharia Economics consultant, who is also a practitioner, Izzuddin Abdul Manaf, Lc. MA There is not a single supporting regulation or fatwa yet. So the regulations as an operational framework for sharia pension funds only refer

to general pension fund regulations and MUI fatwas which are also general, not specific. This is also one of the factors in the slow growth of sharia pension funds in Indonesia. According to Law No. 11 of 1992 concerning pension funds, types of pension funds consist of:

- a. Employer Pension Fund (DPPK); and/or
- b. Financial Institution Pension Fund (DPLK).

What is meant by employer pension fund is a pension fund established by a person or entity employing its employees, as the founder, to administer a defined benefit pension program or defined contribution pension program, for the benefit of some or all of its employees as participants, and which creates obligations towards the employer. . Thus, this type of pension fund is provided directly by the employer. The founder of the DPPK must obtain approval from the minister of finance. What is meant by a financial institution pension fund (DPLK) is a pension fund established by a bank or life insurance company to provide a defined contribution pension program for individuals, both employees and self-employed workers, which is separate from the employer's pension fund for bank or life insurance company employees. concerned. For people who work independently, such as doctors, farmers and fishermen, it is possible to take advantage of DPLK. It is possible for employees in a company to be able to utilize DPLK according to their abilities. The establishment of a DPLK by a bank or life insurance company must obtain approval from the minister.

2. Legal Regulations for Sharia Pension Funds

The legal basis for Pension Fund Institutions in Indonesia is contained in Law Number 11 of 1992 concerning Pension Funds; Government Regulation Number 76 of 1992 concerning Employer Pension Funds; and Government Regulation Number 77 of 1992 concerning Financial Institution Pension Funds (Norman & Pahlawati, 2021). In the Pension Fund Law No. 11 of 1992, it is stated that the existence of the Pension Fund is intended to ensure continued income for workers after retirement (entering retirement age). As a legal entity that manages wealth and runs a pension program promising pension benefits to maintain sustainable income for its participants during the post-employment period, Pension Funds are very vulnerable to risk. Risk can generally be defined as the possibility of material and immaterial losses, which arise directly or indirectly and have an impact on the company's finances now and in the future. In the context of Pension Fund management, the risk faced is the problem of insufficient funds which in turn can disrupt the fulfillment of the Pension Fund's obligations to pay participants' rights to receive pension benefits (Norman & Pahlawati, 2021). The provisions are also stated in the National Sharia Council Fatwa Number 88/DSNMUI/XI/2013 concerning General Guidelines for Organizing Pension Programs

Based on Sharia Principles. Based on these regulations, the principles for managing old age benefits refer to Islamic law or Fatwa from the MUI through the DSN. The Financial Services Authority (OJK) also regulates this management in OJK Regulation No.33/POJK.05/2016 concerning the Implementation of Pension Programs based on Sharia Principles. (Nastiti, 2022).

Management of pension funds in accordance with Islamic teachings will have many benefits for society, especially people who are loyal to sharia and are afraid of violating Islamic teachings. The Qur'an teaches Muslims not to abandon weak communities and teaches the concept of mutual cooperation and mutual help, as mentioned in the Qur'an, Surah Al Hasyr 18. Regulation of the financial services authority number /poj.05/2016 regarding the implementation of the pension program based on Shariah principles, Contracts contained in the Shariah Pension Fund:

- a. Hibah bi syarth:** This contract is used between employers and participants in terms of payment of contributions
- b. Muqayyadah grant:** the use of bi syarth grant contracts and muqayyadah grants has the same use, namely for employers and participants in terms of payment of contributions.
- c. Come on:** used between employers or participants and pension funds that organize pension programs based on sharia principles.
- d. Wakalah ujarah bill:** used between employers or participants and Pension Funds that organize Pension Programs Based on Sharia Principles.
- e. Mudharabah:** used by Pension Funds that organize Pension Programs Based on Sharia Principles with investment managers.
- f. Ijarah:** used by Pension Funds that organize Pension Programs Based on Sharia Principles with actuaries, custodian banks, investment advisors and/or public accountants.

Relevant Institution Financial institution pension fund (DPLK) Bank Muamalat 1. History Bank Muamalat Indonesia (BMI) is the first commercial bank in Indonesia to apply Islamic Sharia principles in carrying out its operations. BMI was founded in 1992 with the initiative of the Indonesian Ulema Council (MUI) and the Indonesian government as well as support from Muslim scholars, entrepreneurs and the wider community. Along with the growth of sharia banking in Indonesia, BMI sees that the public's need for sharia institutions is not only limited to bank financial institutions but also non-bank financial institutions. Therefore, in 1997 BMI established the Muamalat Financial Institution Pension Fund (DPLK), which is a non-bank financial institution that specifically manages pension programs with the Defined Contribution type, so that people can take advantage of this pension savings program/product

to prepare for a more prosperous old age. . PT Bank Muamalat Indonesia, Tbk has a subsidiary which operates in the pension fund sector, namely the Financial Institution Pension Fund (DPLK). DPLK Muamalat was founded by PT. Bank Muamalat Indonesia on 12 September 1997 with Minister of Finance Decree No.KEP-485/KM.17/1997. DPLK Muamalat is the first DPLK and to date is the only sharia DPLK in Indonesia. DPLK Muamalat is a pension fund program established by Commercial Banks/Life Insurance companies to provide a Defined Contribution Pension Program (PPIP) for individuals, both employees and self-employed workers. At the end of April 2015 The total Net Asset Value of DPLK Muamalat reached more than IDR 787 billion with a total of 134,330 DPLK participants. DPLK Muamalat respects the needs of each company which may be different. Therefore, by continuing to comply with applicable regulations, the DPLK Muamalat Pension Program can be adjusted (flexible) to the company's circumstances or needs. For example, in accordance with Employment Law No.13/2003. With the support of Bank Muamalat's network spread across 33 provinces in Indonesia, DPLK Muamalat is ready to provide services at every outlet for registration, deposits and payment of pension benefits at a later date.

2. Vision and Mission

a. Faces DPLK Muamalat's Vision: To become the first Sharia DPLK that prioritizes transparency, togetherness, and customer satisfaction with sharia-compliant transactions.

b. Mission

- Develop information systems and services that are fast, easy, innovative and high quality.
- Providing competitive investment results as a form of professionalism in DPLK management.

3. Products and programs

a) Muamalat protected pension

Muamalat Protected Pension is an old-age savings plan that promises pension benefits equal to accumulated contributions plus accumulated development results based on the results of fund management according to the participant's choice of investment type. The Muamalat Protected Pension Product is also a long-term investment product with insurance cover facilities. The insurance programs that are combined are the Personal Accident Insurance Program in the form of reimbursement for hospitalization costs due to accidents during the first year of the membership period and the Insurance Program Soul in the form of member compensation for the heirs if the participant dies during the membership period. The Personal Accident Insurance Program is intended for every participant and is automatically effective

from the time they become a Muamalat Protected Pension participant, while the Life Insurance Program is intended for participants who want their projected retirement benefits to be Protected, effective from the time of acceptance from the Insurance Party with the obligation to pay Insurance Premiums every month.

b) Employee pension management program

Companies or entrepreneurs who want to provide pension program facilities can go through the DPLK Muamalat defined contribution pension program (PPIP). The percentage of contribution between company subsidies and employee contributions is determined according to the policies and regulations in force at the Company which have been agreed upon by the employees.

c) Pension program for severance compensation

Program objectives

- As a means for companies to fund obligations towards severance pay.
- Helps companies manage and reduce financial and cash flow risks – there is no longer any hesitation in applying full offsets for all cases of layoffs, monthly payments and delays in benefit payments.
- Provide guarantees for the fulfillment of employee rights in the event of layoffs.

Legal basis

- Provisions regarding severance pay based on Law no. 13 of 2003 concerning Employment (UUK-13).
- Provisions regarding DPLK based on Law no. 11 of 1992 concerning Pension Funds and Government Regulation no. 77 of 1992 concerning Financial Institution Pension Funds and Pension Fund Regulations (PDP) for each DPLK as well as other implementing regulations.

Management and Administration

- Management of the severance pay program by DPLK is carried out based on the pooled fund principle.
- Funding comes from the Employer only.
- Companies are required to provide data on employees who are included in the severance pay program, along with any changes thereto.
- Payment of severance pay can only be made based on company orders and can only be paid to employees whose names are registered in the DPLK administration.
- At the time of payment, the DPLK manager is required to provide detailed calculations of the amount of severance pay to participants and a copy of it to the company.
- Severance pay claims can be paid in one lump sum (at any amount)

Conclusion

Sharia pension funds are pension funds that organize pension programs based on Sharia Principles (DSN MUI Fatwa Number: 88/DSN-MUI/XI/2013). Based on the scheme, sharia pension funds involve four main parties, namely the employer (wahib), the investee, participants (mauhub lah), and retirees/heirs. In general, there is nothing different between Sharia pension fund schemes and conventional pension funds, but the main difference is that every transaction in Sharia pension funds uses a sharia contract. Based on law number 11 of 1992, the administration of pension funds is based on several principles, namely the principle of separateness of pension fund assets from the assets of the founding legal entity, the principle of administration in the funding system, the principle of guidance and supervision, the principle of delaying benefits, and the principle of freedom to form or not to form pension fund. The objectives of organizing pension funds for companies include moral obligations, loyalty, labor market competition, giving awards to employees who have served the company, so that at retirement age these employees can still enjoy the results obtained after working at the company, as well as improving the image. company in the eyes of society and government. Meanwhile, the aim of pension funds for participants is a sense of security for the future, as well as better compensation. Then the last one is the purpose of pension funds for pension fund administrators, including managing pension funds to obtain profits, helping and supporting government programs, as well as providing social service to participants. The functions of the pension fund program for participants include insurance, savings and retirement. According to Law No. 11 of 1992 concerning pension funds, the types of pension funds consist of Employer Pension Funds (DPPK) and Financial Institution Pension Funds (DPLK). The contracts used in sharia pension funds include Bi Syarth Grants, Muqayyadah Grants, Wakalah, Wakalah Bil Ujrah, Mudharabah, and Ijarah. Management 15 Pension funds use a Mudharabah agreement, namely a business cooperation agreement between a sharia pension fund and another party, the sharia pension fund as Shahibul Mal, the other party as Mudharib (manager) and profits are shared according to the agreed ratio. The development of sharia pension funds is relatively lagging behind when compared to other sharia financial industries. This occurs partly due to the lack of strategic and regulatory support. In the context of industrial development strategy, while banking, insurance and sharia capital markets already have and are included in their respective industry development strategy road maps, sharia pension funds have not been touched in the slightest in the policies and development strategies for the Pension Fund Industry for 2007-2011. In the regulatory context, sharia

pension funds do not yet have a single supporting regulation or fatwa and only refer to general pension fund regulations and the MUI Fatwa which is also general, not specific and detailed.

BIBLIOGRAPHY

- Dudi, D. &. (2018). *Journal of Islamic Society and Philanthropy*. Livestock and Livestock Businesses as Potential Sources of Zakat in Indonesia, 31-37.
- iqbal, m. (2020). sharia maqasid and sharia pension fund. *indonesian jurnal f islamis business and economics*, 30-36.
- Nastiti, H. (2022, December 15). *Sharia Pension Funds: Definition, Benefits and How They Work*. Retrieved from <https://www.tanamduit.com/>:
<https://www.tanamduit.com/belajar/perencanaan-keuangan/dana-pensiun-syariah>
- Norman, E., & Pahlawati, E. (2021). *Sharia Pension Fund Management*. *Religion Education Social Laa Roiba Journal*, 230-231.
- Pusvisasasri, L. (2022). *MASHLAHAH: Journal of Islamic Economics*. Analysis of Zakat on Foreign Exchange Trading and Zakat on Livestock Traded in Indonesia, 99-110.
- Setiawan, F. (2017). *TEXTBOOK OF NON BANK SHARIA FINANCIAL INSTITUTIONS*. Media Ambassador.
- Soemitra, A. (2017). *Sharia Bank And Financial Institutions*. Jakarta: Prenadamedia Group

SHARIA COOPERATIVE

Lia Olivia ZAHARA

ORCID ID:0000-0002-3971-6650

Ayu ANDINI

ORCID ID: 0009-0008-7199-0570

Tia SYIFANA

ORCID ID: 0000-0002-0237-2778

Intan NADZIFA

ORCID ID: 0000-0001-9103-0229

Ade GUNAWAN

ORCID ID: 0000-0001-8479-0641

UIN KH. Abdurrahman Wahid Pekalongan, Indonesia

ABSTRACT

The aim of this research is to describe the meaning of sharia cooperatives, both in terms of the history of the founding of sharia cooperatives, the function and objectives of sharia cooperatives, the activities of legal business entities or laws or regulations regarding sharia cooperatives, and the profile of one of the relevant institutions. This research method uses a library approach, namely a research approach method that comes from books and journals that are appropriate to the topic of discussion and research focus. The results of the literature review in this research conclude that sharia cooperatives are run guided by sharia laws, thereby ensuring benefits in their activities. Sharia cooperatives must be run by people who understand sharia economics and can convey their knowledge to the community as cooperative members, so that people understand the advantages of transacting in sharia cooperatives, and choose sharia cooperatives rather than transacting in economic institutions with a capitalist system to carry out economic activities. Cooperatives can provide an effort to overcome poverty in society. Sharia cooperatives have products and mechanisms that are based on the Koran and Hadith. Sharia cooperatives have almost the same performance as sharia banking institutions. It's just that there are slight differences, which can be distinguished from the products offered. The contracts in sharia cooperatives are almost the same as the contracts in other sharia financial institutions. In the form of business, sharia cooperatives can channel funds for buying and selling through murabahah, salam and istishna contracts, for cooperation through mudharabah or musyarakah contracts, for multiservices through ijarah contracts, and so on.

Keywords: Institution, economy, cooperative, sharia

INTRODUCTION

The development of a country can be seen in terms of income, welfare, and health in a country. Welfare in a country is very important to provide. The reason is that if a country is

not prosperous, the development and improvement of the country occurs. If a country is healthy and prosperous, the income in a country increases. If a country's income increases and changes and develops, its people will be prosperous and healthy. A country's income can be in the form of cash. If a country's cash increases then all-encompassing development of the country can be carried out.

Indonesia's economic development follows the principles set out in the 1945 Constitution. With reference to the constitution of society, culture, customs, spirituality and economic models, priority is given to unity, community and kinship. The prevailing economic system in Indonesia is the Pancasila economic system (Halid, 2014). The main economic actors in the Pancasila Economic System (SEP) include three actors, namely, BUMN / BUMD, private sector, and cooperatives (Ismail & Santosa, 2014).

One of the institutions that can be a solution for business actors is sharia cooperatives. Islamic cooperatives are able to provide capital to business people who need business capital. The provision of capital on the condition that the type of business does not challenge Islamic teachings. Islamic cooperatives are able to improve the welfare of people who run businesses or businesses. If the business has sufficient capital, the businessman is able to develop his business. Islamic cooperatives can also improve the economy of a country (Muhammad Wandisyah R. Hotalagung, 2021). Cooperatives are one of the pillars of the economy in Indonesia, which has changed over time, including the models and forms of services provided. Cooperatives are also the driving force of the community economy which is managed using the principle of kinship and the principle of togetherness (Sidabalok, 2012).

Lately, in addition to the high level of human understanding of Islamic law, this also provides a challenge for the community to do so, including in the economic field. In the economic field, there has been a change in the mindset of people who initially saved and borrowed at ordinary banks, now turning towards Islamic banks or institutions based on Islamic economics, not only for banks that look at the sharia world, but also for cooperatives. Many cooperatives have begun to adopt the concept of sharia. Cooperatives that should be considered as truly sharia cooperatives will be explained in this article.

Research Method

The method used in this research is a literature approach sourced from books and scientific journals in accordance with the topic and focus of the research. As stated in the abstract section at the beginning of the article, this research uses a qualitative approach. A qualitative approach that uses an explicit literature review strategy. An approach that relies on literacy

and understanding of the literature relevant to the topic under study. There are several review boundaries used in the literature review strategy.

RESULTS AND DISCUSSION

• Definition of Sharia Cooperative

Cooperation according to English is "cooperation" which contains the meaning of Co which is together while operation is working. So, based on the term cooperative is a "cooperation" in economic activities which are carried out by groups or organizations in order to achieve common goals. The purpose of cooperative activities is that in the economic activities of the organization can prosper the economy of members who are in the cooperative organization. The welfare of members in the cooperative can be from the income generated. The results of this income provide a solution in meeting the needs of their daily lives. In carrying out or carrying out activities from the management of Islamic cooperatives, there are principles that can be used as guidelines in business work activities (Amalia, 2020).

Islamic cooperatives have two meaningful aspects, namely social and economic aspects. Islamic cooperatives contain social aspects because humans need each other. Likewise, cooperatives work together and help each other between humans and other humans. Islamic cooperatives in the economic aspect, namely cooperatives usually carry out an activity or activity such as selling, so they contain economic elements. If a cooperative is carried out in the right way, it will result in a stable economic increase.

Cooperatives can provide an effort to overcome poverty in the community. Islamic cooperatives have products and mechanisms based on the Qur'an and haidts. Islamic cooperatives are almost similar in performance to Islamic banking institutions. It's just that the difference can be distinguished from the products offered. The contracts in Islamic cooperatives are almost the same as those in other Islamic financial institutions.

• History of the Establishment of Islamic Cooperatives

Cooperatives were first initiated by Robert Owen (1771-1858) who set up a cotton spinning business in New Lanark, Scotland. The cooperative movement was further developed by William King (1786-1865) by establishing the Brighton cooperative shop in England. On May 1, 1828, King published a monthly publication called *The Cooperator* that contained ideas and practical suggestions on managing a shop using cooperative principles. From these two figures, cooperatives developed to various parts of the world (Tahiya & Hasan, 2010).

In Indonesia, cooperatives were introduced by R. Aria Wiriatmadja in Purwokerto, Central Java in 1896. He established credit with the aim of helping his people who were in debt with

moneylenders. In the era of national awakening during the Budi Utomo period, cooperatives began to develop, namely in the 1900s. As explained earlier, conventional cooperatives emerged as a solution to the unrest of the economically weak population to advance their business due to limited capital. However, unfortunately conventional cooperatives still apply the interest / profit system, while in Islam this is prohibited (Rasti, 2021).

Cooperatives in Indonesia were born at the end of the 19th century in an atmosphere of being a colony and not having a favorable climate for its growth. Only later after Indonesia proclaimed its independence, cooperatives were explicitly written in the 1945 Constitution. Dr. H. Moh. Hatta as one of the 'Founding Father' of the Republic of Indonesia, tried to include the formulation of cooperatives in the constitution. Since independence, cooperatives in Indonesia have also experienced better development. Article 33 of the 1945 Constitution paragraph 1 and its explanation which states that the economy is structured as a joint effort based on the principle of kinship is a cooperative. Article 33 of the 1945 Constitution also regulates the role of State-Owned Enterprises and Private-Owned Enterprises. What Hatta fought for in article 33 actually departs from the cultural conditions of Indonesian society that have lasted for centuries.

Besides advocating the establishment of various types of cooperatives, the Indonesian government tried to expand and spread knowledge about cooperatives by holding cooperative courses in various places. On July 12, 1947, the first congress of cooperatives in Java was held in Tasikmalaya. The congress decided, among other things:

1. Formation of the Indonesian People's Cooperative Organization Center (SOKRI)
2. Making July 12 a cooperative day
3. Advocating cooperative education among administrators, employees and the community.

Djojohadikoesoemo defines that "a cooperative is an association of people who by their own accord want to work together to advance their economy" (Hendrojogi, 2015). Article 1 point 1 of Law No. 25 of 1992 concerning Cooperatives, what is meant by a cooperative is "a business entity consisting of individuals or cooperative legal entities by basing its activities on cooperative principles as well as a people's economic movement based on family principles". In practice, cooperative management does not always bring cooperatives to be more developed. Not infrequently, cooperatives are forced to dissolve because they bear continuous losses. In order to be able to compete with other economic institutions, cooperatives began to

improvise in the form, but did not eliminate the form of cooperatives based on the economy (Hadhikusuma, 2001). Sharia cooperatives are widely discussed as a response to the good development of Baitul Maal Wattamwill (BMT) in Indonesia.

- **Functions and Objectives of Sharia Cooperatives**

The purpose of cooperative activities is that in the economic activities of the organization can prosper the economy of members who are in a cooperative organization. The welfare of members in the cooperative can be from the income generated. The results of this income provide a solution in meeting the needs of their daily lives. In carrying out or carrying out activities from the management of Islamic cooperatives, there are principles that can be used as guidelines in business work activities (Amalia, 2020).

Cooperatives can provide an effort to overcome poverty in the community. Islamic cooperatives have products and mechanisms based on the Qur'an and hadith. Islamic cooperatives are almost similar in performance to Islamic banking institutions. It's just that the difference can be distinguished from the products offered. The contracts in Islamic cooperatives are almost the same as those in other Islamic financial institutions. Therefore, Islamic cooperatives have a relationship with people who need capital in developing the type of business they manage. In addition, Islamic cooperatives have many various roles in the economy, education and others of a country.

The following are the various roles that can be played by Islamic cooperatives in Indonesia, namely (Ratna, 2020):

E. Islamic cooperatives play a role in community justice.

Islamic cooperatives still strive to do justice in every transaction between their customers. Islamic cooperatives have guidelines that are in accordance with Islamic law and rules. In sharia principles in every mechanism in the form of margins, installments of a percentage that must be borne by the cooperative. In every routine activity of Islamic financial institutions, namely cooperatives, they must realize fair principles.

F. Islamic cooperatives have a role in educational activities.

With the presence and emergence of Islamic cooperatives can provide something education to prospective customers or the community. As for what includes education in the pursuit of knowledge such as the danger if a servant of Allah eats other people's rights. Islamic cooperatives teach people not to practice usury. Greedy practices in every profit managed by other cooperatives are not found in the teachings of Islam. Islamic cooperatives in every

mechanism and product based on the Qur'an and hadith can provide benefits for every implement. Sharia practices will be a blessing in the afterlife. Islamic cooperatives provide maslahat to customers who want to make loans or other transactions. Islamic cooperatives can provide social services to every community.

G. Islamic cooperatives have a role in the welfare and economy of a country.

Islamic cooperatives are able to provide loans that are not based on high interest. Islamic cooperatives have a type of contract that can guarantee every customer when they want to make a transaction. Therefore, customers will feel safe and comfortable if the mechanism is always applied. If a lot of financing to customers is done in the right way, Islamic cooperatives become Islamic financial institutions that are in demand by MSMEs. There are types of Islamic financial institutions that have circulated throughout Indonesia. It's just that many people make loans to conventional cooperatives. While the practices carried out in these institutions are not found in Islamic teachings. Therefore, Islamic cooperatives can be used as a guide for small or medium business entrepreneurs in developing their business. Many businesses or community businesses that develop, the economic level of the community also increases and the state's revenue also increases. With the presence of Islamic cooperatives, it provides the community, especially for business people, in realizing and developing the business that was pioneered.

Islamic cooperatives do not contain or are based on usury, gharar and maysir practices. Islamic cooperatives can keep us away from practices that are prohibited by Allah. The sharia cooperative practices that should not be carried out are applying for capital loans against moneylenders. The submission of capital loans to moneylenders has high interest rates, resulting in the practice of usury which is not permitted in Islamic teachings (Muhammad Wandisyah R. Hutagalung, 2021).

Based on Article 4 of Law Number 25 of 1992, the functions and roles of cooperatives are as follows:

1. Building and developing the potential and economic capacity of members in particular and society in general, to improve their economic and social welfare.
2. Actively participate in efforts to improve the quality of human life and society.
3. Strengthening the people's economy as the basis for the strength and resilience of the national economy with cooperatives as its pillar.

4. Strive to realize and develop a national economy which is a joint venture based on the principles of kinship and economic democracy.

Quoted from the journal Health Management of Sharia Cooperatives Adzkie Metro Perspective of the Regulation of the Minister of Cooperatives of 2009 (Saputra, 2018) that cooperatives aim to advance the welfare of cooperative members in particular and society in general, therefore Cooperatives have a function and role to build and develop the potential and business capabilities of cooperative members and the general public, to improve their economic and business welfare.

The purpose of sharia cooperatives, is to improve the welfare of its members and the welfare of the community and participate in building the Indonesian economy based on Islamic principles. The functions of sharia cooperatives are as follows:

- To build and develop the potential and capabilities of members in particular, and the community in general, in order to improve their socio-economic welfare;
 - Strengthening the quality of human resources of members, in order to become more trustworthy, professional fathonah), consistent, and consistent (istiqomah) in applying the economic principles of Islamic principles;
 - Strive to realize and develop the national economy which is a joint venture based on the principles and economic democracy;
 - As a mediator between funders and users of funds, so as to achieve optimal utilization of assets;
 - Control over groups of members so that they are able to work together to do work: cooperatives effectively;
 - Develop and expand employment opportunities.
- **Business Entity Activities Sharia Cooperative Law/Law/Regulations**
 - **Legal Business Entity**

According to Kotler & Armstrong (1997) Products are anything that can be offered to the market to fulfill consumer needs and desires. Meanwhile, according to W.J Stanton, a product is a set of attributes, both tangible and intangible, including color, price, good name of the factory, good name of the store that sells (retailers) and factory services and retailer services,

which are accepted by buyers to satisfy their desires. The types of products for raising funds and channeling funds by Islamic financial institutions are as follows:

c. Fund Raising Products (funding)

Savings or savings services in the form of savings / savings organized are a form of savings / savings that are bound and not bound to a certain period of time and conditions in their participation and withdrawal.

d. Principal Deposits Principal deposits are the initial capital of members deposited where the amount of principal deposits is the same and may not be differentiated between members.

e. Compulsory Deposits Compulsory deposits are included in the category of cooperative capital as principal deposits where the amount of obligations is decided based on the results of the members' deliberations and deposits are made continuously every month until someone is declared out of Islamic cooperative membership.

f. Voluntary Deposits Member deposits which are a form of investment from members or prospective members who have excess funds then save in Islamic cooperatives.

d. Fund Disbursement Products (financing)

Funds received by Islamic cooperatives must be channeled to members or prospective cooperative members. Channeling and used for business activities or also for social activities. In the form of business, Islamic cooperatives can channel funds for buying and selling through murabahah, salam, and istishna contracts, for cooperation through mudharabah or musyarakah contracts, for multi-services through ijarah contracts, and others (Ernawati, 2016). While in the form of benevolence can be with qardh or qardhul hasan contracts. The distribution of Islamic cooperative funds is based on its work units, both Real Sector units and Sharia Financial Services Units (UJKS), namely:

2. Financing transactions aimed at owning goods are carried out with the sale and purchase principle.
3. Financing transactions aimed at obtaining services are carried out under the principle of rent.
4. Financing transactions intended for cooperative business aimed at obtaining at the same time goods and services, with the principle of profit sharing.

e. Profit Sharing Distribution

The income distribution referred to here is the distribution of income on the management of funds received by Islamic cooperatives. Income is distributed to members who have deposits or to capital owners who have provided loans to Islamic cooperatives in the form of Mudharabah or Musyarakah. As for the distribution that is annual (special period), then the distribution of income is included in the category of SHU (Sisa Hasil Usaha). For the distribution of profit sharing to members who have deposits or lenders is based on the real business results received by the cooperative during the current month. Generally, it is determined based on the ratio, namely the ratio of profits between Islamic cooperatives and members or lenders to the real results of their business. For example, the ratio of 30:70 is for the type of sacrificial savings, where members get 30%, while for cooperatives 70% of the net profit of the cooperative (current month's profit) (Putriningtyas, 2019).

This is different from conventional cooperatives, where income from cooperative loan services is called loan services (interest), regardless of the real profit results but from the balance of deposit types. Thus, profit-sharing income from Islamic cooperatives can go up and down, while for conventional cooperatives it is stable or fixed. Furthermore, if the sharia cooperative receives a special loan (restricted investment or Mudharabah mugayyadah), then the profit-sharing income of the special business must be distributed to the lender and the sharia cooperative. For the cooperative, the income is considered as service income on Mudharabah mugayyadah. Similarly, for income derived from cooperative services such as Wakalah, the income is considered as service income on Mudharabah mugayyadah.hawalah, Kafalah is called sharia cooperative fee income. While from ijarah is called rental income (Ijarah). Income derived from sale and purchase (trade receivables) murabahah, salam and istishna is called margin. The income from investment or cooperation (Musyarakah and Mudharabah) is called Profit Sharing Income. Meanwhile, in order to maintain liquidity, cooperatives are allowed to place their funds with Islamic financial institutions, including Islamic Banks, BPRS and other Islamic cooperatives. In the placement of these funds generally get profit sharing as well. Then the income is not included in the distribution of exposure that must be shared with third party fund owners (types of member deposits), but is included in the portion of Islamic cooperative income. For the distribution of SHU, it still refers to the cooperative regulations minus the reserve fund decided at the Members' Meeting (Putriningtyas, 2019).

- **Legal Basis For Cooperatives**

h. Government Regulation No. 17 of 1994

Government Regulation No. 17 of 1994 concerning the Dissolution of Cooperatives by the Government. The dissolution of a cooperative is carried out if the cooperative's activities are deemed to endanger or hinder the cooperative system, for example, its survival can no longer be maintained even though it has been given assistance or it is not running in accordance with the law or the articles of association of the cooperative, so such a cooperative should be dissolved. Dissolution of cooperatives can only be carried out by the authorized government with all kinds of considerations.

i. Government Regulation No. 9 of 1995

Government Regulation No. 9 of 1995 concerning the Implementation of Saving and Loan Activities by Cooperatives. Savings and loan activities are needed by cooperative members, one of which is to increase their business capital. Therefore, this government regulation contains provisions that aim to make savings and loan activities carried out by cooperatives develop and run clearly, independently, regularly and resilient (Purwantini et al., 2017). In addition, it also contains provisions to anticipate future prospects where business capital determines the survival and the members concerned.

j. Government Regulation No. 33 of 1998

Government Regulation No. 33 of 1998 concerning Participation Capital in Cooperatives. This government regulation regulates the principle of capital which includes the source of participation capital, rights and obligations, management and supervision, agreements as the basis for implementation, transfer of participation capital and transitional provisions financed by participation capital for cooperatives that have been conducting business. The implementation of participation capital needs to be regulated in a government regulation to emphasize the position of participation capital and provide legal certainty for investors and cooperatives. As part of the participation capital cooperatives implemented based on agreements between investors and cooperatives, this is inseparable from the guidance of the minister. The minister is responsible for the guidance and development of cooperatives, therefore this government regulation also regulates cooperatives whose business operations are financed by participation capital to report periodically to the relevant minister (Suwandi, 2015).

- **Profile of Relevant Institutions**

- **General History**

Benteng Mikro Indonesia Sharia Cooperative has been known in the community, especially those who live in Tangerang Regency. BMI Sharia Cooperative is one of the cooperatives that is widely known to the public. Initially, the Sharia Cooperative was a Micro, Small and Medium Enterprises Development Institution (LPP-UMKM) by the Regional Planning and Development Agency of Tangerang Regency and the Bogor Agricultural Institute Information Resources Institute (LSI-IPB) in 2002.

The cooperative was first launched in 2002. A year later, its first branch, LPP-UMKM Sukadiri, was established, covering Pekayan and Sukadiri villages in Sukadiri sub-district, based on the association between the Tangerang Regional Investment and Coordination Agency and the Bogor Agricultural University Resource Institute.

Prof. Dr. Muhammad Yunus, owner of the Grameen Bank Pattern born in Bangladesh, June 28, 1940, became the main reference in the service and financing system with some modifications. Grameen Bank was used as a model because it succeeded in lifting Jobra Village in Bangladesh and won the Nobel Peace Prize in 2006 (Fauzi, 2020).

Not only in Tangerang, he developed the same pattern in many areas, such as Maluku, Semarang, Bekasi, Kupang, and so on. On March 20, 2013, this cooperative changed from a legal entity to a Sharia Financial Services Cooperative named KPP-UMKM Syariah with Deed of Establishment No: 03 Dated April 05, 2013 with Legal Entity on April 12, 2013 Number: 518/11/BH/XI.3/KUMKM/2013. In April 2014, it again changed its Articles of Association and changed its name to KPP-UMKM Syariah Cooperative with Deed of Establishment No. 326 of April 11, 2014 with Legal Entity Number: 518/11/BH/XI.3/KUMKM/2013: 326 April 11, 2014 with Legal Entity Date October 10, 2014 Number: 518/11A/PAD/XI.3/KUMKM/2014.

In November 2015, BMI Syariah Cooperative changed its Articles of Association and changed its name to BENTENG MIKRO INDONESIA Sharia Savings and Loan and Financing Cooperative with Deed of Establishment No: 01 Dated September 14, 2015 with Legal Entity Dated November 04, 2015 No. 213/pad/m.kumkm.3/KUMKM/2014: 213/PAD/M.KUMKM.2/XI/2015.

- **Name Meaning of Benteng Mikro Indonesia Sharia Cooperative**

The following is the meaning of the name Benteng Mikro Indonesia Sharia Cooperative:

- Sharia Savings and Loan and Financing Cooperative (KSPPS) is a cooperative with sharia savings, loans and financing activities (including zakat, infaq, sadaqah, and waqf). Can be abbreviated as Sharia Cooperative (Kopsyah).
- Benteng has two meanings, namely place (domiciled in Tangerang. Benteng is another name for Tangerang) and shield or defense.
- Mikro means that this cooperative cares and serves people with micro businesses
- Indonesia means that this cooperative serves anyone who is an Indonesian citizen.

- **Services of Benteng Mikro Indonesia Sharia Cooperative**

Benteng Mikro Indonesia Sharia Cooperative has several services, including:

- a. Loan or Financing Services**

- a. Productive Financing
 - b. Investment Financing

- b. Deposit Services**

- i. Own capital savings (principal savings and mandatory savings)
 - ii. Working capital savings (voluntary savings, term investment savings, sanitation, water, education, umrah, hajj, and qurban.

- **Benefits of Benteng Mikro Indonesia Sharia Cooperative**

- Building an economy based on shar'i principles.
- Raising large funds and mobilizing them nationally.
- Investing in strategic sectors, such as in franchise networks, Islamic financial institutions, media, and food and beverage companies.
- Annual profit from Residual Income.
- Building relationships between members.

CONCLUSION

Islamic cooperatives are run based on sharia laws, so as to ensure benefits in their activities. Sharia cooperatives must be run by people who understand sharia economics and can convey their knowledge to the community as cooperative members, so that people understand the advantages of transacting in sharia cooperatives, and choose sharia cooperatives rather than in capitalist economic institutions to carry out economic activities. When the cooperative is run according to its identity, it will grow and achieve its goals, as if we analogize when we want to cook the food we like, we need special spices and methods to get results that suit our taste, according to what we want, so is the cooperative.

It is hoped that the Indonesian people in general and Muslims in particular can be wiser in making choices in joining or participating in cooperative membership. Because Allah SWT has regulated the procedures for trading in accordance with the Koran and Assunah since before this method was used. Therefore, let us use a sharia system that is more halal and there is no injustice between the two parties, and we firmly say not to use the capitalist system that has destroyed the financial world, either non-bank money institutions, or banking itself.

LITERATURE

- Amalia, I. S. (2020). Equity Management in Sharia Cooperatives. 1(17).
- Ernawati. (2016). Management of Financing Products in Increasing Cooperative Income (Case Study at Sharia Financial Services Cooperative Budi Luhur Syariah Kunjang Kediri) [State Islamic Institute (IAIN) Kediri]. <http://etheses.iainkediri.ac.id/id/eprint/507>
- Fauzi, A. M. (2020). Sharia Cooperative as Indonesia's Micro Fortress: What are its Advantages? *Finansialku.Com*. <https://www.finansialku.com/koperasi-syariah-benteng-mikro-indonesia/>
- Hadhikusuma, S. R. (2001). Indonesian Cooperative Law. PT RajaGrafindo Persada.
- Halid, H. A. M. N. (2014). Cooperative Pillar of the State (S. Pandur & Y. T. Tulis (eds.)). Jetpress.
- Hendrojogi. (2015). Cooperatives: Principles of Theory and Practice. Rajawali Press.
- Ismail, M., & Santosa, D. B. (2014). Indonesian Economic System Interpretation of Pancasila and the 1945 Constitution. Erlangga.
- Kotler, P., & Armstrong, G. (1997). Principles of Marketing. Erlangga.
- Lestari, U. P., Fadhilah, N., Siregar, F. G., & et al. (2004). MANAGEMENT OF COOPERATIONS AND MSMEs (Issue 1).
- Muhammad Wandisyah R. Hutagalung, S. B. (2021). The Role of Sharia Cooperatives in Improving the Economy and Community Welfare in Indonesia. *Scientific Journal of Islamic Economics*, 7(03), 1494-1498.
- Muhammad Wandisyah R. Hutagalung, S. . (2021). The Role of Islamic Cooperatives in the Economy and Community Welfare in Indonesia. *Scientific Journal of Islamic Economics*, 7(3), 1494-1498.
- Purwantini, S., Rusdianti, E., & Wardoyo, P. (2017). Study of Fund Management of Conventional Saving and Loan Cooperatives in Semarang City. *Journal of Socio-Cultural Dynamics*, 18(1), 133. <https://doi.org/10.26623/jdsb.v18i1.564>
- Putriningtyas, U. (2019). Bmt Accountability: Analysis Based on the Implementation of Psak 101 on the Presentation of Financial Statements. *Journal of Economics and Islamic Sciences*, 7(1).
- Rasti, A. (2021). HISTORY OF ISLAMIC COOPERATIVES IN THE WORLD AND IN INDONESIA. Alauddin State Islamic University Makassar.
- Ratna (2020). The Role of Sharia Cooperatives in Improving the Welfare of the Palembang City Community in the New Normal Era. *Journal of LA RIBA*, 2(1).

- Saputra, A. (2018). Management Health of Adzka Metro Sharia Cooperative in the Perspective of the Minister of Cooperatives Regulation of 2009. In *Metrouniv. State Islamic Institute (IAIN) Metro*.
- Sidabalok, J. (2012). *Company Law*. Nuanasa Aulia.
- Suwandi. (2015). Participation Capital, Mechanism and Typology of Implementation Problems. *Infokop*, 25 (April).
- Tahiya, S. A., & Hasan, M. (2010). *Cooperative 1: Introduction, History of Ideology and Its Development in Indonesia*. Publishing Agency of Makassar State University.
- Yuli. (2020). *5 Legal Basis of Cooperatives in Indonesia*.

COMPUTATIONAL MODELING OF THE CORROSION INHIBITION MECHANISM OF MILD STEEL BY TWO SCHIFF BASES

Issam AZGHAY

Applied Chemistry Team, Faculty of Sciences and Techniques, Abdelmalek Essaadi University,
32 003 Al Hoceima, Morocco.

Hassan AMHAMDI

Applied Chemistry Team, Faculty of Sciences and Techniques, Abdelmalek Essaadi University,
32 003 Al Hoceima, Morocco.

ABSTRACT

This study employed a theoretical approach to investigate the corrosion inhibition mechanism of mild steel using two Schiff bases. Statistical analysis was conducted to establish a correlation between the effectiveness of the experimental inhibitor and its quantum properties, aiming to elucidate the inhibition process. Density Functional Theory (DFT) was utilized for quantum calculations on the two inhibitors and their protonated forms in both gas and aqueous phases. The local reactivity parameters were assessed using Fukui indices, while Monte Carlo simulation was applied to analyze the system's dynamics at the steel interface.

Analysis of global quantum descriptors, including E_{HOMO} , ΔE_{gap} , and ΔN , revealed an increase in theoretical efficiency following this sequence: MA7 < MA9. Notably, protonation of the compounds was found to strongly influence inhibition efficiency, as indicated by proton affinity and theoretical pKa values. Thermodynamic properties of the 1-1 complexes (comprising a single inhibitor molecule and a single iron atom) were employed to interpret the formation of the N-Fe bond, with nitrogen atoms identified as the most significant nucleophilic sites, providing an explanation for their experimentally observed efficiency.

Simulation of system dynamics at the interface illuminated the adsorption mechanism above the iron surface. Energy analysis of the most stable adsorption configurations on the 491H₂O/9H₃O⁺/9Cl⁻/Fe{110} interface indicated that MA9 holds the potential to be more effective than PSB7.

Quantitative Structure-Activity Relationship (QSAR) results demonstrated a strong linear relationship between certain global reactivity parameters and experimental inhibition efficiency. In summary, the outcomes of quantum chemistry calculations and molecular dynamics studies align closely with experimental data and offer theoretical insights into the efficiency of each inhibition method.

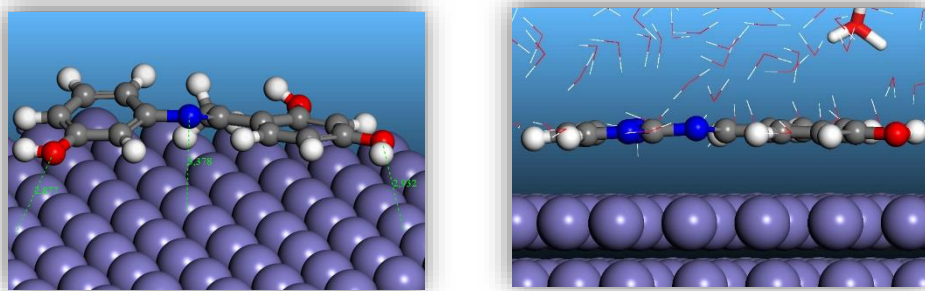
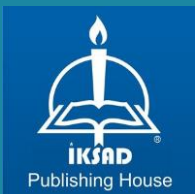


Fig 1: Side views of the most stable adsorption configuration for the Fe (110) / MA9 / 491 H₂O / (9H₃O⁺,9Cl⁻) system obtained by Mont Carlo simulations.

Keywords : Corrosion inhibition ; Schiff bases ; DFT ; QSAR ; Mont Carlo simulation.



<https://www.isarconference.org/>

ISBN: ' 978-625-367-374-1 '