Menba Kastamonu Üniversitesi Su Ürünleri Fakültesi Dergisi
Menba Journal of Fisheries Faculty
ISSN 2147-2254 | e-ISSN: 2667-8659

Menba Kastamonu Üniversitesi Su Ürünleri Fakültesi Dergisi 2024; 10 (3): 223-230 Araştırma Makalesi/Research Article

Bartın Rüzgar Hızları: İklim Değişikliği ve Yerleşimlerin Etkileri

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Makale Bilgisi :
Geliş:
21/10/2024
Kabul Ediliş:
02/12/2024

Anahtar Kelimeler:
- Rüzgar Hızı
- Bartın
- Yenilenebilir Enerji
- Rüzgar Enerjisi Potansiyeli
- Sürdürülebilir Enerji
- İklim Değişikliği
- Mikro İklim

Öz

Bu çalışma, Bartın ilinin aylık rüzgar hızlarını analiz etmeyi ve bu verileri yerel planlama süreçlerine entegre etmeyi amaçlamaktadır. Bartın'ın Karadeniz Bölgesi'ndeki coğrafi konumu, zengin doğal kaynakları ve çeşitli iklim özellikleri, rüzgar analizi için önemli bir araştırma alanı sunmaktadır. Rüzgar, hem enerji üretiminde hem de insan konforunda kritik bir rol oynamakta ve hızla büyüyen yenilenebilir enerji kaynaklarından biri olarak öne çıkmaktadır. Bu bağlamda, Bartın'ın kıyı konumu ve rüzgârlı iklimi nedeniyle yüksek rüzgar enerjisi potansiyeline sahip olduğu değerlendirilmektedir. Bartın'ın rüzgar dinamiklerini belirlemek ve bu dinamiklerin yerleşimler üzerindeki etkilerini incelemek amacıyla aylık rüzgar hızı verilerinin analizi yapılmıştır. Çalışmada, meteorolojik veriler kullanılarak rüzgar hızlarının mevsimsel değişimleri değerlendirilmiş ve bu verilerin biyoklimatik konfor ile olan ilişkisi incelenmiştir. Elde edilen sonuçlar, yerel yönetimlerin sürdürülebilir enerji kullanımı ve kentsel planlama süreçlerinde rüzgar dinamiklerini dikkate almasına yardımcı olacaktır. Sonuç olarak, bu çalışma Bartın ilinin rüzgar hızlarını analiz etmenin önemini vurgulamakta ve yerel planlama süreçlerine rüzgar enerjisi potansiyelinin entegrasyonu ile biyoklimatik konforu artırmaya yönelik öneriler sunmaktadır.

Wind Speeds of Bartın: Impacts of Climate Change and Settlements

Article Info

Received:
21/10/2024
Accepted:
02/12/2024

Keywords:
- Wind Speed
- Bartın
- Renewable Energy
- Wind Energy Potentia
- Sustainable Energy
- Climate Change
- Microclimate

Abstract

This study aims to analyze the monthly wind speeds for the province of Bartın and to integrate this data into local planning processes. The geographical location of Bartın in the Black Sea Region, its rich natural resources, and various climatic features provide an important research area for wind analysis. Wind plays a critical role in both energy production and human comfort, standing out as one of the fastest-growing renewable energy sources. In this context, Bartın has high wind energy potential due to its coastal location and windy climate. The analysis of monthly wind speed data was conducted to determine the wind dynamics of Bartın and the effects of these dynamics on settlements. In the study, seasonal variations of wind speeds were evaluated using meteorological data, and the relationship of this data with bioclimatic comfort was examined. The results obtained will assist local authorities in considering wind dynamics in sustainable energy use and urban planning. In conclusion, this study highlights the importance of analyzing wind speeds for Bartın province and presents recommendations for enhancing bioclimatic comfort through the integration of wind energy potential into local planning processes.

Atıf bilgisi / Cite as: Çetin, İ. Z. (2024). Wind Speeds of Bartın: Impacts of Climate Change and Settlements. Menba Journal of Fisheries Faculty, 10 (3), 223-230. DOI: 10.58626/menba.1570941

INTRODUCTION

As a fundamental component of air movements, wind has significant effects on climate, energy, and environmental processes. Turkey, particularly the Black Sea Region, stands out with its rich natural resources and diverse climatic characteristics. In this context, Bartın province offers an important research area for wind analysis due to its geographical location and meteorological dynamics (Zeren Cetin & Sevik, 2020; Zeren Cetin et al., 2023a,b; Bolat & Şensoy, 2023; Yaman & Ertuğrul, 2020).

Wind dynamics play a crucial role in both energy production and human comfort. Wind energy, as one of the most prominent sources of renewable energy, has seen significant advancements over the last two decades. According to the International Renewable Energy Agency (IRENA, 2021), global investments in wind energy have increased exponentially, driven by its sustainability, cost-effectiveness, and low environmental footprint. In Turkey, studies have highlighted the immense wind energy potential of coastal regions due to their favorable climatic and geographical characteristics (Demirtaş et al., 2020; Hepbasli & Ozgener 2004; Kaygusuz, 2002; Argin et al., 2019; Genç et al., 2021; Kaplan 2015; Ucar & Balo 2010). The establishment of wind power plants not only supports energy independence but also contributes to local economic growth by creating job opportunities and fostering technological development (İlkiliç, 2012; Ilkiliç & Aydin, 2015; Aydin et al., 2013; Hepbasli & Ozgener 2004; Kaygusuz, 2002; Argin et al., 2019; Genç et al., 2021; Kaplan 2015; Ucar & Balo 2010).

On the other hand, the role of wind in urban environments goes beyond energy production. Urban planning and landscape architecture increasingly incorporate wind dynamics into their frameworks to ensure bioclimatic comfort and resilience to climate change. Wind speed and direction significantly influence local microclimates, thermal comfort, and air quality. According to Givoni (1998), appropriately designed urban spaces can harness wind to mitigate heat stress and enhance outdoor comfort, particularly in densely populated areas.

Recent studies have drawn attention to the implications of climate change on wind patterns. Mastrorillo et al. (2016) emphasize that extreme weather events, including abrupt changes in wind speeds and directions, are becoming more frequent and intense. Such changes pose challenges to urban planning, as they can exacerbate existing issues like heat islands, air pollution dispersion, and structural vulnerabilities in settlements. In regions like Bartın, where the topography and climatic conditions interplay dynamically, understanding wind patterns becomes even more critical (Zeren Cetin & Sevik, 2020; Zeren Cetin et al., 2023a,b).

Bioclimatic comfort, a key concept in sustainable urban and landscape design, is also closely linked to wind speeds. Studies have shown that wind is a determining factor in the physiological equivalent temperature (PET) and other thermal comfort indices (Höppe, 1999). In regions with high wind speeds, like Bartın, planning strategies should aim to utilize wind for cooling during warmer months while minimizing its adverse effects in winter (Olgyay, 1963). Additionally, the integration of wind data into green infrastructure design can promote natural ventilation and improve the overall livability of urban areas (Ng, 2009).

Despite the growing interest in wind-related studies, research focusing specifically on coastal provinces. Existing studies often overlook the nuanced interactions between wind dynamics and urban planning at the local level. the localized wind speed analyses are vital for optimizing the placement of wind turbines and designing wind corridors in urban areas. (Liu et al., 2020; Hsieh & Huang, 2016; Ren et al., 2018; Sung et al., 2021; Núñez-Peiró et al., 2021; Liu et al., 2022) Furthermore, Zeren Cetin et al., (2023a,b) highlight the importance of wind mapping in determining the suitability of districts for renewable energy projects and in enhancing bioclimatic comfort.

In summary, while the global and national potential of wind energy is well-documented, there is a pressing need for region-specific studies that integrate wind dynamics into urban and landscape planning. This study aims to bridge this gap by analyzing monthly wind speeds across Bartın province and exploring their implications for energy production, bioclimatic comfort, and sustainable urban development.

The aim of this study is to determine the wind dynamics in the region through the analysis of monthly wind speeds across Bartın province and to demonstrate how this data can be integrated into local planning processes. The analysis of monthly wind speed data will contribute both to the assessment of wind energy potential and to enhancing bioclimatic comfort in urban and landscape planning.

In this study, a bioclimatic comfort assessment based on the monthly wind speeds and their distribution across Bartın province has been conducted. The obtained data provides significant findings that should be considered in urban and landscape planning. Particularly, the effects of wind speeds on local microclimatic conditions can guide the sustainable planning of cities and the design of open spaces. Discussions and recommendations on how the variations in wind speeds in different districts of Bartın can be utilized in landscape design and urban planning approaches are presented below.

MATERIAL AND METHOD

The research focuses on examining the seasonal variations of wind speeds in Bartın province, particularly in the districts of Amasra and Ulus. Monthly wind speed data from 2012 to 2023 was obtained from the General Directorate of Meteorology of the Republic of Turkey, using measurements from local meteorological stations.

The analysis involved collecting wind speed data recorded in meters per second, calculating average, maximum, and minimum speeds for each month using anemometers. The data was analyzed through descriptive statistics and visualized using graphs and GIS software to create maps illustrating the distribution of wind speeds across the region.

The study also assessed the relationship between wind speeds and bioclimatic comfort, considering environmental factors like temperature and humidity. Results were compared with existing literature on local climate variables and sustainable energy use, leading to recommendations for local governments and planning authorities. This process emphasized the importance of understanding wind dynamics for sustainable planning and decision-making.

RESULT AND DISCUSSION

Monthly wind speed values in Bartın province range from 0.9 to 5.5 m/s in January and from 0.8 to 5.6 m/s in December. The districts of Amasra and Ulus have been identified as the areas with the highest and lowest wind speeds (Figure 1). The effects of wind speeds on bioclimatic comfort have been evaluated, comparing the adverse health effects of specific wind speeds with existing literature.

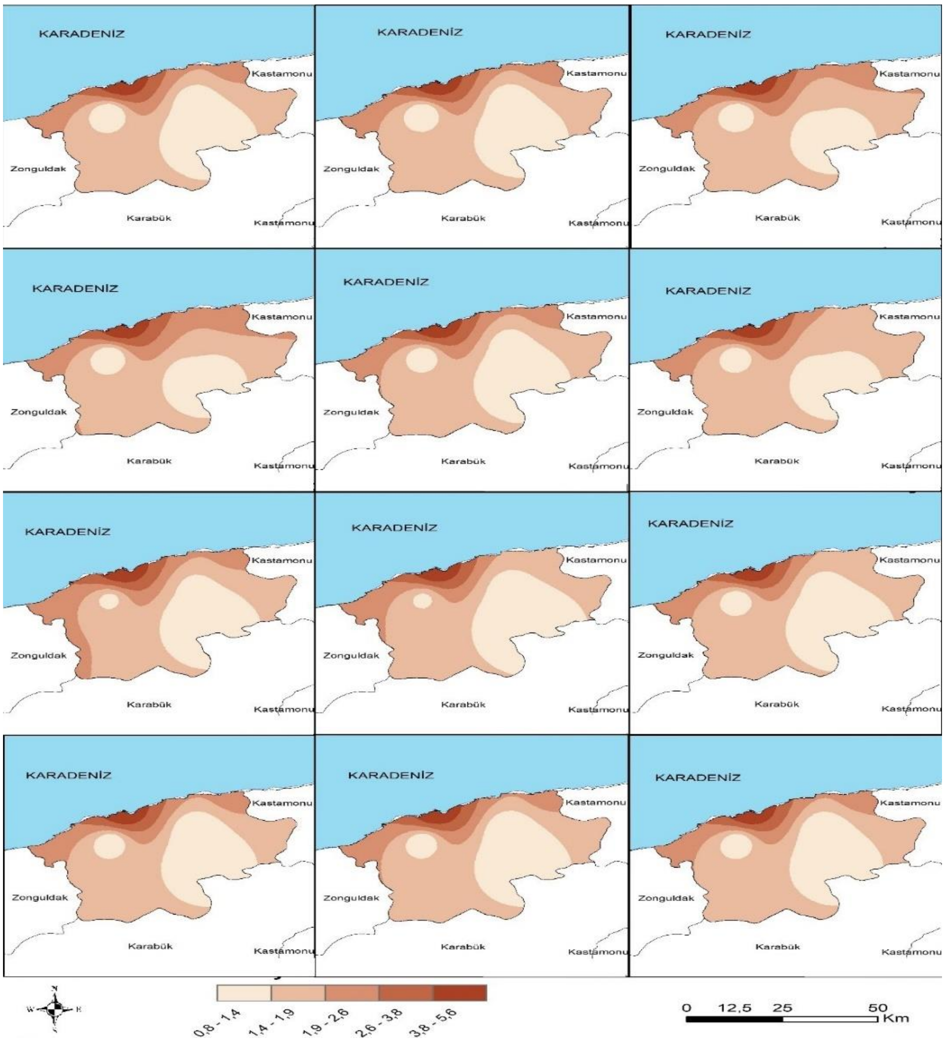

Figure 1 Average Wind Map of Bartın Province

The analysis of wind speeds in Bartın province provides significant findings regarding annual energy potential, bioclimatic comfort, and environmental impact. Monthly wind speed values in Bartın show a specific pattern of variation throughout the year:

January: Wind speeds range from 0.9 to 5.5 m/s; Ulus district shows the minimum value of 0.9 m/s, while Amasra district shows the maximum of 5.5 m/s.

February: Wind speeds range from 1 to 5.4 m/s; Amasra reaches a minimum of 1 m/s, while Ulus reaches a maximum of 5.4 m/s.

March: Wind speeds vary from 1.1 to 5.1 m/s. Ulus has a minimum of 1.1 m/s, and Amasra reaches a maximum of 5.1 m/s.

April: Average wind speeds are between 1.2 and 4.5 m/s; Ulus has the lowest at 1.2 m/s, and Amasra has the highest at 4.5 m/s.

May: Wind speeds range from 1.2 to 4.1 m/s; Ulus shows a minimum of 1.2 m/s, while Amasra reaches a maximum of 4.1 m/s.

June: Wind speeds vary between 1.1 and 4.1 m/s; Ulus shows the minimum at 1.1 m/s, and Amasra has the maximum at 4.1 m/s.

July: Wind speeds range from 1.2 to 4.2 m/s; Ulus has the minimum at 1.2 m/s, while Amasra shows the maximum at 4.2 m/s.

August: Average wind speeds are between 1.3 and 4.4 m/s; Ulus shows a minimum of 1.3 m/s, while Amasra reaches a maximum of 4.4 m/s.

September: Wind speeds vary from 1.1 to 4.6 m/s; Ulus and the central district show a minimum of 1.1 m/s, while Amasra reaches a maximum of 4.6 m/s.

October: Wind speeds range from 0.9 to 4.7 m/s; both the central district and Ulus have a minimum of 0.9 m/s, while Amasra shows a maximum of 4.7 m/s.

November: Wind speeds range from 0.8 to 4.9 m/s; minimum values are 0.8 m/s in Ulus and the central district, while Amasra shows a maximum of 4.9 m/s.

December: Wind speeds range from 0.8 to 5.6 m/s; the minimum is 0.8 m/s in Ulus, while Amasra has a maximum of 5.6 m/s.

The wind speed data in Bartın provides significant insights into the region's climatic dynamics. The variations in wind speeds between the Amasra and Ulus districts may be related to local topography and maritime effects. Amasra's proximity to the coast leads to stronger winds coming from the sea, which is critical for understanding climatic interactions in the region.

The obtained wind speed values are also important for determining the region's renewable energy potential. Wind speeds above a certain level (typically above 5 m/s) are considered suitable for wind energy plants. The high wind speeds in Amasra present opportunities for renewable energy projects in the area.

The effects of wind speeds on bioclimatic comfort are another significant finding. High wind speeds can have a cooling effect, especially during hot summer months. However, excessively high wind speeds can adversely affect human comfort, which should be considered in the planning of settlement areas.

The analysis of wind speeds in Bartın province presents significant findings regarding the assessment of local energy potential and understanding climatic dynamics. The high wind speeds, particularly in the Amasra district, create an opportunity for developing sustainable energy resources. However, strategic approaches should be developed to integrate these wind dynamics into local urban planning.

These findings provide important data for local governments and energy planners, facilitating more effective utilization of Bartın province's wind potential.

DISCUSSION

Wind speeds in Bartın province are significant in terms of both energy potential and bioclimatic comfort. Wind energy is one of the sustainable energy sources and has emerged as a crucial factor to be considered in local governments' energy policies. Additionally, the impacts of wind speeds on settlement areas are becoming increasingly important alongside climate change.

It has been observed that the highest wind speeds in Bartın occur in January and December, while wind speeds are generally lower during the summer months. In light of these data, it becomes evident that the wind effects in open areas should be taken into account, particularly in regions like Amasra during the winter months. For example, the arrangement of urban furniture in wind-exposed areas, the design of outdoor activity spaces, and the implementation of windbreak planting arrangements in landscape design can be beneficial.

The Ulus district and its surroundings experience low wind speeds throughout the year. This condition indicates that planning for quieter areas with low wind effects can be feasible in this region. Slow winds can create a more favorable environment for plant health, especially in areas where agricultural activities take place.

The high wind speeds observed in Amasra district can be evaluated in terms of energy production potential. Identifying suitable areas for the establishment of wind energy facilities can be done more effectively based on such data. Additionally, different strategies can be developed for the utilization of open areas along the coastline during periods of high winds.

Monthly wind speed data across Bartın province reveal that local microclimatic conditions should be considered in urban and landscape planning. The variability of wind speeds across districts serves as an important guide for how design strategies can be diversified in different areas of the city. Particularly in regions where winds are intense, various measures must be taken to ensure microclimatic comfort. This discussion has been addressed more comprehensively in light of data obtained from the existing literature and similar studies.

The Effect of Wind on Microclimate: Wind is one of the most significant factors affecting microclimates in cities (Oke, 1987; Grimmond, 2007). Specifically, the speed and direction of the wind directly influence environmental factors such as air temperature, humidity, and dust transport. The observation of high wind speeds in January and December in Bartın indicates that the cooling effect of the wind in urban areas may be pronounced during these months. This situation can restrict outdoor use and decrease bioclimatic comfort. The wind speeds ranging from 5.5 to 5.6 m/s in Amasra district can make outdoor activities challenging during the winter months. Similarly, high wind speeds can positively affect air quality as they help disperse air pollution and particulate matter.

Landscape Design and Windbreak Elements: Utilizing windbreak elements in urban planning in areas with high wind speeds can be an important strategy for improving microclimate (Heisler & Dewalle, 1988). The capacity of vegetative materials to slow down the wind contributes to increased bioclimatic comfort in residential areas. In areas with high winds, such as Amasra, it is recommended to provide protection using rows of trees, shrubs, and other natural barriers. In regions like Ulus with low wind speeds, preserving and enhancing the natural landscape allows for a calmer and more peaceful living environment.

Wind Energy Potential: In areas like Amasra, where high wind speeds have been observed, there are opportunities in terms of wind energy potential. Studies on Turkey's overall wind energy potential indicate that coastal regions can benefit more from this energy (Hepbasli & Ozgener 2004; Kaygusuz, 2002; Argin et al 2019; Genç et al., 2021; Kaplan 2015; Ucar & Balo 2010). Wind speeds reaching up to 5.6 m/s in Amasra can provide an ideal environment for energy production. Assessing this potential can contribute to investments in sustainable energy sources in Bartın.

The Role of Wind Speeds in Urban Design: Wind speeds also have a significant effect on building orientations and urban development in settlement areas. In regions with high winds, properly orienting buildings can enhance energy efficiency (Emmanuel, 2012; Gómez et al., 2001). In windy areas like Amasra, building layouts should be designed to maximize natural ventilation, which can help reduce energy costs by providing natural cooling, especially during hot summer months.

Bioclimatic Comfort Areas and Social Space Usage: Bioclimatic comfort refers to the provision of microclimatic conditions where people can spend time outdoors comfortably. It is observed that bioclimatic comfort varies across different regions in Bartın, depending on wind speeds. For instance, areas like Ulus, which have lower wind speeds, are more preferred as social activity spaces, particularly in summer. Low wind speeds enable outdoor events to be carried out more enjoyably. Conversely, in regions with high wind speeds like Amasra, the cooling effect of the wind can positively influence bioclimatic comfort in summer; however, its cooling effect can be uncomfortable in winter.

CONCLUSION

The variability of wind speeds throughout the year in Bartın province provides significant insights into local microclimatic conditions. In this context, the following recommendations can be considered in the urban and landscape planning process:

Creation of Windbreak Areas: Especially in regions like Amasra, which have high wind speeds, vegetative arrangements and structural measures should be taken to reduce wind effects. These designs are crucial for protecting settlements and social areas during windy seasons.

Energy Efficiency and Wind Energy: The high wind speeds in Amasra and its surroundings offer an opportunity for renewable energy projects. Assessing the wind energy potential can enhance energy efficiency in the city.

Open Space and Landscape Design: Considering wind speeds across Bartın, appropriate vegetation selection for urban parks and open spaces should be made. In areas with strong winds, plants can serve both aesthetic and protective roles.

Microclimatic Comfort Areas: Regions with low wind speeds, such as Ulus and its surroundings, can offer more comfortable living spaces for residents during summer. Planning social activities and relaxation areas in these spaces can contribute to attracting more visitors.

The Role of Wind in Urban Planning: The impact of wind speeds on urban development should be taken into account, optimizing building placements and orientations according to wind speeds. In particularly windy areas, designing buildings in alignment with wind directions can provide energy savings.

These data demonstrate the importance of climatic data in urban and landscape planning, specifically in Bartın province. Considering microclimatic factors like wind speeds is crucial for enhancing the sustainability of cities and improving quality of life.

The analysis of wind speeds conducted across Bartın province offers significant insights for urban planning, landscape design, and sustainable energy use. In this context, taking into account local wind dynamics will contribute to planning the city in a way that is more livable, energy-efficient, and suitable for climate conditions. Below, detailed recommendations based on the results of this study are presented.

Regional Differences in Wind Speeds: Wind speeds vary significantly across the districts in Bartın province. Amasra district, which reaches the highest wind speeds in January and December, is particularly noted for its harsh wind effects during the winter months. In contrast, areas like Ulus, with lower wind speeds, offer calmer and more stable weather conditions.

Microclimatic Comfort and Wind: Areas with low wind speeds, such as Ulus and the central district, provide more suitable conditions for bioclimatic comfort in summer, while high-wind areas like Amasra may have adverse microclimatic conditions, especially in winter.

Wind Energy Potential: It has been determined that wind energy potential is high in the coastal areas of Bartın, particularly in Amasra. Wind speeds reaching 4.5 to 5.6 m/s throughout the year create a favorable environment for sustainable energy investments in these areas.

Urban and Landscape Planning: The effects of wind on urban areas must be considered in terms of building development and landscape arrangements. Seasonal changes in wind speeds should be taken into account, especially in the design of open areas. Protecting open area designs with windbreak vegetation in windy regions like Amasra is essential, while preserving the natural landscape is important in quieter areas like Ulus.

Urban Planning: Settlement Arrangements Based on Wind Speeds: In regions with high wind speeds like Amasra, settlement arrangements should be made in accordance with the prevailing wind directions. In open areas, building placements should be optimized according to wind direction to reduce wind intensity and provide energy savings.

Wind Tunnels and Natural Ventilation: In areas with high wind speeds, natural ventilation can be achieved by creating wind tunnels. The spaces between buildings can minimize wind effects while providing natural cooling and reducing energy costs.

Landscape Design and Vegetative Arrangements: Windbreak Plants and Structural Arrangements: In open areas of regions like Amasra, windbreak plants and structural measures should be taken. Rows of trees, shrubs, and other vegetative elements can slow down high wind speeds, providing a more comfortable environment outdoors. Additionally, the placement of urban furniture in public areas should be arranged according to wind direction.

Preservation of Green Areas in Low Wind Regions: In areas with low wind speeds like Ulus, it is recommended to preserve and expand natural landscapes and green areas. Such areas are important for ensuring bioclimatic comfort and protecting agricultural production areas.

Sustainable Energy Use: Supporting Wind Energy Projects: Amasra district has the highest wind energy potential in Bartın. Wind speeds averaging between 5.5 to 5.6 m/s throughout the year encourage investments in wind energy in this area. Evaluating this potential can increase regional energy production and reduce reliance on fossil fuels.

Expanding Renewable Energy Areas: The wind potential in coastal regions can help local governments achieve their sustainability goals in combating climate change, not only for energy production. It is essential for local governments to enhance incentives and investments in this area.

In conclusion, the analysis of wind speeds across Bartın province provides significant insights for urban planning, landscape design, and energy efficiency. By considering wind dynamics, we can enhance the sustainability of cities and improve the quality of life. The detailed recommendations presented in this study aim to support sustainable planning processes in Bartın province, contributing to climate-resilient urban areas.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Ondokuz Mayis University for providing administrative and technical support, as well as the materials used in the experiments. I acknowledge the valuable contributions of Ondokuz Mayis University.

COMPLIANCE WITH ETHICAL STANDARDS

a) Authors' Contributions

İZÇ: Data collection, investigation, formal analysis, and writing the original draft, Project administration, supervision, conceptualization, methodology, review and editing, Data collection and investigation, designed the study and performed the experiments; performed the experiments, analyzed the data, and wrote the manuscript

b) Conflict of Interest

The authors declare that there is no conflict of interest.

c) Human Ethical Approval Certificate

Not applicable.

d) Fund Statement

There is no financial support.

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