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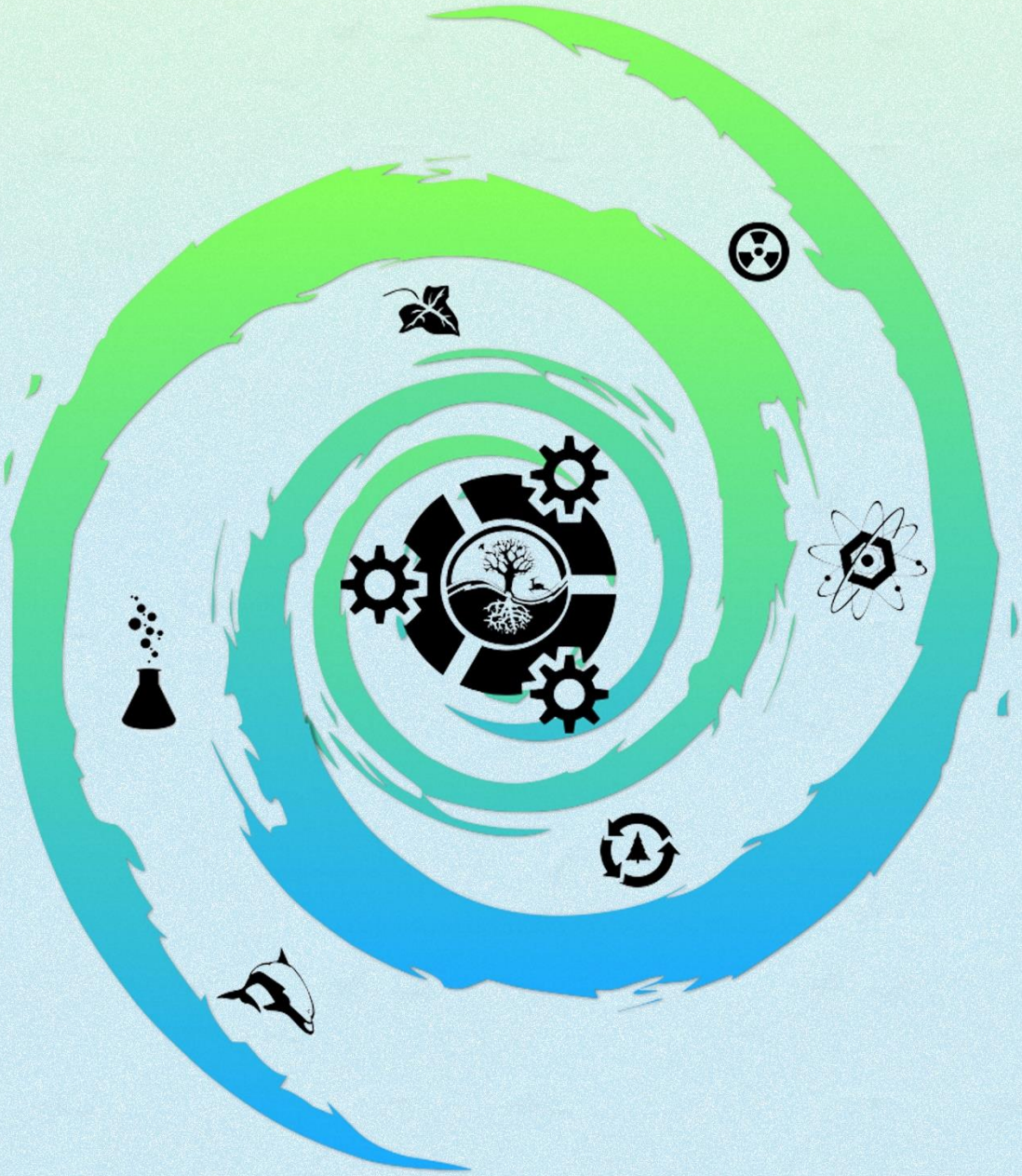

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Does Maritime Transport Network Converge? Evidence From EU Countries

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ABSTRACT

The concept of convergence is an important issue that has gained a wide place in the economics literature. The convergence of economies is likely to have an impact on the transportation sector as well, since it is the most important supporter of economic activities, and it is directly affected by economic indicators due to its derived demand structure. However, the possible reflections of economic convergence in the transportation sector have not received sufficient attention in the literature. In this study, we investigated this issue in the European Union (EU) countries, where economic convergence is implemented as a union policy and the existence of convergence is empirically supported in many studies. We select Liner Shipping Connectivity Index (LSCI) as a variable, which indicates the countries' level of connectivity in the liner transportation network mostly used to transport intermediate and finished goods. We have determined that there is a convergence in EU countries in terms of maritime transportation network. This result shows that economic integration leads to improvements not only in the incomes of poorer countries but also in their transportation networks.

INTRODUCTION

Policy makers in European states are implementing policies aimed at reducing income inequalities between member states. To achieve this aim, they conduct practices such as liberalization in the trade of goods and services, facilitating the transfer of financial assets, facilitating the mobility of factors. Thus, they aimed that the poorer regions and countries catch up with the richer ones in terms of income and welfare (Yin et al., 2003). These policies have caused the differences between countries to decrease and the gap between low-income and high-income countries to close over time (Marelli et al., 2019). This situation is called "Convergence" in the literature.

Convergence is a concept that emerged from Solow's (1956) neoclassical growth model. According to this growth model, the income gap between high-income and low-income countries gets smaller over time. The main reason for this structure is shown as diminishing returns to scale. Although the term convergence was originally developed and used for economics, it has also been the subject of research questions in many different fields in the EU region. The subject of convergence in EU countries has been the subject of research in the literature on gross domestic product (GDP) per capita (e.g. Yin et al., 2003; Borsi & Metiu, 2013; Siljak, 2015; Cabral & Castellanos-Sosa, 2019), unemployment (e.g. Cuestas et al., 2015; Monfort et al., 2018), labor productivity (e.g. Doyle & O'Leary, 1999), trade (e.g. Jena & Barua, 2020), energy consumption (e.g. Markandya et al., 2006; Kounetas, 2018; Kasman & Kasman, 2020), CO_2 emissions (e.g. Jobert et al., 2010; Herrerias, 2012; Marrero et al., 2021), life satisfaction (e.g. Welsch & Bonn, 2008). These studies in the literature show that convergence can be

observed not only in the economic sense, but also in many other areas related to the economy.

As it is understood from the studies in the literature, it is possible to talk about an economic and financial convergence in EU countries, and this convergence is especially supported by policy makers. The liberalization of the circulation of goods also causes an increase in the flow rate and amount of these goods between countries. Here, it forms the need for the transportation of these goods to be conducted quickly and systematically. As commercial activities between countries increase and income converges, a similar effect is likely to be seen in the transportation sector, which has a derived demand structure. The main reason for such an effect can be shown as converging welfare levels and developing technology. As countries' level of well-being increases due to income convergence, people may tend to consume more goods, increasing the need and demand for transportation networks (Cowie, 2009). Additionally, thanks to the ongoing technological developments, the share of transportation costs in the final price of the product decreases due to the decrease in absolute transportation costs and increase in fleet productivity (Ma, 2020). This leads to an increase in the demand for the cheaper products and therefore the need for the transportation network. However, the literature mostly concentrates on economic and financial issues and is insufficient to examine the possible convergence issue in the transportation sector.

On the one hand, the transportation sector also differs according to the types of cargo. Because production centers are concentrated in certain centers of geography due to economic concerns, raw material transportation routes and ports are concentrated at certain points. However, since container transportation is used to transport intermediate and final products (OECD/EUIPO, 2021), it has spread in much more general regions, because it is used to deliver products that each individual may need to consume. On the other hand, in the economy, it is important not only to produce but also to ensure that these products are delivered to the relevant markets in a healthy way. Because transportation options make it possible to reach many more customers, and transportation costs affect the price of the final product, affecting the demand for that product. Additionally, in today's era, a global value chain is formed as many companies conduct their production in different countries. Production points are usually located in developing countries due to cost concerns (van Ham & Rijsenbrij, 2012). In this respect, container transportation makes great contributions to the formation of the global value chain as well (Greve et al., 2007). Therefore, the development of transport networks is an important requirement for sustainable economic development. In this study, we determined whether the connectivity of maritime container transport network, which is mostly used in the import and export of final products, converges among EU countries. For this purpose, by using the LSCI variable produced by the United Nations Conference on Trade and Development (UNCTAD), we determined whether transportation connectivity converges, whether economic integration has an effect on the transportation possibilities of countries, and whether the network capacities of countries with weak transportation networks and countries with strong transportation networks converge. As a result of the research, we found that the LSCI variable converges for EU countries and that economic integration also leads to improvement in the transport networks of countries with weak transport possibilities.

In the second section of the study, the method we used for testing the convergence is presented. Additionally, the LSCI variable that we used in the analysis and the descriptive statistics of the index values of the countries are introduced. In the third section, results of the necessary pre-tests for selecting the generation of panel unit root test and the implemented unit root test are presented. In the last section, the results are discussed, and the conclusions are made.

METHODOLOGY AND DATA

The convergence approach can be examined in two types as traditional and stochastic. Stochastic convergence can be analyzed with unit root tests. If it is desired to measure the convergence between two countries, univariate unit root tests are sufficient. However, if convergence is to be analyzed for more countries and regions, panel unit root tests are preferred (Naveed, 2017).

When analyzing the convergence with the panel unit root, it is assumed that there is a steady state for each unit. According to this approach, deviations of units from their long run steady state values should be temporary. The fact that shocks are temporary requires that the values of the units do not contain a unit root and be stationary. Here, the values of the units converge to each other in the long run. On the other hand, if the deviations from the steady state values are permanent, then the values of the units diverge from each other (Guetat & Serranito, 2007). Based on these assumptions and by using panel unit root tests, we tested whether the connectivity values of the container transportation network of the countries in the EU region converge. If the series do not contain a unit root and are stationary, it is concluded that the LSCI values converge. In the opposite case, it is concluded that the LSCI values diverge.

In panel unit root analysis, cross-sectional dependence and homogeneity in the series should be considered. To test

the cross-sectional dependence, we used LM test (Breusch & Pagan, 1980), CD and CDLM test (Pesaran, 2004) and LM adjusted test (Pesaran et al., 2008). To test homogeneity, we used Delta Tilde and Delta Tilde adjusted (Pesaran & Yamagata (2008) tests. Since we detected cross-sectional dependence in our series, according to the results of this analysis, we preferred to use Bootstrap IPS (Smith et al., 2004) and Bootstrap Hadri tests, which are robust unit root tests in case of cross-sectional dependence.

Bootstrap IPS (Smith et al., 2004) test is an improved version of the IPS test (Im et al., 2003) and Bootstrap Hadri test is improved version of the Hadri test (Hadri, 2000). On the one hand, the Bootstrap IPS (Smith et al., 2004) test is a unit root test, and its null hypothesis is that the series contains a unit root. On the other hand, the Bootstrap Hadri test is the stationarity test, and the null hypothesis is that the series is stationary. We applied the Bootstrap IPS test as the primary test and the Bootstrap Hadri test as the supporting test.

We chose the LSCI variable to represent transport networks for two reasons. First, due to the market structure, container ships regularly follow certain routes. This specification provides a regular and dynamic indicator for the countries visited by the ships. For bulk cargoes, route distribution and cargo volumes are generally irregular, as tramp shipping is generally used. Second, a more comprehensive situation arises as the final products are transported in container transportation and there is a demand for these products from every country. However, the traffic of bulk cargoes is concentrated only in certain production centers. For these reasons, we thought that the effects of economic convergence in countries could be seen more clearly in container transportation network.

Our dataset consists of Liner Shipping Connectivity Index (LSCI) scores of 22 EU countries. The LSCI developed by UNCTAD has six components that form the index which are "(i) the number of scheduled ship calls per week in the country; (ii) deployed TEU capacity offered at the country; (iii) the number of regular liner shipping services from and to the country; (iv) the number of liner shipping companies that provide services from and to the country; (v) the average size in TEU of the ships deployed by the scheduled service with the largest average vessel size; and (vi) the number of other countries that are connected to the country through direct liner shipping services". The index was determined as 100 for China in 2006 and the calculations of other countries are made based on China (UNCTAD, 2020a). The fact that the index has been published since 2006 causes our data to remain short, but it is hoped that this situation may not be a major obstacle in terms of analysis.

Table 1. Descriptive statistics of panel dataset

Country	Mean	Median	Max	Min.	Std. Dev.	Skew.	Kurt.	Obs.
Belgium	81.18	79.85	89.50	72.49	4.62	0.02	1.92	61
Bulgaria	7.48	6.94	16.56	5.27	2.34	2.76	10.95	61
Croatia	21.89	19.84	34.26	7.96	7.87	0.12	1.78	61
Cyprus	17.03	17.33	20.20	12.28	1.61	-0.90	4.22	61
Denmark	37.36	42.74	47.76	21.72	9.30	-0.48	1.54	61
Estonia	8.26	8.22	12.41	6.00	1.52	0.74	3.07	61
Finland	14.71	14.70	18.75	12.75	1.31	0.86	3.73	61
France	66.55	67.66	79.29	56.83	6.93	0.08	1.60	61
Germany	81.85	82.45	85.53	76.07	2.39	-0.43	2.05	61
Greece	41.93	41.19	60.31	25.00	10.96	0.38	2.03	61
Ireland	11.45	11.52	14.12	7.68	1.59	-0.56	3.16	61
Italy	63.36	62.89	77.14	54.19	5.22	0.62	3.45	61
Latvia	7.87	7.57	10.81	5.72	1.23	1.07	3.49	61
Lithuania	12.69	11.68	30.78	5.61	4.70	1.44	5.70	61
Malta	41.22	42.82	56.57	26.59	7.57	-0.26	1.94	61
Netherlands	82.19	81.25	92.16	71.35	5.08	0.29	2.50	61
Poland	35.17	43.61	56.67	8.88	16.49	-0.55	1.79	61
Portugal	43.01	44.38	59.91	26.42	8.17	-0.33	3.26	61
Romania	22.79	22.79	27.65	15.99	3.30	-0.30	1.74	61
Slovenia	23.74	21.47	35.47	12.50	7.28	0.25	1.67	61
Spain	77.78	75.43	89.97	65.45	6.81	0.28	1.71	61
Sweden	40.38	41.86	51.77	26.85	8.52	-0.34	1.49	61
All	38.18	30.68	92.16	5.27	26.63	0.49	1.85	1342

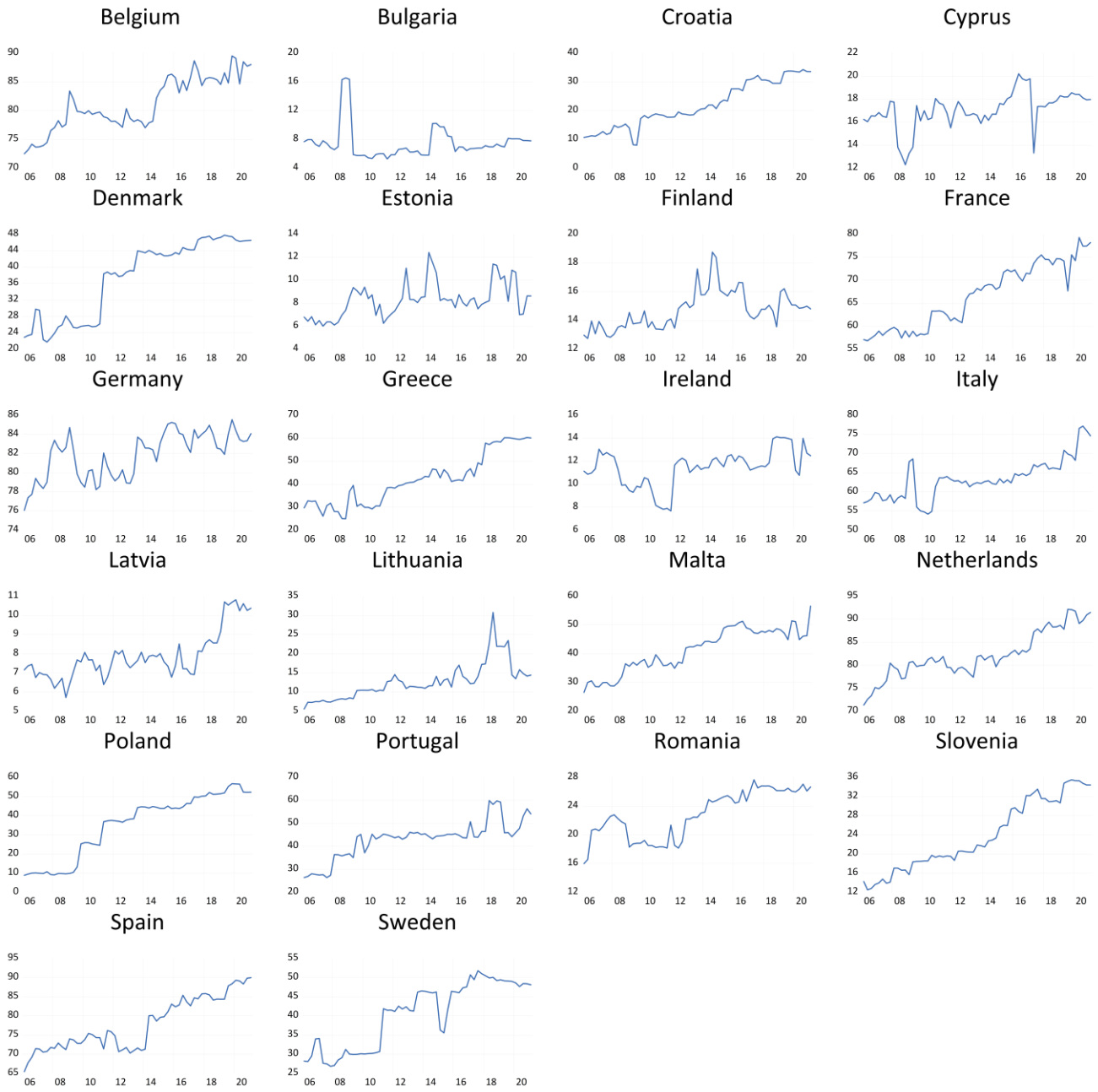

Figure 1. Graphical display of variables

Liner Shipping Connectivity Index values are obtained from UNCTAD (2020b). The dataset covers the period between the first quarter of 2006 and the first quarter of 2021. The included EU countries are Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, and Sweden. Since their LSCI values do not exist, Austria, Czechia, Hungary, Luxembourg, and Slovakia cannot be included in the sample. Therefore, the EU panel sample includes LSCI of 22 countries and consists of 1342 (22×61) observations. Descriptive statistics for each country included in the sample are presented in Table 1. When the mean values are examined, the countries with the highest LSCI values are the Netherlands (82.19), Germany (81.85), Belgium (81.18) and Spain (77.78), respectively. The countries with the lowest values are Bulgaria (7.48), Latvia (7.87), Estonia (8.26) and Ireland (11.45), respectively. The standard deviation values provide information about the size of the deviations in the LSCI values in the relevant countries. Considering the factors that make up the content of the LSCI variable, it can be said that there are great changes in the number of ships calling in the country, the number of companies providing regular line service and the average ship size calling into the country. These deviations may be caused by business strategies, political factors, and trends in global trade. While some

countries have positive changes, some countries have experienced negative changes. The graphs of the index values of the countries are presented in Figure 1.

In the next section, cross-sectional dependency and homogeneity tests were applied for a unit root selection to EU countries using the LSCI index. Then, appropriate unit root tests were selected and applied.

RESULTS

To select the most appropriate panel unit root test for the data set, the series should be examined in terms of cross-sectional dependence and homogeneity. LM test (Breusch & Pagan, 1980), CD and CDLM test (Pesaran, 2004) and LM adjusted test (Pesaran et al., 2008) were applied to the series by using GAUSS 19 to evaluate cross-sectional dependence and the results are presented in Table 2 for the EU countries. 6 lags were selected for the analysis since the sample was quarterly. LM, CD and LM adjusted tests can be used in the case of T>N and according to the applied cross-sectional dependency test results, null of no cross-sectional dependence hypothesis is rejected by all tests. The table also includes homogeneity test results conducted by Delta Tilde and Delta Tilde adjusted tests. The results show that the null of homogeneity is rejected for the EU countries. According to these results, it has been revealed that the use of second-generation unit root and stationarity tests is more appropriate for the EU sample.

Table 2. Cross sectional dependence and homogeneity test results

Test	Stat	Prob
LM (Breusch & Pagan, 1980)	418.649	0.000*
CDlm (Pesaran, 2004)	8.730	0.000*
CD (Pesaran, 2004)	-2.943	0.002*
LMadj (PUY, 2008)	7.204	0.000*
Delta Tilde	4.909	0.000*
Delta Tilde Adjusted	5.039	0.000*

Note: * indicates that H_0 is rejected

Considering the heterogeneity and cross-sectional dependency in the structure of the data set, it has been determined that the application of second-generation unit root tests is necessary. We applied the Bootstrap IPS test as the primary test and the Bootstrap Hadri test as the supporting test. In the application of the tests, quadratic spectral was selected as variance estimator, maximum lags were selected as 6, block size was selected as 50 and number of bootstrap simulations was selected as 1000. In this direction, tests were applied by using GAUSS 19, and the results are presented in Table 3. The null hypothesis of the Bootstrap Hadri stationarity test is that the series is stationary. According to the results obtained, the null hypothesis could not be rejected in trend & intercept. This result shows that the variable is stationary. On the other hand, the null hypothesis of the Bootstrap IPS unit root test is that the series contains a unit root. According to the results obtained, the null hypothesis is rejected at the 10% confidence level in the intercept and at the 1% confidence level in the trend & intercept. The results obtained from both tests show that the series is stationary and does not contain unit root.

According to the analysis results, the LSCI variable converges for EU countries. The deviations in the long run steady state index values of the countries are temporary and the values tend to return to their average in the long run.

DISCUSSION AND CONCLUSION

The relationship between the transportation sector and the economy can be explained by the supply-led growth and demand-led growth models. According to the supply-led growth model, improving transportation infrastructures and increasing investments to these structures increase commercial activities and support economic development in the relevant regions. There are always potentials for supply and demand for various goods in any part of the world. However, in addition to marketing activities, transportation opportunities and costs are important obstacles for these goods to reach the relevant places. By providing the necessary investment and infrastructure opportunities, these obstacles can be removed, and commercial activities can be realized. In this context, the developments in the LSCI variable also affect the transportation costs negatively (Fugazza & Hoffmann, 2017) and contribute positively to exports (Şeker, 2019). According to the demand-led growth model, there is a demand for certain goods first and as a result of this demand, transportation infrastructure and investments are needed. This situation leads to an increase in investments in the transportation sector and facilitating commercial activities. Whatever the direction, supply or demand led, there is a very close relationship between transportation possibilities and economic activities. Situations such as increasing commercial activities and facilitating the mobility of capital and production factors cause the gap between economically poor countries and rich ones to decrease over time. In this way, the distribution of income and welfare is balanced, and the countries converge to each other. This convergence can be seen more clearly in regions with high integration, such as the European Union. In addition, economic integration is implemented as a policy in such regions. As a result, there is economic convergence in the European Union countries, both politically and empirically. In economic terms, this convergence is likely to show its effects in the transportation sector, which is the most

Table 3. Results of stationarity and unit root tests

Tests		Intercept	Trend and Intercept
Bootstrap Hadri	Panel – Z	14.578	4.254***
	Bootstrap CV. 10%	4.114	2.337
	Bootstrap CV. 5%	6.080	3.126
	Bootstrap CV. 1%	10.844	4.738
Bootstrap IPS	t-bar statistic	-1.761*	-2.827***
	p-value for t-bar	0.097	0.000

Note: *** indicates acceptance at 99% for Bootstrap Hadri and rejection at 1% for Bootstrap IPS; * indicates rejection at 10% for Bootstrap IPS.

important factor supporting commercial activities. Because as the welfare level of economically poor countries increases, their demand for goods will also increase, which will require the development of the transportation networks that the country needs. Thus, a convergence in transport networks is likely to be observed.

We chose container shipping to measure the convergence of transport networks. The first reason for this selection is that mostly final and high value-added goods are transported with this mode of transport. As the transport of raw materials will be around certain production centers, convergence may be somewhat more difficult to observe. Because final products are demanded by all people, while raw materials are demanded only by industrial production centers. The second reason is related to data availability. Since raw material transportation is mostly conducted on irregular lines and under perfectly competitive market conditions, there is no regular indicator of transport network of every country. However, since container transportation is generally monopolistic and oligopolistic, there are regular voyages to countries. In addition, the demand for cargoes also requires regular transport activities because there are many cargo owners on a single ship. Therefore, considering the LSCI variable, we analyzed whether the liner shipping connectivity in EU countries converged.

As a result of the analysis in which we measured stochastic convergence using panel unit root tests, we determined that the panel data set did not contain a unit root, was stationary, and thus the series converged. Additionally, according to the results of the cross-sectional dependence test, we found that there is a dependency in the dataset and that the shocks (changes) in the LSCI value of a country also affect other countries. Considering the integrated structure of the European Union, it is clear that this result is quite normal. The convergence of LSCI values may also be related to the increasing welfare levels of the countries. As the welfare levels of economically converging countries increase, their demand for goods also increases. Since the transport sector also has a derived demand structure, convergence in the economy also affects transport networks. This situation causes convergence in terms of connectivity in the transportation sector. The gap between countries with weak transport network and countries with strong transport network is decreasing over time. This situation emerges because of both EU policies and the globalizing world. Additionally, increased efficiency and technological development in the fleets for various reasons over time have led to a decrease in absolute transportation costs. This reduction has encouraged trade and increased the number of stakeholders interested in commercial activities, which has consequently resulted in a convergence in transportation networks. In conclusion, our findings show that the process of economic integration not only contributes to the economic income of poor countries but also leads to improvements in their transport networks. Here, strategic partnerships to be established between countries by considering the strong sides of them contribute to collective development.

As a result, the fact that the subject of examining the transportation sector in terms of convergence in the literature does not attract the attention of enough researchers has formed our motivation. By choosing an economically, politically and geographically integrated region such as the EU, we identified the similar impact of economic convergence on transport. We made an original contribution by finding that, in addition to the convergences in GDP, unemployment, and trade determined in the literature, there is also convergence in the liner shipping transport. In future studies, the issue of convergence in transportation can be examined in terms of different regions. For countries with similar characteristics in various profiles, the subject can be discussed again.

Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Are Housing and Ship Demolition Markets Integrated? Evidence From Turkey

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ABSTRACT

The purpose of this study is to investigate the impact of the demand for new houses to ship demolition prices in Turkey through new house sales statistics and Turkish ship demolition prices. In this direction, asymmetric causality test is used which allows to separate the shocks contained in the variables and to determine the causal relationships between these shocks. According to test results, causality relations are determined from positive shocks in house sales to positive shocks in demolition price and from negative shocks in house sales to negative shocks in demolition price. On the other hand, any significant causality from demolition prices to new house sales cannot be determined. This situation shows that changes in the new house sales are determinative for ship demolition prices in Turkey.

INTRODUCTION

Ship demolition market is affected by both maritime developments and developments in other sectors using iron, and this situation causes it to have a complex structure. The effect stem from the developments in the freight market is due to the supply of ships in the market. Since the supply in maritime transport is inelastic in the short run, it cannot respond to increasing demand immediately and freight rates may rise to high levels in a short time. Accordingly, new ship orders increase due to increased revenues and when these new ships enter the market, they generate surplus supply in the market. As the operational costs of the new ships are lower than the old ones, the old ships cannot compete with the new ships when the freight is very low. Old ships that cannot carry out transportation in the market are sent to demolition and their commercial life is terminated if the price offered by demolition yards is at satisfying levels. Then the freight levels in the market decreases and forms a new equilibrium rate (Buxton, 1991). Since the freight rates consequently increase and decrease in the long run, researchers define structure of freight market as mean-reverting (Tvedt, 2003).

The ship demolition market is centered in a few number of countries in the world which are Bangladesh, India, Pakistan, Turkey and China. In 2020, their shares in the market are 40.4%. 30.5%. 17.4%. 9.2% and 1.1% respectively (UNCTAD, 2021). In times gone, demolition activities were conducted in many different countries, however these activities have been displaced over time due to the search for cheap labor and the regional demand for recycled steel (Stopford, 2009).

Prices in the demolition market are also determined by the demand for scrap iron in that country. Therefore, the demolition sector has a complex and non-linear structure, because the offer of a higher demolition price does not always mean more ships are to be dismantled, or the suggestion of a lower demolition price does not always mean that fewer ships are dismantled. This requires an asymmetric network of relationships. In the literature, there are several studies examining the relationship between the demolition

market and the freight market (Açık & Başer, 2017; Açık & Başer, 2018a), its relationship with the international scrap market (Kagkarakis et al., 2016) and its relationship with the construction market (Açık & Baran, 2019). However, studies examining the relationship of scrap iron with the housing sector, which is one of the biggest customers of demolition sector, are just emerging. The impact of ship demolition prices on construction costs in Turkey has been investigated by Açık & Baran (2019) and it has been found that positive demolition price shocks have triggered positive construction cost shocks. However, this study has not examined the possible impact of the construction sector on the demolition market. Since the demolition prices have an impact on construction costs, the housing sector can be considered a customer for the ship demolition market that can have an impact on the ship demolition prices. However, this question remains unclear in the literature. The new housing sales volume, which is an objective indicator of the construction sector away from inflation and nominal values, is considered as a reliable indicator to determine the interaction with the demolition sector, and the effect of the housing sector on the demolition market is examined by asymmetric causality method.

As the changes in the new housing sales amount indicate the demand for new houses, it is inevitable that the changes in demand may affect the prices in the ship demolition sector. On the other hand, as the ship demolition sector is also affected by developments in the freight market, its relationship with housing sector is likely to be asymmetric. Therefore, the asymmetric causality method proposed by Hatemi-J (2012a) is considered to be appropriate for the purpose of this study. The results show that the increase in new house sales is reflected in the increase in ship demolition prices, indicating that demand for new house sales is important for the Turkish ship demolition sector.

The literature on ship demolition market is presented in the second section, and the framework of the study is drawn. The method used in the research is introduced in the third section. After examining the data set, the findings obtained from analyzes are presented in the fourth section.

LITERATURE REVIEW

Studies in the literature have approached the ship demolition market from six main aspects; (i) its relationship with the freight market (Açık & Başer, 2017; Açık & Başer; 2018a); (ii) its relationship with the demolition market (Kagkarakis et al., 2016; Açık & Başer, 2019); (iii) its relationship with the construction sector (Açık & Baran, 2019); (iv) the ship owners' decision for demolition in different market conditions (Yin & Fan, 2018); (v) the factors affecting the probability of demolition in major yards (Knapp et al., 2008); (vi) process of ship sale for demolition (Karlis & Polemis, 2016); (vii) its relationship with steel prices (Tunç & Açık, 2019); (viii) and its relationship between interest rate (Açık et al., 2020).

The ship demolition market is also related to the freight market and its structure becomes asymmetrical. In the first of the studies related to the freight market, Açık & Başer (2017) discussed the relationship between freight rates and the tonnage of ships sent for demolition with a general analysis. At the end of the study, the authors found a negative correlation between the freight rates and the tonnage of the ship demolished. This situation is interpreted as the inability of the old ships against falling freight levels when excess supply occurs in the market. In addition to freight rates, interest rates also have a negative effect on the tonnage of ships sent for demolition, as they affect the cost of purchasing new or second hand ships (Açık et al., 2020). On the other side of the complexity, ship demolition prices are placed, because ship demolition prices are an evaluation criterion for older ships in the market and high prices can be effective in demolition decisions of shipowners as also mentioned by (Knapp et al., 2008). In this respect, the study examining the issue was again conducted by Açık & Başer (2018a) and the relationship between freight rates and demolition prices was examined. The study found a positive correlation between freight rates and ship demolition prices, and this was attributed to two factors: (i) the high demolition price is indicative of a buoyant economy, which consequently causes high demand for transport resulting in a high freight rates (ii) demolition yards offer higher prices to ships due to the low number of ships sent to the demolition due to high freight rates.

Since the customers of the ship demolition market are the sectors that use scrap iron, it is likely to have a relationship with global scrap iron market. The share of ship demolition in the global scrap market is very low (Mikelis, 2013), which prevents it from assuming a price-determining role. Even this situation causes ship demolition prices to be inefficient, which means prices can not follow random walk (Açık & Başer, 2018b). The relationship between international scrap prices and ship demolition prices was analyzed by Kagkarakis et al. (2016) using Granger causality analysis. They determined one-way causality from the international scrap steel price to the ship demolition price, which confirms the inability of price-determination for ship demolition market. In addition to being influenced by global scrap prices, Açık & Başer (2019) conducted a study showing that they follow each other's prices while setting demolition prices. On the customer side of the ship demolition market, a paper very close to the subject we have examined in this

study was carried out by Açık & Baran (2019). The authors examined the effect of Turkish ship demolition prices on construction costs in Turkey with an asymmetric causality test. The results revealed that positive shocks in the demolition price were identified as the cause of positive shocks in construction costs in Turkey. The main reason for this is that steel prices are closely related to ship demolition prices and they significantly affect demolition prices as indicated by Tunç & Açık (2019). Considering the interaction in previous study, in order for ship demolition prices to affect construction costs, the housing sector must be a customer of the demolition market. Therefore, it is inevitable that developments in the housing sector will affect the demolition market, and this is a question mark in the authors' work. In this respect, our study assumes a complementary role and examines the impact of changes in Turkish new house sales on Turkish demolition prices and makes an original contribution to the literature.

METHODOLOGY

Many statistical methods are used to examine the relationships between variables. Their choices may vary according to the data available, the desired result and the theoretical point of view. One of the most common is causality tests and was first developed by Granger (1969). According to this method, if own and past values of a series explain the present and future values of the other series better than its own values, a Granger causality can be mentioned among them (Dura et al., 2017). However, in later studies, it has been shown that linear causality analysis failed to identify nonlinear relationships between the variables (Adıgüzel et al, 2013; Bal & Rath, 2015; Kumar, 2017).

Asymmetric causality method proposed by Hatemi-J (2012a) is one of the methods developed by considering standard linear causality as insufficient. This method separates the shocks of the variables as negative and positive, and presents the causal relationship between these shocks in four different combinations. It includes the view of Toda & Yamamoto (1995) test and considers the possible nonlinear structures in the series (Shahbaz et al, 2017). Given that asymmetric positive and negative shocks can produce different causal impacts (Hatemi-J, 2012b), it provides a very good advantage in diversifying the results. Hatemi-J (2012a) uses bootstrap simulations in order to calculate critical values, since the possible autoregressive conditional heteroscedasticity in the series should be evaluated (Tugcu et al., 2012). Therefore, thanks to the leverage corrections, this method provides more accurate critical values (Hatemi-J & Uddin, 2012). In addition, the asymmetric test does not oblige to data to be normally distributed and this provides a great advantage (Hatemi-J, 2012a) considering that financial series are exposed to too many unexpected shocks and events causing non-normal distributions.

In this method, the series do not have to be stationary since it includes Toda & Yamamoto (1995) process, but the maximum degree of integration needs to be found (Umar & Dahalan, 2016). It is investigated by unit root tests and if there is unit root, additional lag(s) is added to established unrestricted vector autoregression (VAR) equations (Hatemi-J & Uddin, 2012).

If signs of nonlinear structures can be detected, it can be said that nonlinear methods are more appropriate (Lim & Ho, 2013). In this direction, before the application of the asymmetric causality test, BDS (Broock et al., 1996) Independence test, ARCH LM (Engle, 1982) test, Ljung-Box (Ljung & Box, 1979) test and Normality test are applied to the residuals of autoregressive moving averages (ARMA) models developed for each variable in order to investigate non-linear structures.

DATA AND FINDINGS

Among the variables discussed, the house sales variable includes the first sales amounts of mortgaged and other sales types in Turkey. Second hand house sales statistics are excluded from the study considering the lack of relationship with construction iron. The Turkish demolition and house sales data consists of 77 monthly observations and covers the period between January 2013 and May 2019. The graphical display of the variables is presented in Figure 1. In the graph, the sudden decline in house sales due to the recent economic fluctuations and the rise in interest rates can be clearly seen.

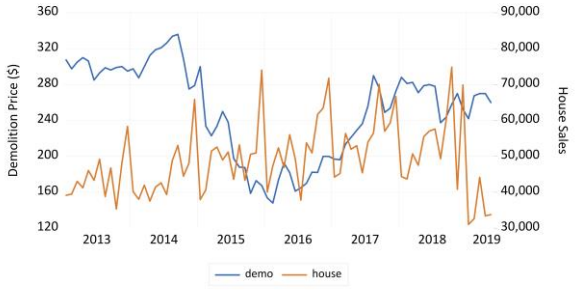

Figure 1. Graphical display of the variables (Sources: Athenian Shipbroker, 2019; TurkStat, 2019)

Descriptive statistics of the demolition price and house sale are presented in Table 1. In the period under consideration (January 2013-May 2019), an average of 49 thousand new houses have been sold per month. Sales increased to 75 thousand at most while the lowest was 31 thousand. In the demolition prices, pricing is made based on US dollars per Light Displacement Tonnage (LDT), which is used for measurement of the steel content of the ships. The

total demolition value is calculated by multiplying LDT by the current demolition price (Allum, 2013).

Table 1. Descriptive statistics of the variables (Sources: Athenian Shipbroker, 2019; TurkStat, 2019).

Variables	Demo	House	Δ Ln Demo	Δ Ln House
Mean	251.5	49186	-0.002	-0.001
Med.	267.5	48255	0.006	0.02
Max.	336	74815	0.16	0.53
Min.	148	31048	-0.24	-0.81
Std. Dev.	51.1	9907	0.07	0.24
Skew.	-0.42	0.63	-0.85	-0.97
Kurt.	1.99	3.07	4.64	4.40
J-B.	5.52	5.18	17.8	18.3
JB Pro.	0.06	0.07	0.00	0.00
Obs.	77	77	76	76

The logarithms of the series have been taken before the analysis in order to increase the processability of the series and to make the discrete data continuous. In addition, better distribution properties may be obtained by doing so. The statistics of the variables that are converted to return series via formula given in the Equation (1) are also presented in the table. When the distribution of return series is examined, it is seen that they do not show normal distribution and this situation may indicate that they are not linear. However, this information needs to be verified by improved nonlinearity indicators.

$$R_t = \ln(P_t) - \ln(P_{t-1}) \quad (1)$$

Since the method used in the study follows Toda & Yamamoto (1995) process, the stationarity of the series is not compulsory. Only the maximum integration degree needs to be determined. For this purpose, Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Philips Perron (PP) (Phillips & Perron, 1988) tests are performed. The results presented in Table 2 indicated that, the null of unit root has been rejected at level for hose sales variable, while the null of unit root for demolition price has been rejected at first difference. In this case, house sales are determined as I (0) and demolition prices as I (1), which indicate that maximum order of integration (dmax) value is 1.

Granger causality test has been also performed to determine the possible linear relationship between the variables and the results are presented in Table 3. In order to apply the standard Granger causality analysis, the series must be stationary. Therefore, the level of house sales and the first difference of demolition have been used. The most appropriate lag for VAR equations has been chosen as maximum 7, and it has been determined that the fourth lag having the lowest Akaike information criterion (AIC) value (-2.80) is the optimal lag. The results revealed that, no significant causal relationship has been found. This provides an indication that it is not possible to obtain results with linear methods in nonlinear variables. Therefore, the non-linear structures of the series are examined and the appropriateness of the asymmetric causality test is checked in the further sections.

In order to examine the nonlinear structures in the variables, the most appropriate ARMA models are estimated for both variables in return form. When the residuals of the model are separated, the series is freed from the deterministic parts. Afterwards, ARCH LM, BDS Independence, Normality and Ljung-Box tests are applied to the residuals of the model. The rejection of the null hypothesis in any of these tests can be interpreted as a sign of nonlinear structures. Firstly, ARMA (1, 8) model with -2.62 AIC value has been found as the most appropriate one for demolition price. As a result of the tests applied to the residuals, the null hypothesis has been rejected only in the normality test. Secondly ARMA (11, 2) model with -0.53 AIC value has been found as the most appropriate one for house sales. When tests were applied to residues, the null hypothesis has been rejected in ARCH LM, BDS Independence and Ljung-Box tests. Accordingly, it may be concluded that the housing sales variable has a strong nonlinear structure and the demolition price variable has a weak nonlinear structure. In this case, asymmetric causality test can be applied and the results can be interpreted safely.

Table 2. Unit root test results

		Level		First Difference	
	Variable	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
ADF	Ln House	-6.56***	-6.73***	-10.6***	-10.7***
	Ln Demo	-1.57	-1.39	-7.95***	-8.03***
PP	Ln House	-6.85***	-6.95***	-20.6***	-22.6***
	Ln Demo	-1.68	-1.53	-7.82***	-7.75***

Note: Critical Values: -2.58* for 1%0, -2.90** for 5%, -3.51*** for 1% at Intercept; -3.16* for 10%, -3.47** for 5%, -4.08*** for 1% at trend and intercept.

Table 3. Standard granger causality test

H_0 Hypothesis	Chi-Square	DF.	Prob.
House does not granger cause demolition	6.68	4	0.15
Demolition does not granger cause house	5.43	4	0.24

Table 4. Asymmetric causality test results

		House => Demolition				Demolition => House			
		H^+D^+	H^+D^-	H^-D^-	H^-D^+	D^+H^+	D^+H^-	D^-H^-	D^-H^+
Optimal Lags; VAR(p)		1	1	1	1	1	1	1	2
Additional Lags		1	1	1	1	1	1	1	2
Test statistics (MWALD)		3.72	0.14	6.85	0.92	0.16	1.30	1.36	2.32
Asym. chi-sq. p-value		0.05*	0.70	0.00*	0.33	0.68	0.25	0.24	0.12
Critical Values	1%	10.4	10.7	11.3	7.84	6.30	8.54	7.98	7.39
	5%	4.72	5.03	4.39	4.50	3.57	4.74	3.59	4.58
	10%	3.06	2.96	2.85	2.86	2.61	3.04	2.59	3.12

The two-way causality test results between the variables are presented in Table 4. The results revealed that, significant causal relationships have been found only from the house sales variable to demolition prices. Positive shocks in home sales are the cause of positive shocks in the demolition price, and negative shocks in home sales are the cause of negative shocks in the demolition price.

DISCUSSION AND CONCLUSION

The ship demolition sector is complex due to its relationship with both the freight market and the iron and steel market. It is affected both by the developments in the freight market and by global scrap prices. This situation makes it difficult to determine econometric relations by linear methods. When the literature on ship demolition sector is examined, it is observed that the studies made on the customers of ship demolition sector are insufficient. In particular, there are almost no studies examining the relationship between ship demolition and construction sector. The only study available in the literature was conducted by Açık & Baran (2019) and the impact of the change in ship demolition prices on Turkish construction costs was examined. The authors found that positive shocks in ship demolition prices were the cause of positive shocks in construction costs. These results show that the construction sector is a customer of the ship demolition sector. However, in the study conducted by the authors, the impact of the housing sector on the ship demolition sector was not examined and constitutes an important gap. Our study examines the impact of the construction sector on ship demolition market by taking on an integral role using the number of new house sales in Turkey. Our results show that the increase in house sales leads to an increase in ship demolition prices and the decrease in house sales causes a decrease in ship demolition prices, and indicate that the Turkish construction sector is effective in Turkish demolition market prices.

These results show that new house sales numbers in Turkey can be used as a leading indicator for ship owners who want to evaluate their ships in the Turkish demolition market. This is because there is an asymmetric causality relationship from house sales to demolition prices. Past and current house sales values can significantly explain future demolition prices. Furthermore, considering the fact that other ship demolition prices follow Turkish prices in the study conducted by Açık & Başer (2019), this indicator quality increases its importance for all international shipowners.

The limitation of the study is the available data set, and more results that are robust can be obtained if longer dataset is obtained. Further studies can obtain results that are more generalizable by examining the relationship discussed here with panel data sets for countries with intense ship demolition activities.

Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Effects of Temperature and Nitrogen Concentration on Growth and Lipid Accumulation of the Green Algae *Chlorella vulgaris* for Biodiesel

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ABSTRACT

This study investigated the effect of different temperatures and different nitrogen concentrations on the lipid content and biomass of *Chlorella* microalgae. In this study, algae were cultured in five media with different amounts $NaNO_3$ as 3, 1.5, 0.80, 0.40 g/L, and three temperatures (10, 20, 30 °C). The results of the experiments showed that the optimal temperature and nitrogen concentration for the biomass increase in *Chlorella vulgaris* are 30°C and 3 g/L, respectively. It was observed that biomass decreased and lipid amount increased due to the decrease in nitrogen concentration. The high lipid amount of 20.80% dry weight (DW) was obtained from the algae produced at 30°C in the free-nitrate medium. The contribution of temperature change to lipid production was not as effective as nitrogen deficiency in the study. According to the fatty acid analysis results made by GC-FID, *C. vulgaris* seems suitable for biodiesel production because it contains medium-length (C16-C18) fatty acid chains.

INTRODUCTION

The world population is increasing day by day, and it is predicted that the world population will increase by 1.5 times in 2050 (Sajjadi et al., 2018). Fossil fuel reserves, which use for a significant part of the energy need in the world, are rapidly being depleted. The efficient use of energy is even more vital today due to the rapid decrease in fossil fuels and the increase in fuel demand (Widjaja et al., 2009). In addition to the depletion of oil reserves, another essential issue that should not neglect is the rapidly emerging environmental pollution (Liew et al., 2014). Therefore, the production and use of environmentally friendly, renewable, and sustainable energy resources are supported worldwide. Most of the renewable energy sources such as biodiesel, bioethanol, and biohydrogen are produced from plant sources. However, since more than 95% of its production produces in vital soil resources or arable lands required for living creatures and depletes freshwater used in irrigation, it is more harmful to both environment and economy (Sajjadi et al., 2018). In this case, the importance of alternative biofuel sources has increased. The most striking of these alternative sources recently are algae. Microalgae can produce lipids without the need for arable land. Microalgae are much more advantageous than terrestrial plants for potentially producing biodiesel in all regions of the World (Metting, 1996). Therefore, microalgae are considered an important

source of raw material for biodiesel (Li et al., 2008). However, not every microalgae species can be produced easily and quickly. The microalgae species selected for biodiesel production should both be able to increase its biomass rapidly and have high lipid content. However, algae containing a high number of lipids grow more slowly than those with low content (Vasudevan & Briggs, 2008; Deng et al., 2009). Chlorella is the first to come to mind because it can both produce rapidly, and its lipid content reaches approximately 14 to 22% of its dry weight when produced under normal conditions (Illman et al., 2000; Spolaore et al., 2006). Nevertheless, the quality and quantity of algal lipids exhibit changes depending on various environmental conditions such as temperature, nutrient, light intensity (Illman et al., 2000; Liu et al., 2008; Seyhaneyildiz Can et al., 2015).

Many studies have been conducted on the role of nitrogen and temperature in algal lipid accumulation (Dong et al., 2013; Olofsson et al., 2014). In the study conducted to determine the effect of nitrogen on lipid accumulation, it was observed that microalgal growth was negatively affected by nitrogen deficiency, whereas lipid accumulation increased (Lombardi & Wangersky 1991). The increases in lipid content vary by species (El-Baky et al., 2004; Pal et al., 2011; Olofsson et al., 2014). Also, nitrogen is the limiting factor for developing many species (Li et al., 2010; Park et al., 2012). Another important factor is temperature. Temperature is one of the environmental factors affecting algal development and lipid accumulation. Again, the effect of temperature on biomass and lipid accumulation varies from species to species (Xin et al., 2010; Park et al., 2012; Roleda et al., 2013).

The main objective of this study is to examine the synergistic or antagonistic effects of nitrogen and temperature on growth rate and lipid productivity of *Chlorella vulgaris*. For this purpose, *C. vulgaris* was cultivated at three temperatures using nutrient media containing five nitrogen concentrations. Additionally, optimum temperature and nitrogen concentration have been determined for both biomass production and lipid accumulation to determine the suitability for biodiesel production.

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MATERIAL AND METHODS

Microalgae

C. vulgaris Beijerinck (Chlorophyceae) used in the study was isolated from a fish pond in Ege University, Faculty of Fisheries, Izmir, Turkey. The isolated algae were transferred from agar plate prepared with f/2 nutrient medium (Guillard, 1975) to liquid culture medium.

Culture System

Trials were conducted in triplicate in 1000 mL Erlenmeyer flasks with 500 mL f/2 medium at different temperatures (10, 20, 30 °C) and different nitrogen concentrations (3, 1.5, 0.8, 0.4 g/L, and nitrate-free) to investigate the effects of nitrogen deficiency and temperature on biomass and lipid yield. All glassware and nutrient media used in the trials were sterilized by autoclaving for 15 min, at 121°C, 1-atmosphere steam pressure, to prevent contamination during production, and they were kept at room temperature for 24 h before inoculation. Algae in 20 mL test tubes were inoculated into 1mL Erlenmeyer flasks. The continuously aerated culture medium was kept constant at pH 7.5 with sodium bicarbonate and HCl buffer solution. In the 18-day experiment, the light intensity of 33.6 µmol photon was applied continuously to all experimental groups, and the cultures were shaken twice a day to prevent algae precipitation.

Microalgal Biomass Concentration

Algal dry weight was measured daily by a precision balance (Precisa XB 220A) for 18 days. Before measuring the dry weight, the algae were filtered with filtration papers, then washed with distilled water and dried at 100°C for 12 h (Lee, 1998). All measurements were conducted in triplicate. At the end of the culture period, all algal biomass was centrifuged at 4000 rpm for 5 min using a TD3 (800B) centrifuge. The algal biomass was washed with distilled water three times to cleaned biomass from nutrient media, and they were dried stored at −20°C for later analysis (Lee, 1998).

Cell Disruption and Lipid Extraction

Before starting to break up dried algae cells, 5 mL phosphate buffer solution (pH 7.4) was added to prevent side reactions. An aliquot (1 g) of the dry cell biomass was broken up in Bead-beater at 4800 rpm for 3 min. The algae broken up in Bead-beater were removed into centrifuge tubes, and 6 ml hexane per 1 g dry algae was added and centrifuged at a high-speed of 4000 rpm for 5 min. After 24 h, residual microalgae were separated from the lipid-hexane mixture using a filter paper with 0.50 µm mean pore diameter. The

hexane in the hexane-lipid mixture was evaporated at 60°C, and the remaining lipid was measured gravimetrically. Lipid amount was determined in terms of the percentage of dry weight (Lee, 1998).

Fatty Acid Composition

To determine the fatty acid compositions of lipids were used Perkin Elmer Clarus 500 gas chromatography (GC-FID) and fused silica RTX-2330 capillary column (30 m × 0.25 mm i.d. × 0.25 μm film thickness; Restek Corp., Bellefonte, PA, USA). Instrument check-out and determination of fatty acids of the samples was accomplished with a 37-component mixture (Supelco number 18919). As a carrier, helium was used at an injection-split ratio of 1/50 and a gas flow rate of 1.0 mL/min. The gas chromatography column was started to be heated. When the column temperature reached 100°C, 1 μL of the extracted lipids were injected. The column temperature was increased at 5°C/minutes from 100 to 180°C (for 10 min), and then to 250°C (for 20.7 min) at 3°C/minutes.

Statistical Analysis

The dry weight and the extracted lipid contents from the five groups were compared using a one-way ANOVA and Duncan's multiple comparison method. The level of significant difference was at $P<0.05$.

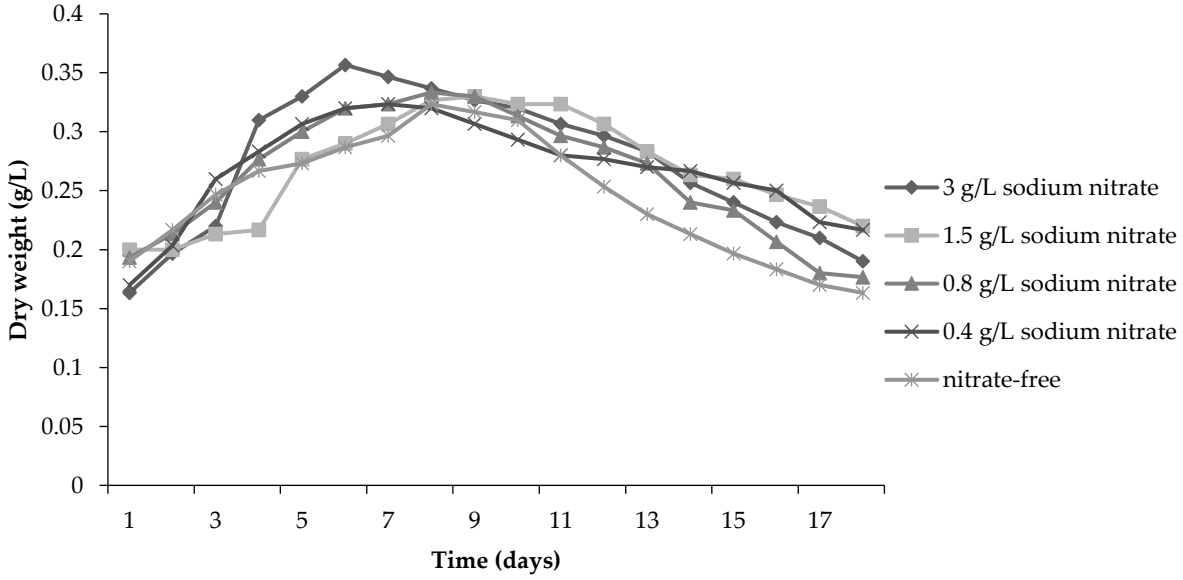

Figure 1. The dry weight of *C. vulgaris* cultured at 10°C

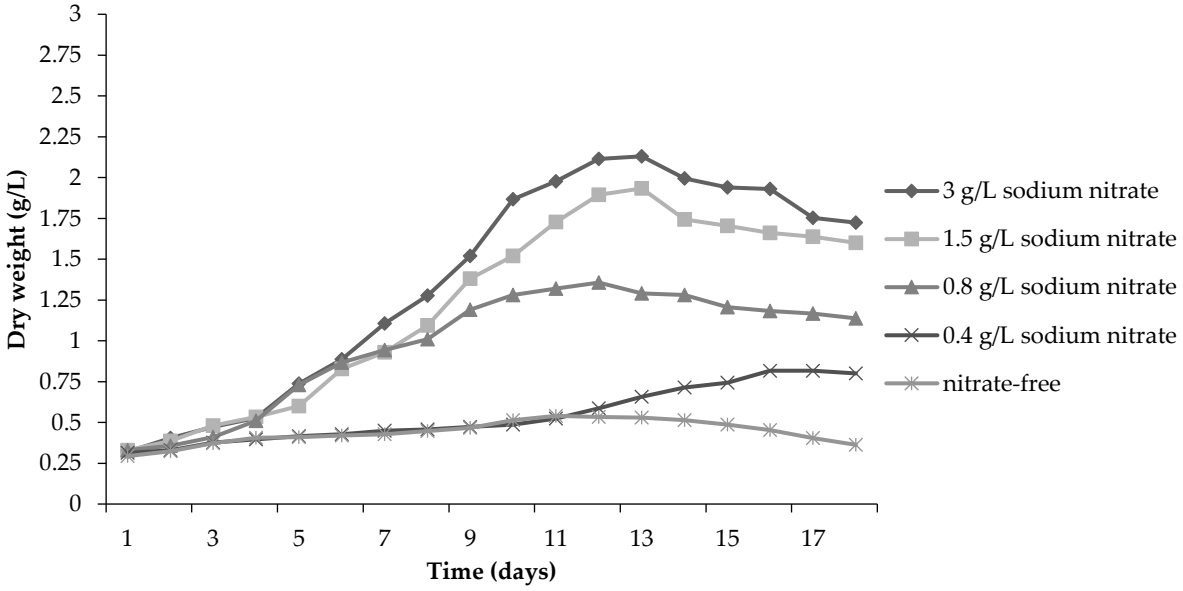

Figure 2. The dry weight of *C. vulgaris* cultured at 20°C

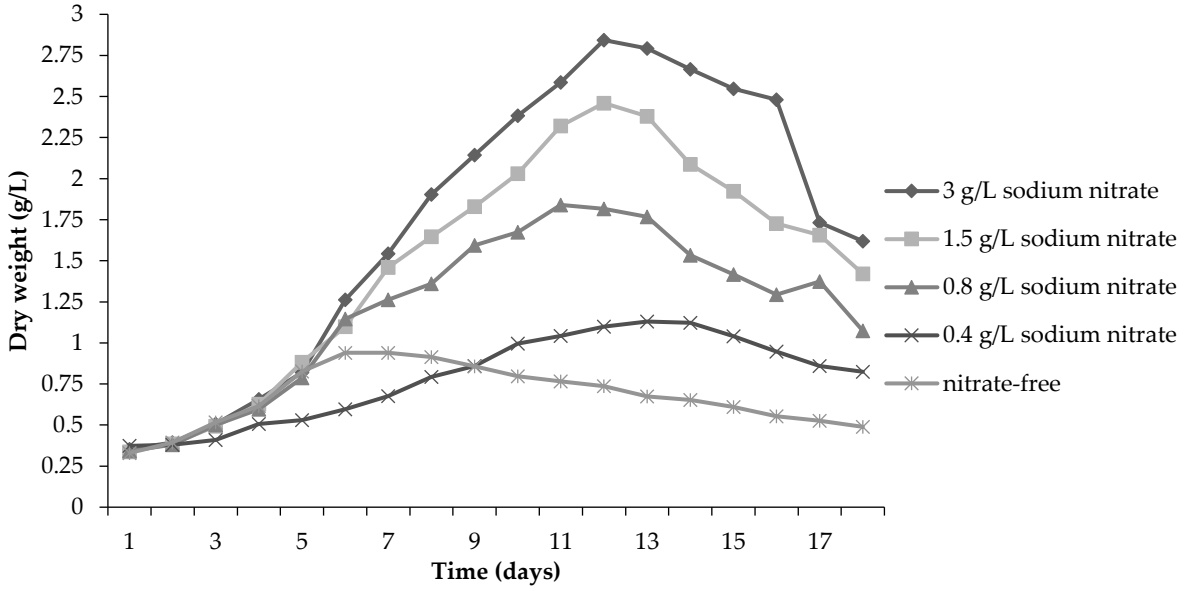

Figure 3. The dry weight of *C. vulgaris* cultured at 30°C

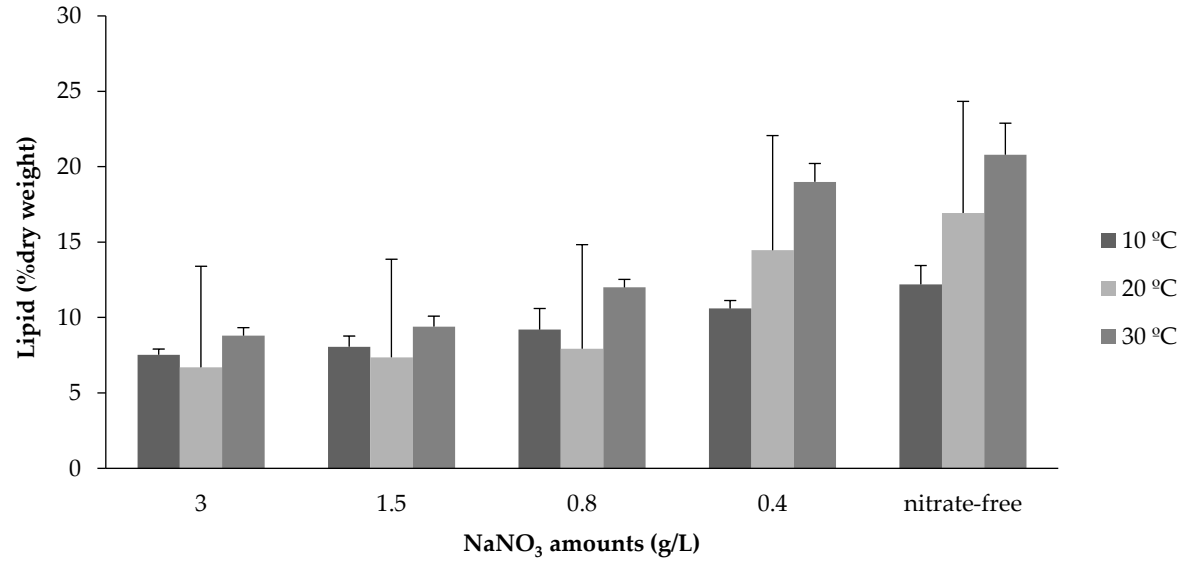

Figure 4. The total lipid amount of *C. vulgaris* cultured at different temperatures

RESULTS

Effect of Temperature and Nitrogen Concentration on Algal Biomass

Biomass slowly increased in algae culture at 10°C until day 9th and decreased in the following days (Figure 1). The maximum biomass obtained during the 18-day-old trial was determined as 0.357 g/L on the 6th day, in the nutrient medium containing 3 g/L $NaNO_3$ concentration. When the results of the experiment conducted at 20°C were examined, it was noted that the logarithmic phase continued until the 13th day in medium containing 3 g/L $NaNO_3$ concentration, and the maximum biomass was 2.13 g/L on the 13th day (Figure 2). The logarithmic phase continued until the 12th day for the trial conducted at 30°C, and again, maximum development was achieved as 2.84 g/L on the 13th day, with 3 g/L $NaNO_3$ concentrations (Figure 3).

The Effect of Temperature and Nitrogen Concentration on Algal Lipid Production

The changes in temperature and nitrate concentration led to significant changes in the cell composition, facilitating the accumulation of lipid components in microalgae during batch culture. In this study, reducing nitrate was more effective than the temperature for lipid accumulation. When the results of the study are examined, it was determined that

Table 1. Growth and lipid values for *C. vulgaris* microalgae cultured at different temperatures (mean ± standard deviation)

$NaNO_3$ (g/L)	10°C		20°C		30°C	
	DW (g/L)	*Lipid (% DW)*	*DW (g/L)*	*Lipid (% DW)*	*DW (g/L)*	*Lipid (% DW)*
3	0.273^{a}±0.06	7.53^{c}±0.38	1.371^{a}±0.75	6.700^{c}±0.20	1.735^{a}±0.87	8.80^{c}±0.53
1.5	0.268^{a}±0.05	8.07^{c}±0.71	1.221^{a}±0.59	7.367^{c}±0.25	1.487^{b}±0.69	9.40^{c}±0.69
0.8	0.263^{ab}±0.06	9.20^{bc}±1.40	0.976^{b}±0.44	7.933^{c}±0.50	1.209^{c}±0.49	12.00^{b}±0.53
0.4	0.2681^{a}±0.05	10.6^{ab}±0.53	0.544^{c}±0.17	14.467^{b}±1.10	0.788^{d}±0.34	19.00^{a}±1.22
Nitrate-free	0.245^{b}±0.05	12.2^{a}± 1.25	0.439^{c}±0.07	16.933^{a}±1.10	0.674^{d}±0.22	20.80^{a}±2.09

Note: *Different superscript letters (^{a}, ^{b}, ^{c}, ^{d}) indicate that the values of the means in the table are significantly different P<0.05*

the most efficient group in terms of lipid is the algae cultured in the nitrate-free nutritional medium at 30°C (Figure 4). In terms of biomass, the most productive group is algae cultured in a nutrient medium containing 3 g/L nitrate at 30°C (Table 1).

In this study, both the optimum and adverse conditions were created on algae to observe the change in lipid amounts. The following equation (1) was used to find the most efficient group in terms of lipid production in studies.

$$Lipid\ amount\ (g) = \frac{DW(g) \times lipid(DW\%)}{100} \quad (1)$$

According to the equation, it was determined that the most efficient group for both biomass and lipid is the culture in a nutrient medium of 3 g/L nitrates at 30°C (Table 1).

Table 2. The fatty acid content and concentration of *C. vulgaris*

Fatty acids	Fatty acid concentration (%)
Linoleic acid	23.89±0.04
Margaric acid	0.86±0.06
Miristoleic acid	1.66±0.03
Oleic acid	4.24±0.08
Palmitic acid	32.72±0.06
Palmitoleic acid	3.88±0.007
Stearic acid	10.15±0.006
Trans linolenic acid	20.76±0.004
Undecanoic acid	1.84±0.004

Fatty acid compositions of the lipids obtained from the most efficient group were determined by GC-MS (Table 2). Biodiesel is defined as fatty acid alkyl esters (FAAEs) derived from vegetable and animal oils. Biodiesel is mainly esters of six fatty acids: palmitic acid (C16: 0), stearic acid (C18: 0), oleic acid (C18: 1), linoleic acid (C18: 2), and linolenic acid (C18: 3) (Chuck et al., 2009). Table 2 shows that most fatty acids of *C. vulgaris* are essential fatty acids for biodiesel production. These results demonstrate that *C. vulgaris* is an appropriate species for biodiesel production.

DISCUSSION

Differences in the culture environment affect the biomass and cell contents of algae. Changes in algal growth and lipid production of cells have been more pronounced, particularly in nitrate deficiency, the essential nutrient (Pinto et al., 2003; Ip and Chen, 2005). All studies conducted with microalgae, it has been observed that algae accumulate lipids, especially triglycerides, despite nitrogen deficiency (Hsieh and Wu, 2009; Yeh and Chang, 2011; Sun et al., 2014). In this study, the response of *C. vulgaris* to varying nitrate concentrations was investigated. Dry biomass weight was used for *C. vulgaris* growth assessment. Results indicated that biomass decreased in response to declining nitrate concentrations, but conversely, lipid production increased. Similarly, other studies were reported that the growth of *Chlorella pyrenoidosa* and *Scenedesmus obliquus* decreased growth under nitrogen-deficient conditions (Mandal and Mallick, 2009; Nigam et al., 2011). In this study, there is an inverse relationship between the lipid produced by algae and nitrate concentration. The reason can be expressed as algae modifying their lipid metabolism to adapt to adverse conditions occurring in culture conditions (Su et al., 2011).

However, one of the main factors affecting the growth of fatty acids, lipids, and species produced by microalgae is the temperature (Renaud et al., 2002; Converti et al., 2009; Taoka et al., 2009). In this study, besides the nitrate concentration, the effect of different temperatures on the algae biomass and lipid content was also investigated. Algal biomass increased with temperature. However, the effect of temperature on lipid production was not significant as on algal growth. However, lipid production at 30°C was higher in all groups compared to other temperatures. The differences in both temperature and nitrogen concentration in the experiments made stress on *C. vulgaris*, and this stress caused a response as increased lipid accumulation. As seen in the literature, Illman et al. (2000) and Liu et al. (2008) reported that the amount and content of lipids inside the cell vary depending on factors temperature or light intensity. Temperature affects the physiological process by changing the speed and stability

of the chemical reactions of cellular components. However, this effect also depends on the strain species (Sandnes et al., 2005; Griffiths and Harrison, 2009; Van et al., 2012).

In this study, the suitability of *C. vulgaris* for biodiesel production was also tried to be determined. Therefore, the answer to the question of how to increase biomass and the amount of lipid was sought. Because biomass production is as significant as lipid accumulation for the efficiency of the study. We observed that the most productive group in terms of both biomass and lipid was the algae grown in medium with 3 g/L nitrogen at 30°C. Fatty acid analysis of this most productive group was made. The fatty acid profile of an alga determines the usage areas of that alga. For example, it is harmful to use an oil with a high erucic acid content as a food raw material. On the other hand, polyunsaturated fatty acids are highly nutritionally valuable (Sissener et al., 2018). Oils containing excessive amounts of free fatty acids reduce biodiesel yield by producing soap in reactions with alkali catalysts. Therefore, triglycerides containing long-chain fatty acids and oils containing less free fatty acids are preferred for biodiesel production (Ekin, 2019). According to the fatty acid analysis results of *C. vulgaris* in our study, it was seen that it contains high amounts of long-chain fatty acids (Table 2).

CONCLUSION

It was interesting data that lipid production increases by reducing nitrogen in the nutrient media. It was also noteworthy that the temperature was not as effective as nitrogen. However, if we want to produce fuel that can compete with petroleum both ecologically and economically, we must make a product that is more cost-effective and more environmentally friendly. For example, algae can be produced in wastewater. Thus, while the nutrient medium required for algal biomass is taken from wastewater, the polluting effects of wastewater are also reduced. Or, algae production facilities can be established in areas where the industry is concentrated, and thus, algae can reduce industry-source carbon dioxide. As the number of such applications to be conducted on a commercial scale increases, the biodiesel obtained from algal lipids will be superior to petroleum-based fuel.

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Compliance With Ethical Standards

Authors' Contribution

ŞSC designed the study and performed algae culture and lipid extraction from algae. EK prepared the literature. SC wrote the first draft of the manuscript. GT performed statistical analyses. HT assisted in laboratory work. TS helped in all phases of the studies. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Effect of *Homalothecium sericeum* (Hedw.) Schimp. Extract on SOD1 Activity in Rat Tissues (Kidney, Adrenal Gland, Ovary)

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ABSTRACT

Homalothecium sericeum (Hedw.) Schimp. is growing in habitats such as walls and roofs. It is supported by the studies that moss contains antioxidant, antimicrobial and antitumoral compounds. It was aimed to determine the immunoreactivity of Cu / Zn SOD enzyme in the kidney, adrenal gland, and ovarian tissues of rats due to the increase in the dose of moss extract. In this study, 1 mL of distilled water were given control groups (G1), 50 mg/kg (G2), 100 mg/kg (G3), 300 mg/kg (G4) and 500 mg/kg (G5) moss extract were administered by gavage for 30 days another groups. At the end of the experiment period, the tissues taken from the rats were subjected to routine histopathological procedures. Cu /Z n SOD primary antibody was applied using immunohistochemical staining methods to detect immunoreactivity. The study was terminated by using the Kruskal-Wallis test, which is one of the nonparametric tests. To determine the differences between the groups by evaluating the stained tissue samples with the image analysis system in the light microscope. A significant difference was found in the dose-related positivity of the kidney, ovarian and adrenal gland tissues of the groups given moss extract p. It has been determined that *H. sericeum* species increases Cu/Zn SOD enzyme activity in the kidney, adrenal gland and ovarian tissues, and its cytotoxic effects shows a dose-related increase in the histopathological table.

INTRODUCTION

Bryophytes have been widely used as medicinal plants to cure cuts, burns, boils, abscesses, fractures, ringworm, convulsions, pneumonia, tuberculosis, uropathy, and neurasthenia in many countries (Chandra et al., 2016). The bryophytes have been medically used in Chinese traditional medicine for thousands of years and contained compounds with antioxidant, antimicrobial, and antitumoral activity (Sabovljević et al., 2016). There are few in vivo studies to determine the antioxidant and therapeutic activity of bryophytes, these studies led to the research of many biologically active compounds that are likely to be found in bryophytes (Krzaczkowskieta et al., 2009). The liverworts and mosses had the potential to have active compounds that may affect the cell cycle. Pharmacological studies showed that different moss species had cytotoxic, antifungal, antimicrobial, and antioxidant activity. They were

secondary metabolites, phenolic compounds, benzyl, mono-di-tri sesquiterpenes, and flavonoids that provide antioxidant activity in mosses (López-Lázaro, 2009).

The first defence in the organism against free radicals occurs with SOD. The Cu/Zn SOD enzyme is in the cytoplasm. An increase in the amount of cellular SOD was observed during stress (Ighodaro & Akinloye, 2018). Many studies have proven that herbs are antioxidant components that help cope with oxidative stress. Another study, they reported that the antioxidant activity of *Nyctanthes arbor tristis* would be beneficial in the development of drugs for the treatment of arthritis (Lad & Bhatnagar, 2017).

Our study aimed to determine the enzyme production of Cu/Zn SOD in the kidney, adrenal gland, and ovarian tissues of rats fed with the extract obtained from *Homalothecium sericeum* species.

MATERIAL AND METHODS

Plant materials were collected from Karabiga and Bayramiç (Çanakkale, Turkey) and identified by Dr. O. TONGUC YAYINTAS and Dr. L. Ceyda İRKİN from Çanakkale Onsekiz Mart University in May 2018.

Ethical Statement

A total of 30 female Wistar albino rats, weighing 290-310 g, were included in the study. The study protocol was approved by the Çanakkale Onsekiz Mart University Ethics Committee for Animal Research (Protocol number: 2018-03).

Preparation of the Extracts

Fresh gametophytic samples of *H. sericeum* were treated with Tween 80 aqueous solution (0.8%) to remove the epiphytic hosts normally found on the surface, extensively washed in tap, and distilled water, and dried on filter paper at room temperature. Extraction procedures were applied as described elsewhere (Yetgin et al., 2017). The flour-form material will be treated with methanol to 10 mL/g in the dark for 24 hours (Yayintas et al., 2019).

Animal Groups

In this study, animal groups were designed in five different groups.

1. The first group (n: 6); 1 ml of distilled water for 30 days (gavage)
2. The second group (n: 6); 50 mg/kg moss every day for 30 days (gavage)
3. The third group (n: 6); 100 mg/kg moss every day for 30 days (gavage)
4. The fourth group (n: 6); 300 mg/kg moss every day for 30 days (gavage)
5. The fifth group (n: 6); 500 mg/kg moss every day for 30 days (gavage)

Histopathological Examination

The animal model study of our investigation continued approximately for a month. At the end of one month, the kidney, adrenal gland and ovaries of rats anesthetized with rompun and ketas were removed and trimmed and placed in tissue transport cassettes for 24 hours. Tissue samples taken from each subject and cut to a thickness of 5 μm were treated with Hematoxylin-Eosin (H&E) and staining was performed (Ozturk et al., 2019).

Immunohistochemical Examination

Immunohistochemical reactions were performed according to the ABC technique described. First, the endogenous peroxidase activity was inhibited by exposing the specimens to 3% hydrogen peroxide in distilled water for 30 minutes. After washing the sections in distilled water for 10 minutes, the binding of nonspecific antibodies was diluted by 1:4. Following this step, the sections were incubated with a polyclonal rabbit anti-superoxide dismutase (Cu/Zn SOD1, dilution 1:50, Enzo Life Sciences, Lausen, Switzerland) and following another step (Ozturk et al., 2019).

Evaluation of Tissue Samples and Statistics

The immunoreactivity was evaluated with the H-score method, calculating the ratio of immunopositively cells to all cells in the selected fields. The results obtained with this formula were analysed using SPSS 21 software package program. Kruskal–Wallis test was used to determine the differences between Cu/Zn SOD immunoreactivities between groups. A difference of $p<0.05$ between the groups were considered significant (Numata et al., 2013).

RESULTS

Kidney

There were no histopathologic findings in the renal tissues of rats in the first control group with routine haematoxylin-eosin. Cortex and medulla were normal. Tubular dilatations were increased in some of the mossed groups and renal parenchyma of G_4 and G_5 groups and tubules and the concentration of glomerular shrinkage were observed in some groups. There were remarkable enlargements in the cavities of the Bowman capsule. Swelling and necrotic cells were observed in tubular

epithelial cells. Congestion was also observed in the capillaries (Table 1, Figure 1).

The rats receiving moss extract differed between the control group and other dose-dependent groups in immunohistochemical Cu/Zn SOD staining of renal tissue. Immunoreactivity was observed in the distal and proximal tubule epithelial cells in the control group, G_2 and G_3. Groups' immunity was more intense in cortex tubules but also in collecting tubule cells along the medullary beam. The severity of immunoreactivity increased in line with the moss dose. Cu/Zn SOD immunoreactivity was severed especially in the cortex of kidney tissues of G_4 and G_5 groups (Figure 2, Figure 3).

Adrenal Gland

Histological staining with haematoxylin-eosin did not reveal the cortex and medullary structure in the adrenal tissue of rats in the first group (G_1). The zones located under the connective tissue capsule were clear and normal. The boundaries between the zones disappeared in the cortex of the adrenal tissue of the G_4 and G_5 mossed groups, the pyknotic cells increased in the zone glomerulosa, the fat droplets in the zone fasciculata increased with steroid secretions and expanded considerably. Focal haemorrhage and increased necrotic cells were observed (Figure 4).

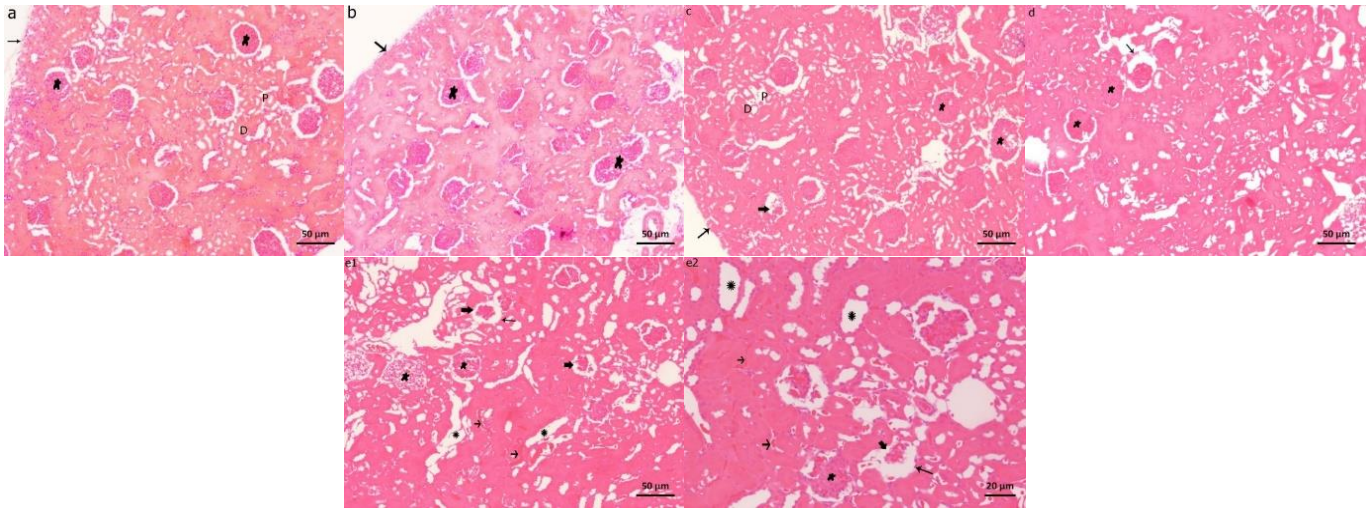

Figure 1. a-) Renal tissue of control group, magnification ×100 (Ok: Cortex capsule, renal corpuscle), b-) Renal tissue of the second group of giving moss, magnification ×100 (Star: glomeruli), c-) Renal tissue of the third group of giving moss, magnification ×100 (Star: renal corpuscle, thin arrow: capsule, thick arrow: shrunk glomeruli, P: proximal tubule, D: distal tubule), d-) Renal tissue of the fourth group of giving moss, magnification ×100 (Star: glomeruli, arrow: Bowman capsule), e-) Renal tissue of the fifth group of giving moss, magnification ×100, ×200 (Thick arrow: shrunk glomeruli, Thin arrow: expanded Bowman capsule, Star: glomeruli, Short arrow: congestion, Multiple stars: dilated collector tubules).

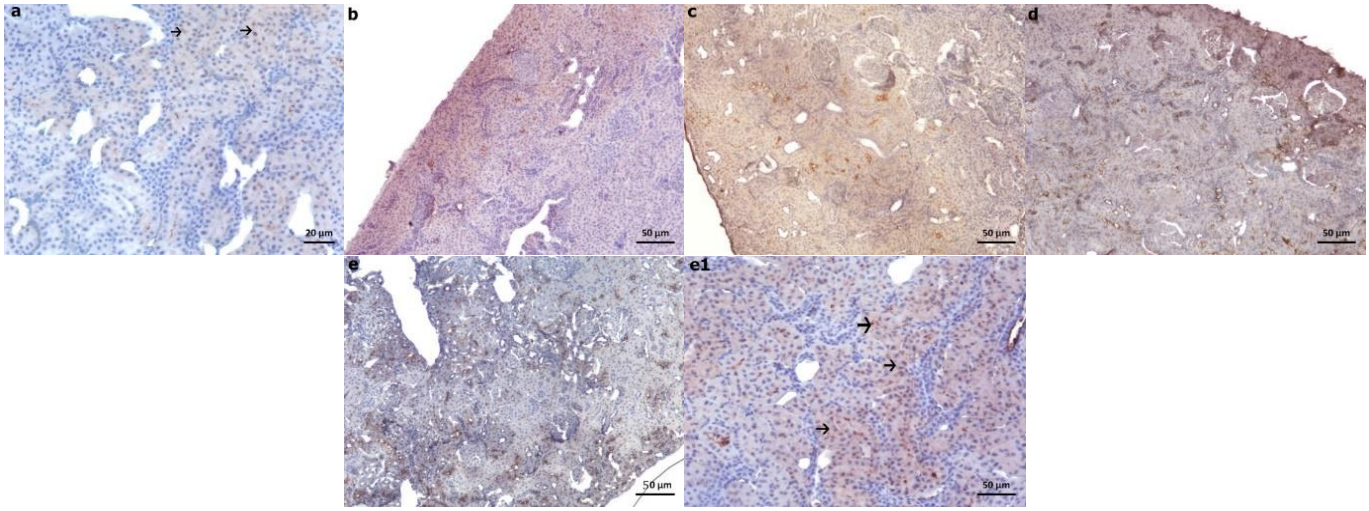

Figure 2. Control and experimental groups of renal tissue. Immunohistochemical staining of Cu/Zn SOD, magnification a, e1 ×200, other samples ×100 (Arrow: immunoreactivity).

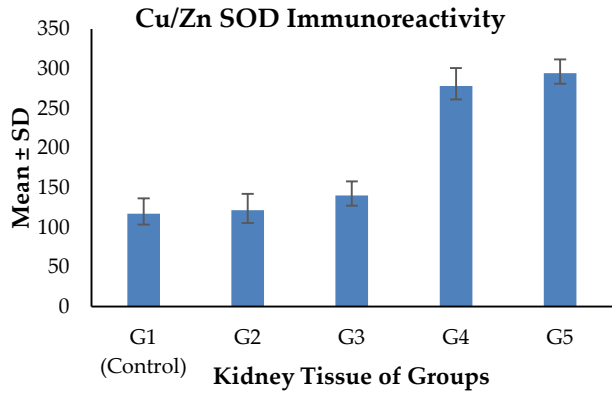

Figure 3. Immunoreactivity distribution of Cu/Zn SOD immunohistochemical staining in renal tissues of groups (Control (G1) vs G2 *p<0.05, G1 vs G3 **p<0.01, G1 vs G4 ***p<0.001, G1 vs G5 ****p<0.0001, G2 vs G3 **p<0.01, G4 vs G5 *p<0.05).

The control group had more positivity in glomerulus cells than G_2 and G_3. Both groups' immunity was increased. The severity of immunoreactivity increased in G_4 and G_5 in line with the moss dose. There was a significant difference between the H-scores of the control group and G_4 and G_5 ($p<0.0001$) (Figure 5, Figure 6).

Ovary

No histopathologic structures were observed in the ovarian tissue of the rats in the first group in the histological staining with Haematoxylin-Eosin. Like the control group, G_2 and G_3 also had a normal histological structure in the ovary. Primordial follicles and developing follicular structures were observed in the cellular connective tissue located on and below the germinal epithelium.

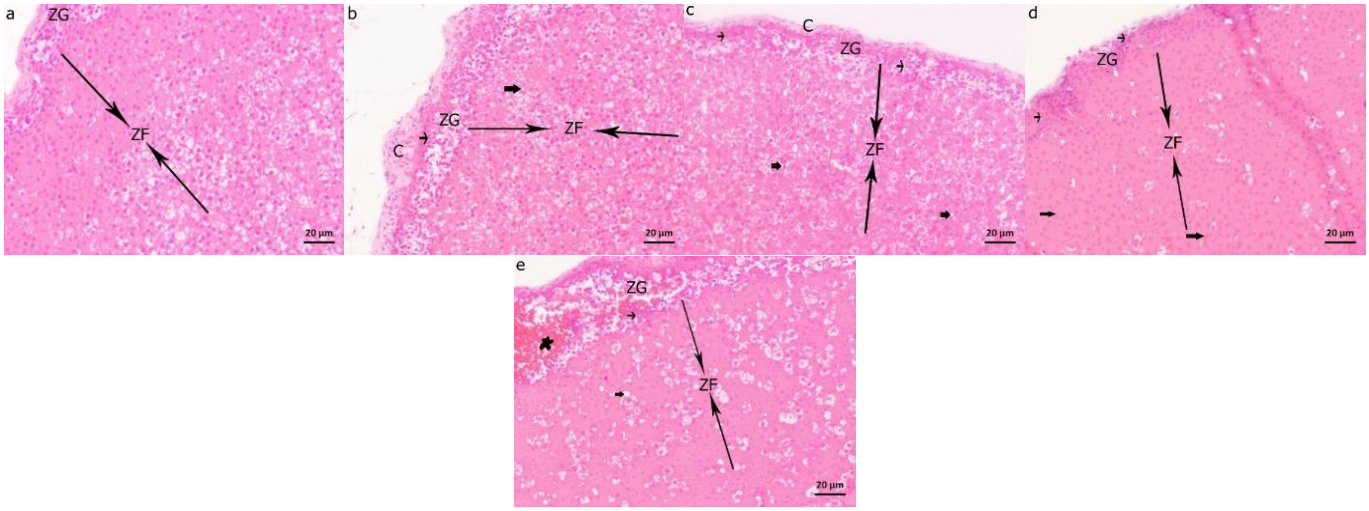

Figure 4. a-) Control group adrenal gland tissue b-) The second group of mossed adrenal gland tissue (Thick arrow: vacuolysis, Thin arrow: cells with pyknotic nuclei), c-) The third group of mossed adrenal gland tissue (Thick arrow: vacuolysis, Thin arrow: cells with picnotic nucleus), d-) Fourth group of mossed adrenal gland tissue (Thick arrow: hemorrhagic areas, Thin arrow: cells with pyknotic nuclei), e-) Fifth group of mossed adrenal gland tissue (ZG: zona glomerulosa, ZF: zona fasciculata, Thick arrow: vacuolysis, Thin arrow: cells with pyknotic nuclei, Star: hemorrhage area), magnification ×200.

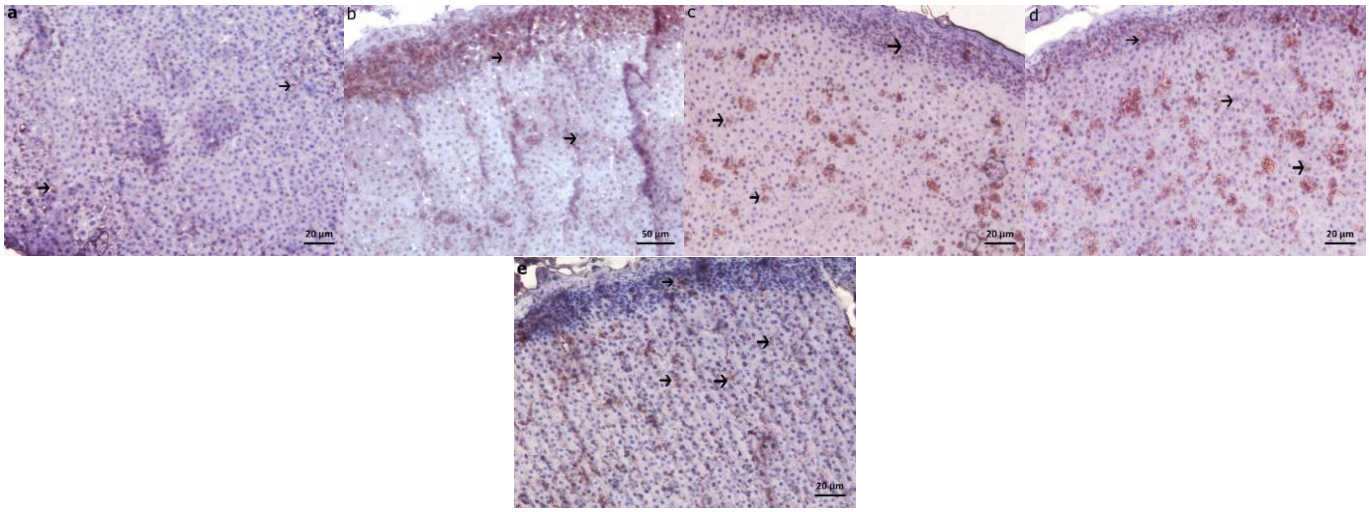

Figure 5. Control and experimental groups of adrenal gland tissue of Cu/Zn SOD immunohistochemical staining, magnification ×200, other samples ×100 (Arrow: immunoreactivity).

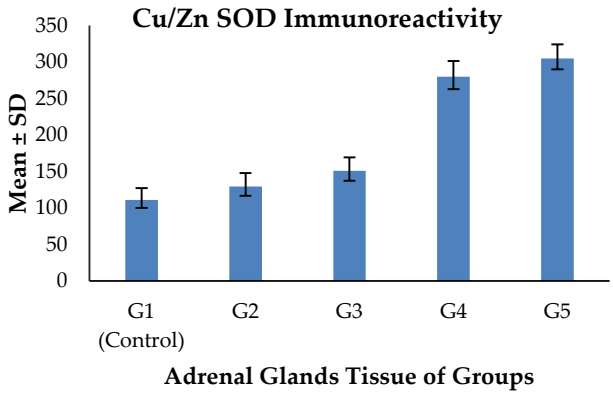

Figure 6. Immunoreactivity distribution of Cu/Zn SOD immunohistochemical staining in adrenal gland tissues of groups (Control (G1) vs G2 *p<0.05, G1 vs G3 **p<0.01, G1 vs G4 ***p<0.001, G1 vs G5 ****p<0.0001, G2 vs G3 *p<0.05, G4 vs G5 *p<0.05).

The corpus luteum was formed because of follicles excreted by ovulation. There was no inflammatory reaction in the ovaries of G_4 and G_5. The primordial follicles in the cellular connective tissue, which were observed in the secondary follicles, were present in the general histological structure (Figure 7).

The Cu/Zn SOD immunohistochemical staining of ovarian tissue was detected in the control group, G_2 and G_3, it was increased immunity in groups. The severity of immunoreactivity was moderated in G4 and G5 as the moss dose increased (Figure 8, Figure 9).

DISCUSSION

Active compounds responsible for existing antimicrobial effects were identified in many bryophyte species. For instance, some extract of liverwort such as Polygodial from Porella and *Conocephalum conicum*, Lunularin from *Lunularia cruciata* were proposed to have not only effective fungicide and bacteriocidic, but also a weak biocide (stomach poison) effect against pests (Saxena & Harinder, 2004).

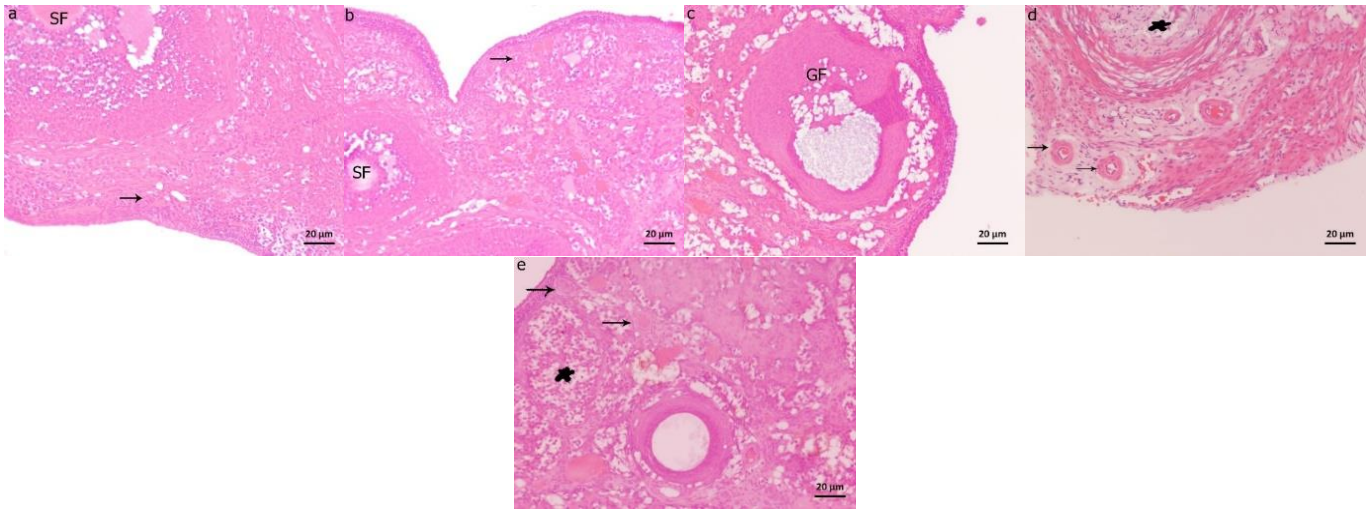

Figure 7. Control and experimental groups of ovarian tissue, magnification ×200 (Long arrow: primordial follicle, Star: corpus luteum, GF: graafian follicles).

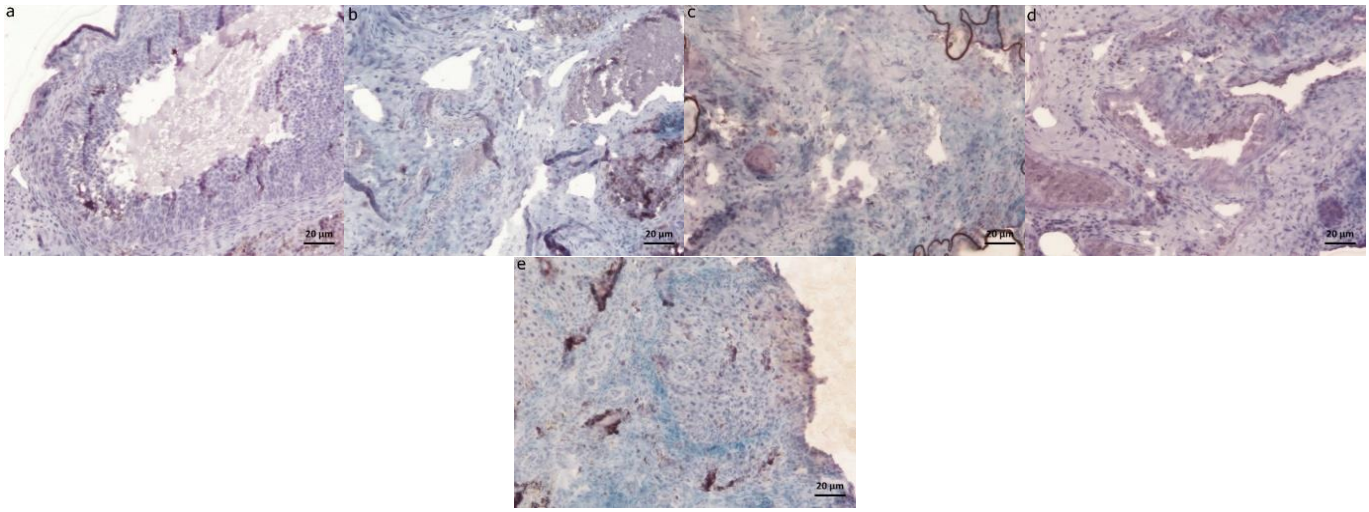

Figure 8. Control and experimental groups of adrenal gland tissue Cu/Zn SOD immunohistochemical staining ×200.

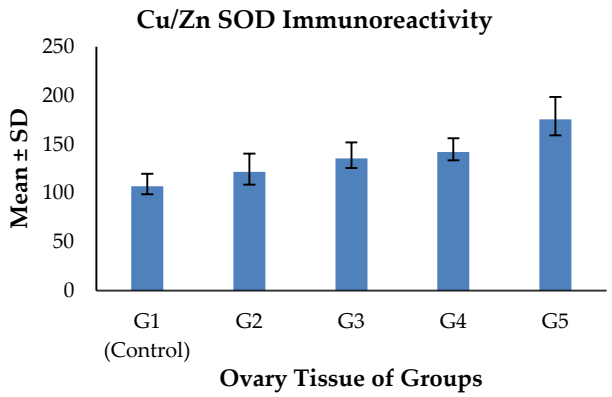

Figure 9. Immunoreactivity distribution of Cu/Zn SOD immunohistochemical staining in ovarian tissues of groups (Control (G1) vs G2 **p<0.01, G1 vs G3 *p<0.05, G1 vs G4 ***p<0.001, G1 vs G5 ***p<0.001, G2 vs G3 p>0.05, G4 vs G5 *p<0.05).

Alcoholic or acidic extracts of *Polytrichum juniperinum* were injected into muscle cells of CAF1 mice and showed antitumor activity against carcinoma (Cheng et al., 2012). In other cases, bryophyte extracts showed a tumour-promoting activity. Molecules such as Marchantin A, cyclopentanol fatty acids and their precursors had antimicrobial activity (Huang et al., 2010). Sanionin A and B were isolated from *Sanionia georgicouncinata* collected from Antarctic Livingston Island. These compounds showed inhibitory activity against multiple resistant staphylococci, gram-positive pathogens, and vancomycin-resistant enterococci. Inflammatory activity and low cytotoxicity were also observed (Ivanova et al., 2007). In a different study, lipophilic extracts of several types of liverworts showed antifungal and antibacterial effects. Bryophytes showed antibiotic activity against fungi and prokaryotic cells (Subhisha & Subramoniam, 2005). Saigusa et al. (2009) investigated CD133, SOX2, and OCT4 gene expression in two colon cancer cell lines, SW480 and LoVo. Following these results, they concentrated on the most active species and carried out antitumoral tests. Again, a fractioned polar isolate of *M. polymorpha* (T1) was the only antiproliferative species against HeLa and A549 lung cancer cells (Yetgin et al., 2017). Oztopcu et al. (2011) investigated the antimicrobial and antiproliferative properties of *Homalothecium sericeum* (Hedw.) Schimp. extract C from this moss was effective on C6 cells. A concentration of 85 μg/mL reduced the survival of cancer cells by 39% and a concentration of 170 μg/mL by 86% after 24 hours (Oztopcu et al., 2011). The results of bryophyte studies showed that they had quite high antibacterial and anticancer properties due to the flavonoid content they contain. There were a very limited number of experimental in vivo studies. The species we studied in the literature was never used in experimental animal models. Therefore, the findings of the present study will contribute to the literature. In subsequent studies, findings that are more specific will contribute to the use of moss extracts in medical treatments by using molecular techniques. Considering the anticancer properties, it can be provided to develop prophylactic drugs that will cost less and have a shorter duration for cancer treatments that increase day by day.

Superoxide dismutase (SODs) constitutes a very important antioxidant defence against oxidative stress in the body. The enzyme acts as a good therapeutic agent against diseases associated with reactive oxygen species. SOD has therapeutic effects in various physiological and pathological conditions such as cancer, inflammatory diseases, cystic fibrosis, ischemia, aging, rheumatoid arthritis, neurodegenerative diseases, and diabetes. However, the enzyme has some limitations in clinical applications. The most abundant copper-zinc (Cu/Zn) SOD in the body is found in the cytoplasm. Superoxide has an important role in cell structure and life such as the bactericidal activity of neutrophils, apoptosis, inflammation, and regulation of vascular functions (Younus, 2018; Rosa et al., 2021). In our study, *H. sericeum* was provided in different doses in immunohistochemical staining with Cu/Zn SOD, and antioxidant activity was tried to be determined in different tissues of rats that were given different doses. Immunoreactivity differed in the cases when *H. sericeum* was taken.

The protective effect of lavender oil was investigated in mice that produced hepato and nephrotoxic effects with the Malathion application. It increased the oxidative stress, which was assessed by the depletion of sulfhydryl group content (-SH) and antioxidant enzyme activity, as well as MDA and hydrogen peroxide levels. Cu/Zn-SOD, Mn-SOD and Fe-SOD increased in kidney and liver. In conclusion, lavender had potential hepato- and nephroprotective effects against oxidative stress caused by malathion in mice. This beneficial effect may be partially related to its antioxidant properties (Selmi et al., 2015). It has been observed that the moss extract we use in vivo increases the antioxidant enzyme activity (SOD) at low doses due to its compounds such as flavonoids and alcohols. Similar effects to the results of lavender and other similar plant-based applications were observed in our study. However, it has been observed that high doses may cause toxic effects. Therefore, we think that it would be beneficial to try it in anticancer studies with its high dose content.

Dynamic expressions of Cu/Zn SOD and Mn-SOD increased in liver, gill, kidney, and spleen after difficulties encountered with *Aeromonas hydrophila* or lipopolysaccharide in a study conducted with fish to determine the level of Cu/Zn SOD in tissues. mRNA expressions are downregulated after a time point in the

kidney. In this study, the molecular structures and functional motifs of Cu/Zn SOD and Mn-SOD were determined, and a very important finding was presented for us to understand the biological functions of SODs (Sai et al., 2017). As a mammal, we tried to determine the SOD activity of moss in different tissues of rats. Our findings show that SOD activity increased in kidney and adrenal gland tissues of rats exposed to high-dose moss, while it is stable in the ovary. The reason is thought to be caused by the blood follicle barrier in the ovarian tissue. Cu/Zn SOD enzyme is localized in the cytoplasm of eosinophilic cells in the reticular zone or the internal fascicular region of the cortex. Studies were shown that Cu/Zn SOD and Mn-SOD are stained in the normal adrenal gland and the inner areas of the fascicular zone and the medulla, but the Mn-SOD is weakly stained with the medulla. SOD reflects the origin of the tumour cell and is stained in different cells in different adrenal tumours. Thus, only part of the Mn-SOD is stained in a pheochromocytoma. Medullary tumour tissues were reported to have lower SOD expression than the normal adrenal gland and adrenocortical adenoma. Cushing syndrome adenoma was higher in tumour tissue with Cu/Zn concentration and Mn-SOD is lower in normal adrenal gland concentration (Iwase et al., 2006). The findings obtained in the adrenal gland were in line with the findings in tumorigenic studies. While Cu/Zn SOD activity was characterized by the remuneration showing severe immune reactivity in shingles fascicule, the immune reactivity was milder in the medulla. As a protective mechanism of action in acidophilic cells, SOD reactivity was increased in cytoplasm's of cells against damage in the reticular zone.

In PCOS (polycystic ovary syndrome) patients, serum SOD activity has been reported with mixed results. Follicular fluid is easily available during oocyte pick-up and provides a very important microenvironment for the development of oocytes (Seleem et al., 2014). The immunohistochemical findings of ovarian tissue in our study showed that Cu/Zn SOD immunoreactivity was quite weak. This showed us that ovarian tissue was well protected by the blood follicle barrier and was affected later by metabolic effects. It also suggested in case of damage, the first SOD is not activated as a defence. Lee et al. (2019) investigated the effects of *Populus tomentiglandulosa* extract (PTE) on histopathology and antioxidant enzymes in rat liver and kidneys. PTE examined immunohistochemistry for antioxidant enzymes such as superoxide dismutase (SOD1 and SOD2), catalase (CAT) and glutathione peroxidase (GPx) in the rat liver and kidneys. There were no significant histopathological changes in the liver and kidneys of the diet fed rats with the PTE group. According to these results, PTE treatment significantly increased antioxidant enzymes in rat liver and kidneys (Lee et al., 2019).

CONCLUSION

Cu/Zn SOD activity, which is like our findings in our study, was detected in tissues such as kidney, adrenal gland and ovarian in studies with various plant extracts. The increase in histological damage due to the dose increase in our study contradicted the findings of these and similar studies. It should be said that with the increase of dose, *H. sericeum* species caused histopathology in much important tissue, especially in the liver and kidney, however, it was stronger in antioxidant activity by providing defence. These results showed that the effect of anti-cancer and antitumoral studies will be more effective. Generally, studies carried out with mosses (*H. sericeum*) are in vitro and our study was the first study in vivo.

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Compliance With Ethical Standards

Authors' Contribution

Author ŞÖ and ÖY designed the study, LCİ and ÖY wrote the first draft of the manuscript, ŞÖ performed and managed statistical analyses. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

A total of 30 female Wistar albino rats, weighing 290–310 g, were included in the study. The study protocol was approved by the Çanakkale Onsekiz Mart University Ethics Committee for Animal Research (Protocol number: 2018-03).

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Determination of Sexual Dimorphism in the Freshwater Blenny, *Salaria fluviatilis* (Asso, 1801), Distributed in Brackish Water Habitats

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ABSTRACT

The present study aimed to determine the presence of the sexual dimorphism based on the morphometric measurements in a total of 60 samples (♀: 26; ♂: 14, immature; 20) which were obtained in April 2017 from the population of *Salaria fluviatilis* which shows distribution in the brackish waters in the Karpuzçay Creek (Antalya, Turkey). As a result of the morphometric analysis performed in both sexes of samples, it has been determined that there were differences between body parts in terms of total length (TL), dorsal fin length (DFL), snout length, and eye diameters in the head area. Accordingly, it has been observed that the lengths of allometric growing body parts of males were greater than that of females. The properties of sexual dimorphism in the body parts of freshwater blenny cause significant differences between sexes in brackish water forms. The differences in male individuals such as TL and long DFL are important criteria for the selection of large male individuals for sexual selection in mating. It was thought that the increase in snout length and eye diameter in the head region gives males some advantages in various areas such as feeding performance from the habitat, male selection of females in mating, and swimming performance.

INTRODUCTION

Salaria fluviatilis (Asso 1801), known as the freshwater blenny, is a sensitive endemic species of the streams in the Mediterranean and the Black Sea and is spread in the benthic region (Laporte et al., 2013). In time, these areas may threaten the river populations of the species with factors such as the change in the morphological structure of the river resources or pollution (Crivelli, 1996). Also, the freshwater blenny populations, which show distribution both in the world and in Europe's inland and wetlands, are in the Least Concern (LC) category, which is considered to be the least worrying level (Crivelli, 2006).

The species which are maintaining their lives in the habitats, where they live, have a significant level of sexual dimorphism features (Kottelat & Freyhof, 2007; Laporte et al., 2016a). Among these features are mainly a longer body and a wider head structure of male specimens (Roché, 2001; Alp & Kara, 2007; Keith et al., 2011; Laporte et al., 2018). Sexual dimorphism is the most common feature in the animal world (Shine, 1989), it affects many vital factors such as reproduction, parental care (fry or egg) throughout the life of the individuals, and is considered an important factor in the emergence of sex selection (Laporte et al., 2018). Accordingly, it was determined that sexual dimorphism is different for species in ecological terms of the river and lake blenny populations. It was determined that freshwater blennids

have larger bodies than river populations compared to lake populations (Laporte et al., 2013). Rispoli & Wilson (2008) estimated that local living conditions can affect both morphological and vital characteristics of the species. This estimate was based on Bergmann (1847)'s rule which indicates that the existence of a positive correlation between the size of the organism and the latitude that the organism is distributed at.

Some studies on sexual dimorphism in terms of reproduction and parental care determined that there were cephalic crest and two anal glands around the anal fin in males, especially during the breeding season and parental care (Fabre et al., 2014), and the researchers considered this result a dimorphic structure for sexes (Laporte et al., 2018). Sexual dimorphism, which develops based on the differences in habitat, is considered as an effort to increase the mating chance of females in river form, whose swimming skills are more effective than that of males (Vinyoles & De Sostoa, 2007).

However, the composition of Blennid species in brackish water ecosystems has not been fully clarified (Innal, 2019). The primary objective of the present study was to determine the prominent sexual dimorphism characteristics in specimens of *S. fluviatilis*, a blennid species which shows the distribution in brackish water habitats other than a river or lake form.

MATERIAL AND METHODS

Salaria fluviatilis (Asso, 1801) was used as the research material, caught from the brackish water zone (36°42'56.84" N 31°33'00.95" E) of the Karpuzçay Creek Estuary, which flows into the Antalya Bay, in April 2017, using a beach seine net (10 m long and 2 m high; 1.2 × 2 mm mesh size). The sampling area and Google Earth images are given in Figure 1. Seventy-five samples were fixed in 10% formalin solution, and the species identification was determined as described by Akşiray (1987). Sixty of these samples (♀: 26; ♂: 14, immature; 20) were evaluated in morphometric measurements.

The sex determinations of the specimens were evaluated by the dissection method according to the presence of ovaries and testicles. Specimens' sex ratio (F/M) was determined; however, meristic measurements were not taken into consideration. A total of 11 morphometric measurements, 4 from the head area and 7 from the body region were evaluated for the morphometric study. These are total length (TL), standard length (SL), head length (HL), eye diameter (ED), snout length (SNL), head height (HH), predorsal length (PDL), body height (BH), dorsal fin length (DFL), dorsal fin

Figure 1. Brackish zone of the sampling area (Karpuzçay Creek Estuary)

height (DFH), and caudal peduncle height (CauPH) (Figure 2). A digital compass with a sensitivity of 0.01 mm was used. The height values of morphological characters were evaluated according to total height (TL%). By providing logarithmic transformation of independent variables, linear regression values were calculated using the equation $\log y = \log a + b \log x$ as described by Choo & Liew (2006). The averages of morphometric measurements between sexes were determined using the Student's t-test. The regression relation of morphometric characters and length conversion equations were determined using (r^2) (Gulland, 1969), the significance test (<0.05) was used in the STATISTICA v11 program for the statistical differences.

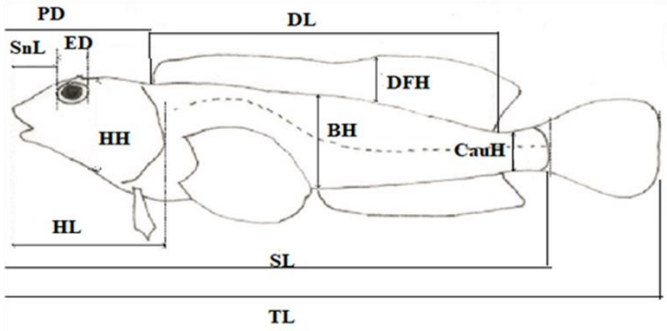

Figure 2. Morphometric measurements of *Salaria fluviatilis*. TL: Total length, SL: Standard length, HL: Head length, ED: Eye diameter, SnL: Snout length, HH: Head height, PDL: Predorsal length, BH: Body height, DL: Dorsal fin length, DFH: Dorsal fin height, CauPH: Caudal peduncle height.

RESULTS

The averages of the morphometric characters of *Salaria fluviatilis* samples according to sex are given in Table 1. The average height value for all specimens obtained in the study was 48.92±11.92 mm. Evaluating the average height according to sex, it was determined that the tallest specimens were male specimens with 57.00±12.00 mm. Therefore, the evaluations made according to the total height values showed that the first difference between the sexes was the total height values (P<0.05) (Figure 3 and Table 1).

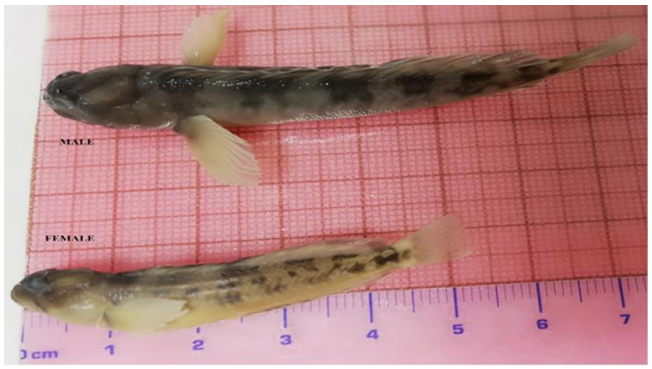

Figure 3. The image of male and female specimens of *Salaria fluviatilis* (upper: male; lower: female)

The average total length value (TL) in all individuals of the species, which shows the distribution in the Karpuzçay River was determined to be 48.92±11.92 mm. It was also seen that males had a longer body length than females. There was a statistical difference between the sexes in terms of total height values (t_{cal}: −2.139, p=0.0038, P<0.05). Dorsal fin length (DFL) values had an average of 25.49±6.70 mm in the whole population and corresponded to 52% of the total length. The dorsal fin length of the sexes was statistically different (t_{cal}: −2.206, p=0.032, P<0.05). These results showed that males had a larger dorsal fin size than females (Figure 3 and Figure 4A). In two important measurements, eye diameter (ED) and snout length (SnL) in the head region had statistically significant differences. Examining the results of the snout length in all specimens, it was determined that the average results were 3.33±0.93 mm in the population and corresponded to approximately 7% of the total length. There was a statistically significant difference in snout length between the sexes (t_{cal}: −2.470, p=0.017, P<0.05), and it was understood that males were more advantageous than females in this difference (Figure 3, Figure 4B and Table 2).

It was determined that the average eye diameter values, another important measurement of the head area, was 1.91±0.44 mm in the whole population, and corresponded to approximately 4% of the total length (t_{cal}: −2.277, p=0.027, P<0.05) (Table 2, Figure 3 and Figure 4C).

Table 2 shows the allometric growth results of the body parts that cause sexual differences depending on the total height. DFL and SnL measurements showed increases in female and male specimens depending on the total height. ED, on the other hand, showed positive allometric growth in males, whereas this growth rate was very low in females.

Table 1. The average morphometric features of *Salaria fluviatilis* (m±sd: mean±standard dev.)

Morphometric features	Male	Female	All	Mean (%)	P
Total Length (TL)	57.00±12.00	49.77±9.59	48.92±11.92	-	P<0.05*
Standard Length (SL)	47.72±11.51	42.35±7.81	42.14±10.15	86.14TL	P>0.05
Head Length (HL)	12.97±3.21	11.49±2.62	11.39±3.08	23.28TL	P>0.05
Head Height (HH)	8.58±4.03	6.74±2.98	6.75±3.38	12.79TL	P>0.05
Snout Length (SnL)	3.94±0.84	3.34±0.75	3.33±0.93	6.80TL	P<0.05*
Eye Diameter (ED)	2.19±0.49	1.90±0.37	1.91±0.44	3.91TL	P<0.05*
Predorsal Length (PDL)	13.62±2.64	12.31±2.24	12.02±2.77	24.58TL	P>0.05
Dorsal fin Length (DFL)	29.85±7.02	25.85±5.03	25.49±6.70	52.11TL	P<0.05*
Dorsal fin Height (DFH)	3.19±1.53	2.81±1.15	2.67±1.30	2.65TL	P>0.05
Body Height (BH)	8.61±2.38	7.51±1.77	7.32±2.19	4.56TL	P>0.05
Caudal Peduncle Height (CauPH)	4.31±1.23	3.74±0.90	3.68±1.10	7.51TL	P>0.05

Note: *P<0.05: statistically difference

Table 2. Allometric growth models of *Salaria fluviatilis* according to the in $L = aTL^b$ equation

	Male			Female			All Sexes		
	a	*b*	*r*	*a*	*b*	*r*	*a*	*b*	*r*
DFL	0.464	1.030	0.93	0.579	0.971	0.96	0.469	1.025	0.96
ED	0.052	0.924	0.82	0.193	0.583	0.61	0.143	0.664	0.74
SnL	0.082	0.958	0.90	0.056	1.040	0.85	0.041	1.125	0.89

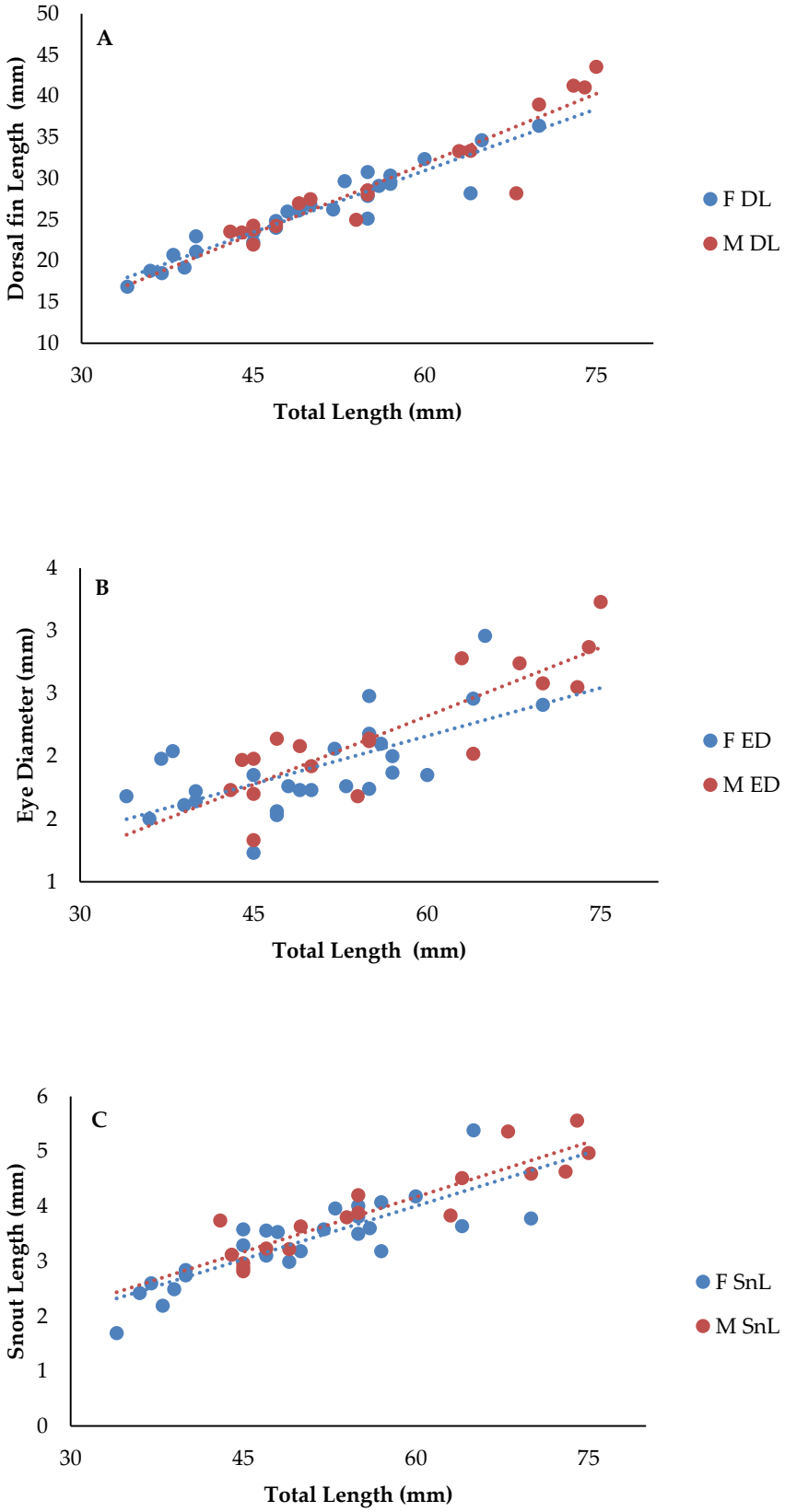

Figure 4. Allometric relations in the sexes of *Salaria fluviatilis* specimens (A: dorsal fin length-total length relation, B: eye diameter-total length relation, C; snout length-total length relation; F: female; M: male)

DISCUSSION

In this study, the sex ratio (♀:♂) was determined to be 1:0.54 in the freshwater blenny population, and it was observed that female individuals were dominant in the habitat. The various studies have reported that females form dominant populations in the Ceyhan River (Alp & Kara, 2007), Kournas, Fango, and Garda rivers (Neat et al., 2003). However, it was thought that the reason for the differences in sex rates of the species was the hiding behavior to protect their eggs and the nest from predators (Côté et al., 1999; Alp & Kara, 2007).

In the present study, it was determined that *S. fluviatilis* male specimens were larger in terms of total length, snout length, eye diameter, and dorsal fin length values. It was also observed that males of freshwater blennid species were larger than females (Rensch, 1950; Roché, 2001; Kottelat & Freyhof, 2007; Alp & Kara, 2007). While these determinations are more common in males in river populations, the opposite was observed in marine forms (Côte & Hunte, 1989). Neat et al. (2003) have stated that lake populations were generally smaller than river populations. As the main reason for the difference between populations was thought to be the preference of blennid species in mating by resorting to sexual selection at the time of reproduction and the preference of larger males in mating (Laporte et al., 2018). According to these evaluations, it was considered that the results obtained in the present study were in line with two different opinions. The first opinion is that males are larger than females and was in line with the basic rule of Rensch (1950), while the second is that the head structure in females is smaller than that of males, in line with that previously described by Laporte et al. (2018).

In the present study, the first sexual difference was determined in total height values, and the results showed that males are larger than females. Rispoli & Wilson (2008) have stated that local living conditions can be effective on both morphological and vital characteristics of the species. As seen clearly in *S. fluviatilis*, this difference in height values may vary according to the rapid growth rate or long life-period determined by the presence of food in the habitats such as rivers or lakes in which the species lives, and the predator effect (Laporte et al., 2018).

In the study, although the head length and height values of the female specimens were determined to be lower than those of the males, they did not show statistically significant differences. However, several studies indicated that the small head structure is related to the hydrodynamics and swimming performance of the fish species (Laporte et al., 2016b). Therefore, this feature is mainly considered a phenotypic approach of *S fluviatilis* in river populations with water current (Laporte et al., 2016a). However, it has been stated that the low growth of the head structure in females affects behavior during the reproductive period (Laporte et al., 2018). That may be effective in the female's mate selection the size of the head profile displayed by the species in different habitats such as a lake or river (Laporte et al., 2018).

In the present study, another important difference in the head of the species was determined in the eye diameter values of the sexes. Neat et al. (2003) have stated that the larger eye diameters of fish in Lake Kournas than other populations may be due to an accidental genetic structure or mutation. However, in this study, differences between the sexes in a population that show the distribution in a brackish water habitat were interpreted as the advantage of adaptation in proportion to body size in male specimens. Differences were also found between the sexes in the head structure, the snout length. Neat et al. (2003) emphasized that in *S. fluviatilis* individuals which shows the distribution in the lake habitat, the snout length in the head region is long and this structure may be related to nutritional adaptation. Accordingly, the results obtained from this study showed that the difference in snout length between sexes can be considered as nutritional adaptation in the habitat in question.

CONCLUSION

Results provided us an insight that freshwater blennids, which show the distribution in brackish waters may continue to differ in terms of total length, dorsal fin length, snout length, and eye diameter values. Therefore, our results showed that sexual selection continues without causing much change for males in brackish water habitats, except for lake and river habitats. However, the results also indicated that the existing differences are a phenotypic response to this type of habitat.

Compliance With Ethical Standards

Authors' Contribution

SG and DI designed the study, SG managed statistical analyses and wrote the manuscript, all authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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A Mini-Review on Polycyclic Aromatic Hydrocarbons (PAHs) in Some Smoked Fish

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ABSTRACT

The effects of sources that cause pollution in the environment in organisms can occur in different ways. The participation of polycyclic aromatic hydrocarbons (PAHs), one of the pollutants caused by organic materials, into aquatic ecosystems by washing from the atmosphere and soil causes accumulation in aquatic ecosystems and is easily transported to the upper trophic zones through the food chain. Consumption of these products with high nutritional value poses a threat to human health. The processing of these products, which are widely consumed as fresh, with different processes is another way to remain under the influence of PAH. As it is known, PAHs are formed as a result of pyrolysis and prosynthesis of organic materials that are not sufficiently burned. In this sense, smoked products that are not produced under suitable conditions may carry a risk for the formation of PAH. In this study, the factors that cause PAH formation in smoked products and the appropriate processing processes developed to eliminate these factors were compiled.

INTRODUCTION

Seafood attracts attention because they constitute healthy protein sources that have an important place in human nutrition, as well as because terrestrial resources cannot meet the needs of the increasing population. Although fresh consumption is common, salted, dried, canned, and smoked products produced with different processing techniques in the food industry are offered for consumption by extending their shelf life (Abraha et al., 2018). These processing techniques, which are developed with new technologies today, are basically based on the history of humanity. Salting, drying, and smoking is preservation methods that human beings have discovered in order to keep meat and fish products intact (Horner, 1997; Slámová et al., 2021). It provides an increase in flavor due to the aroma added to the meat, as well as the storage of the products applied by the smoking method. Various woods and fragrant plants are used to create different aromas. Industrial applications in fish smoking 19th century were started and continue to be developed with new technologies today.

One of the basic principles of smoking is to remove some of the water contained in the meat and to prevent microbial spoilage by passing the antibacterial substances in wood smoke to the meat. However, the composition of the smoke and the processing conditions affect the sensory quality of the product, its shelf life, and healthy product acquisition (Ceylan & Şengör, 2015; Jinadasa et al., 2020). Carcinogenic components of wood smoke, such as PAH, nitro-PAH or PAH derivatives such as oxygenated PAH, and to a lesser extent N-nitroso compounds and heterocyclic aromatic amines, which are formed as a result of insufficient combustion of organic materials, can cause potential health problems in smoked products (Öz, 2020). It has been reported that N-nitroso compounds are in lower concentrations in hot-smoked fish than in other foods

(Roper et al., 1981). It has been reported that the carboxylic acid content of N-nitrosothiazolidine is found at a concentration of 1 mg/kg (wet weight) in smoked poultry (Mondagere, 1986). Heterocyclic aromatic amines have been found in heavily smoked, dried mackerel at concentrations below 1 μg/kg (Kato et al., 1986).

It has been reported that wood smoke contains a large number of PAHs (Pirsaheb et al., 2018), and 61 of them which has different molecular mass weights are clearly identified in products, meanwhile 15 PAHs of them cause mutagenicity/genotoxicity in somatic cells in experimental animals by the Scientific Committee on Food (Stołyhwo & Sikorski, 2005; Mihalca et al., 2011; Mahugija & Njale, 2018).

PAHs are classified according to their chemical structures and molecular weights, and carcinogenic and mutagenic effects are seen in PAHs with high molecular weights (228-278 g/mol) which contain five–seven rings such as benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1, 2, 3-c, d)pyrene (Palm et al., 2011). Among these, Benzo[a]Pyrene (BaP), with a molecular mass of 252 Dalton, has been accepted as a marker of carcinogenic PAHs in wood smoke, smoked products, and environmental samples due to its strong mutagenic and carcinogenic effect (SCF, 2002).

The most important uptake route of PAHs by human is foods prepared as grilling, smoking, frying, roasting at the highest temperature and less breathing and smoking (Silva et al., 2011). Due to the carcinogenic and mutagenic properties, PAHs are included priority pollutants lists by The United States Environmental Protection Agency (USEPA), European Union Scientific Committee for Food (EUSCF), and the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

Maximum BaP level for smoked seafood and other products is 5.0 μg/kg established by European Commission (Regulation (EC) No 2008/2005) (Wretling et al., 2010; Mihalca et al., 2011). After this decision, BaP concentrations were determined in commercially smoked products, and it was reported that BaP levels did not exceed the maximum acceptable limit in the meat and seafood examined (Duedahl-Olesen et al., 2006; Reinik et al., 2007). In one study, while the BaP concentration was 0.15 μg/kg, only one of the samples in the products exceeded the limit, due to intense smoke odors and darkening, while all products were considered to have rich BaP content (Jira et al., 2006).

Among PAHs with high molecular weight, it is necessary to determine their maximum levels in drinking water and food, taking into account the carcinogenic potential of those other than BaP.

Factors Affecting the Formation of PAH in Smoking and Solution Suggestions

Smoke Formation Temperature and Filtration

Factors causing PAH formation in smoked products were determined and studies were carried out to develop appropriate methods. The most important factor affecting the formation of PAH is the smoke formation temperature (Ceylan & Şengör, 2015; Jinadasa et al., 2020). When the smoke generation temperature was optimized between 400 and 600 °C, the fish had less PAH formation than when it was outside this range (Hokkanen et al., 2018). It has been reported that BaP formation does not occur in products produced by keeping the temperature of wood pyrolysis below 425°C and the oxidation temperature of pyrolysis volatile products below 375°C using a two-stage smoke generator. In the study, it was stated that as a result of reducing the temperature of wood chips or sawdust pile to 300-400°C and using filters, the PAH content in the smoke could be reduced by about 10 times (Tilgner & Miler, 1963).

Resins

Resin, any natural or synthetic organic compound consisting of a noncrystalline or viscous liquid substance from wind, fire, lightning, or other cause. Most natural resins are exuded from trees, especially pines and firs. Resin formation occurs as a result of injury to the bark. Plants secrete resins for their protective benefits in response to injury. The resin protects the plant from insects and pathogens. Natural or synthetically produced resins are used in many areas in the industry and are also used as chelators due to their ion exchange capacity.

In the smoking industries, the types of wood used to add flavor and aroma to meat vary. Resins on trees used in smoking have also been reported to increase the PAH content in the smoked product. It has been reported that smoke flavors produced commercially for use in the meat and fish industries contain only trace amounts of PAH as a result of the removal of the resinous parts (White et al., 1971; Miler & Sikorski, 1990).

Canned Oils

Although it is known that a significant portion of the PAHs in smoked foods come from wood smoke, the PAH contamination in canned smoked fish is also caused by the vegetable oils used in the can. Some oils are known to contain high amounts of PAHs, at the level of 50 μg/kg. It is stated that the source of PAH in oils may be direct drying processes of oilseeds or the olive mass remaining after

pressing (Stołyhwo & Sikorski, 2005). It has been reported that grape seed oil contains BaP at concentrations of about 20 μg/kg (Moret et al., 2000). It has been reported that the content of BaP in cans of smoked sardines is five times higher in canned oil than in fish (Lawrence & Weber, 1984). To reduce contamination of oils with PAHs, it is recommended to add about 20% activated carbon to the bleaching earth in the refining process.

Traditional Ovens

Studies have reported that in cold and hot-smoked fish, PAH content can vary from raw material to approximately 0.05-60 μg/kg concentration of BaP depending on the fish species, smoking method and smoking parameters, smoke composition, and exposure (Petrun & Rubenchik, 1966; Tilgner & Daun, 1969; Wierzchowski & Gajewska, 1972; Lawrence & Weber, 1984; Nistor, 1985; Duedahl-Olesen et al., 2015; Jinadasa et al., 2020). It has been determined that the BaP content is generally lower, approximately 0.1 μg/kg BaP in smoke-smoked fish produced under modern, fully automatic controlled conditions compared to conventional ovens.

While the BaP content of commercially hot and cold smoked fish was found at a concentration of 4.2-60 μg/kg, BaP content was found to be 1.7 μg/kg in anchovy smoked in an electrostatic device with smoke produced at 25-300°C (Petrun & Rubenchik, 1966). With recent applications, BaP has not been detected in commercially smoked sardines, silver carp, squid, or tuna (Kannappan et al., 2000).

In a study conducted with a large number of smoked marine fish, the total PAH concentration was found to be 46.5 μg/kg in swordfish and 124 μg/kg in herring. BaP, which was not detected in a few fish species, was determined as 0.7 μg/kg in salmon (Storelli et al., 2003).

The average BaP content was determined as 5.12 and 8.43 μg/kg, respectively, in lean and fatty hot-smoked trout fillets by heating the fish to an internal temperature of 82°C for 30 minutes (Zabik et al., 1996). BaP concentration was found to be approximately 12 μg/kg wet weight in fatty sardines smoked for 6 hours at 45-70°C using smoke produced in a conventional oven at 400-600°C. BaP content was determined as only 1.6 μg/kg in fish that were smoked at 45°C for 3.5 hours in filtered smoke produced at a temperature of 300-400°C, followed by drying in the sun for 4-5 hours (Changrasekhar & Kaveriappa, 1985).

Fatty and Lean Fish

PAHs are known to have high lipid affinity. It has been reported that the PAH concentration due to smoking is higher in fatty fish than in lean fish (Akpan et al., 1994; Başak et al., 2010). It was stated that the PAH concentration determined at the end of smoking in fish species with different total lipid levels (salmon and rainbow trout) had a positive correlation with the total lipid levels of the fish.

Exposure Time

Repeating the smoking process may increase PAH formation depending on the exposure time (Jinadasa et al., 2020). In an application with Atlantic bonito, it has been reported that a tar layer of approximately 3% by weight was formed on the surface of the fish as a result of overnight drying after repeated smoking cycles at 80-120°C for several hours. It has been also determined that the BaP content under the formed tar layer is 20-40 times higher than the deeper meat layer (Kikugawa et al., 1986).

Storage

Information on the persistence and distribution of smoke components, including PAHs, in different parts of smoked products during storage, is limited. The diffusion rate of smoke components in fish is controlled by the character of the surface as well as the properties of the meat and the accumulated compounds. Most of the smoke phenols accumulate in the skin and in the layer approximately 6 mm deep of the product, especially in adipose tissue. However, in some products, especially lean fish, up to 60% of the total phenol mass can penetrate deeper layers (Kurko & Mezenova, 1985).

According to Simko (1991), the concentration and distribution of BaP in smoked fish may change during storage due to the varying rate of diffusion and degradation depending on the characteristics of the product and environmental factors. Under the influence of light, PAHs are sensitive to photodegradation and oxidation. It is known that the half-life of PAHs varies from a few hours to a few days depending on the type of PAH. While the BaP concentration in the surface tissue of the fish was 10.6 μg/kg after smoking, it was found to be 0.0 μg/kg in the internal tissues, and it was reported to be 1.3 in the outer tissues and 0.1 in the internal tissues at the end of the 7-day storage period (Simko, 1991). In the same study, it was also determined that the BaP concentration, which was initially determined as 0.6 μg/kg, decreased to approximately 0.1 μg/kg after four days, as a result of aeration in daylight at 18°C.

PAHs in Smoked Food Sources Other Than Seafood

BaP contents were determined as a result of smoking in different products are approximately 0.01-1.11 μg/kg in lightly smoked ham, 0.18-2.08 μg/kg in cooked sausages, and 0.14-56.04 μg/kg in black smoked ham (Potthast, 1978).

Although some smoked fish products may contain high concentrations of PAH, it has been reported that the consumption of smoked meat and fish generally does not contribute to the human uptake of these compounds. According to the Scientific Committee on Food (SCF, 2002), the concentration of BaP from smoked fish accounts for only a small part of the total dietary intake in several European countries.

Fats, grains, and vegetables accounted for 90% of total BaP intake in the United Kingdom, while fats, cereals, sweets, and sugar accounted for 97% of total BaP intake in the Netherlands. However, in local communities where traditionally smoked fish forms a large part of the diet, BaP intake from these sources may be significantly higher.

In conclusion, smoked fish forms an important part of the human diet due to its desirable sensory properties, high nutritional value, and lipids rich in n-3 fatty acid levels. Wood smoke used for smoking fish can contain a wide variety of PAHs, including the most carcinogenic, depending mainly on the temperature of production. With the filtered smoke coming from external generators, smoking in modern smokehouses under suitable conditions allows the production of products away from carcinogenic PAHs. The BaP levels in hot-smoked fish are not above the limit set by different national and European regulations. However, heavily smoked products with smoke from conventional furnaces may contain about 50 mg/kg wet weight concentration of BaP. For this reason, it is very important to eliminate the factors that cause PAH formation in production by using modern application processes in terms of providing healthy products.

BaPs constitute the most carcinogenic group of PAHs, and BaP levels are examined in terms of food safety in smoked products (EFSA, 2008). According to the European Commission and the Turkish Food Codex, the acceptable level of BaP in smoked seafood has been reported to be 2.0 μg/kg (CR(EU), 2011; TFC, 2014).

CONCLUSION

Smoking was a process used to prevent meat from spoiling during the periods when coolers were not invented and wars continued. Today, it is applied to add aroma and flavor to meat as well as its antibacterial properties. Fish is one of the main sources of protein for humans and has a high nutritional content. Although it is mostly consumed fresh, a group of consumers prefer smoked fish. Researchers have encountered PAH contents in fish smoked in conventional ovens and have developed new methods to minimize their toxic effects. Research findings have reached the conclusion that fish produced with developing technology and new methods and kept under appropriate storage conditions are not harmful for consumption.

Compliance With Ethical Standards

Authors' Contribution

Both authors have contributed equally to the paper.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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ICCAT Inspections in Turkey and Turkey's National Legislation Compliance With the ICCAT Recommendations

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ABSTRACT

It was determined that bluefin tuna fishing within the scope of the International Commission for the Conservation of Atlantic Tunas (ICCAT) inspections was carried out in accordance with the 19-04 ICCAT Recommendation in Turkey. In the swordfish fishery, it was observed that the 16-05 ICCAT Recommendation was not completely compatible with Turkey's national legislation. In the 16-05 ICCAT Recommendation; the fishing gear was determined as the longline in swordfish fishery, the length of the pelagic longlines and the number of hooks were limited, the minimum weight limit was set on swordfish, and the transshipment operations at sea of swordfish was prohibited in the fishing season. However, these legal regulations were not available in Turkey's national legislation. The following issues could be evaluated as the reasons why these regulations were not included in Turkey's national legislation; the majority of the fishing vessels engaged in swordfish fishery in the seas of Turkey are less than 12 meters in total length, the fishing vessels of 12 meters in length or more can only use the first fishing gear, the length of pelagic swordfish longlines and the number of hooks used in Turkey are far below the regulations set forth in 16-05 ICCAT Recommendation, the caught swordfish are landed as a whole, and the majority of swordfish fishery vessels stay for a day or 2-3 days for fishing at sea. The ICCAT inspections in the swordfish fishery were carried out according to the 16-05 ICCAT Recommendation in Turkey. The necessary information and incentives should be provided for the fishing vessels of less than 12 m in length, which had obtained swordfish fishery permits, to use fuel without special consumption tax, in order to monitor them electronically via Vessel Tracking Module. In order to control the quota in swordfish fishery, it should be obligatory to use a paper logbook for fishing vessels less than 12 meters in length. In addition, an application can also be made to install a Vessel Monitoring System on fishing vessels less than 12 m that will catch swordfish.

Türkiye'de ICCAT Denetimleri ve Türkiye'nin Ulusal Mevzuatının ICCAT Tavsiye Kararları İle Uyumu

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ÖZET

Türkiye'de Uluslararası Atlantik Orkinosunu Koruma Komisyonu (ICCAT) denetimleri kapsamındaki mavi yüzgeçli orkinos avcılığının 19-04 ICCAT Tavsiye Karına uygun olarak yapıldığı tespit edilmiştir. Kılıç balığı avcılığında ise 16-05 ICCAT Tavsiye Kararının Türkiye'nin ulusal mevzuatı ile tamamen uyumlu olmadığı gözlenmiştir. 16-05 ICCAT Tavsiye Kararında kılıç balığı avcılığında kullanılacak av aracı parakete olarak belirlenmiş, parakete oltasının uzunluğu ve iğne sayısına sınırlama getirilmiş, kılıç balığında minimum ağırlık yasağı konmuş, av sezonu dahil denizde kılıç balıklarının gemiden gemiye aktarılması yasaklanmış olup, Türkiye'nin ulusal mevzuatında ise söz konusu yasal düzenlenmeler yer almamaktadır. Söz konusu bu düzenlemelerin Türkiye'nin ulusal mevzuatında yer almamasının nedenleri olarak şu hususlar değerlendirilebilir; Türkiye denizlerinde kılıç balığı avcılığı yapan gemilerin çoğunluğunun 12 m'den küçük balıkçı gemilerden oluşmaktadır; 12 m ve üstü olan balıkçı gemileri sadece birincil av aracını kullanabilmektedir; Türkiye denizlerinde kullanılan pelajik kılıç balığı paraketelerin uzunluğunun ve iğne sayısının 16-04 ICCAT Tavsiye Kararında belirtilen düzenlemelerin çok altındadır; Avlanan kılıç balıkları bütün olarak karaya çıkarılır ve kılıç balığı avcılığı yapan gemilerin çoğunluğu günübirlik ya da 2-3 gün denizde kalarak avcılık gerçekleştirir. Türkiye'de kılıç balığı avcılığında ICCAT denetimleri 16-05 ICCAT Tavsiye Kararına göre yapılmaktadır. Kılıç balığı avcılığı izni alan 12 m'den küçük balıkçı gemilerinin tekne takip modülü (TTM) üzerinden elektronik ortamda takibi için bahse konu gemilerin özel tüketim vergisiz yakıt kullanması yönünde gerekli bilgilendirme ve teşvikler yapılmalıdır. Kılıç balığı avcılığında kota takibi için bu avcılığı yapan 12 m'den küçük balıkçı gemilerine matbu seyir defteri kullanılması zorunluluğu getirilmelidir. İlaveten 12 m'den kılıç balığı avcılığı yapacak balıkçı gemilerine Balıkçı Gemileri İzleme Sistemi (BAGİS) cihazı taktırılması yönünde de bir uygulama gerçekleştirilebilir.

GİRİŞ

Uluslararası Atlantik Ton Balıklarını Koruma Komisyonu (ICCAT) Atlantik Okyanusu ile Akdeniz ve bağlı denizlerdeki 30'dan fazla ton ve ton benzeri balık türünün korunması amacı ile Birleşmiş Milletler Gıda ve Tarım Örgütü'ne bağlı halihazırda 52 akit taraftan müteşekkil uluslararası bir bölgesel balıkçılık yönetim örgütüdür (ICCAT, 2021a; TOB, 2021a). ICCAT Brezilya, Rio de Janeiro'daki Tam Yetkili Temsilciler Konferansı'nda 1966'da hazırlanan ve 1969 yılında yürürlüğe giren Atlantik Ton Balıklarının Korunmasına İlişkin Uluslararası Sözleşme bağlamında tesis edilmiştir (TOB, 2021a). Türkiye 28 Mayıs 2003 tarihli ve 4859 sayılı Kanunla ICCAT'a üye olmuştur (TOB, 2021a).

ICCAT mavi yüzgeçli orkinos (*Thunnus thynnus* Linnaeus, 1758), yazılı orkinos (*Euthynnus alletteratus* Rafinesque, 1810), uzun kanat orkinos (*Thunnus alalunga* Bonnaterre, 1788) ve kılıç balığı (*Xiphias gladius* Linnaeus, 1758) hakkında uzun yıllardan beri yasal düzenlemeler uygulamaktadır (TOB, 2021a). Akdeniz'de mavi yüzgeçli orkinos ve kılıç balığı avcılığı konusunda uygulanan ICCAT tavsiye kararlarından bazıları minimum avlanma boyu ve ağırlık, av aracı ve avcılık zamanı yasağı, Akdeniz'de orkinos avcılığında uçak veya helikopter kullanma yasağı, mavi yüzgeçli orkinos yetiştiriciliğine yönelik oluşturulan yönetim planlarıdır.

Türkiye, ICCAT'a üyeliğin gerçekleştiği 2003 yılı öncesinde, gözlemci statüsünde toplantılara iştirak etmiş ve "diğer ülkeler" adı verilen mavi yüzgeçli orkinos kotası payından, bazı Akdeniz ülkeleriyle müştereken faydalanmıştır (TOB, 2021a). Türkiye'nin üyeliğine müteakip, 22 Ağustos 2003 tarihinden itibaren mavi yüzgeçli orkinos avcılığında kota takibi yapılmaya başlanmıştır (TOB, 2003).

ICCAT Uluslararası Müşterek Denetim Planı ilk olarak 1975 yılında oluşturulmuştur (ICCAT, 1975). Atlantik Okyanusu ve ona bağlı denizlerde etkin bir balıkçılık denetim faaliyeti amaçlanmıştır. Mavi yüzgeçli orkinos avcılığında 08-05 ICCAT Tavsiye Kararı ile 2008 yılında ICCAT Müşterek Denetim Programı yürürlüğe konmuş olup, kılıç balığı avcılığında ise 16-05 Tavsiye Kararı ile 2017 yılında müşterek ICCAT denetimleri başlatılmıştır (ICCAT, 2008; ICCAT, 2016).

Mavi yüzgeçli orkinos avcılığı Türkiye'nin güneyinde Akdeniz'de 20-120 mil açıklarda yapılmaktadır. Av sahaları Türkiye'nin Akdeniz kıyıları, Kuzey Kıbrıs Türk Cumhuriyeti'nin kıyıları (özellikle doğusu) ve Antalya Körfezi'dir (Dağtekin, 2009; Yalçın, 2019). Avcılık gırgır ağları ile gerçekleştirilmektedir (ICCAT, 2019; TOB, 2020a). Avlanan mavi yüzgeçli orkinoslar canlı olarak taşıma kafeslerine transfer edilerek, dikkatli ve yavaş bir şekilde (saatte 1 ile 1,5 mil hızda) İzmir (Türkiye) ilinde bulunan toplam 6 adet orkinos çiftliğine taşınır. Mavi yüzgeçli orkinoslar pazar boyuna ulaşıncaya kadar çiftliklerde beslenir (Başaran & Özden, 2004; Dağtekin, 2009; ICCAT, 2021b).

Kılıç balığı avcılığı ise ülkemizde özellikle yoğun olarak Ege Denizi ve Akdeniz'de gerçekleştirilmektedir (Aydın & Doyuk, 2012; Akyol & Ceyhan, 2013; Altın vd., 2016; Alver vd., 2016). Ülkemizde kılıç balığı avcılığı dolanan (sürüklenen) ağlar (drift net), zıpkın ve parakete ile yapılmakta iken 1998-1999 tarihleri arasındaki av dönemiyle birlikte dolanan (sürüklenen) ağların su ürünleri avcılığında kullanılması yasaklanmıştır (TOB, 1998; Aydın & Doyuk, 2012; Ceyhan vd., 2012; Akyol & Ceyhan, 2013; Ceyhan & Akyol, 2013; Altın vd., 2016; Alver vd., 2016).

ICCAT kapsamında gerçekleştirilen mavi yüzgeçli orkinos avcılığının dünyadaki toplam kota miktarı 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 ve 2020 yılları için sırasıyla 12.900, 12.900, 13.400, 13.400, 16.142, 19.296, 23.155, 28.200, 32.240 ve 36.000 ton olurken, Türkiye'ye verilen kota miktarı sırasıyla 535,89, 535,89, 556,66, 556,66, 657,23, 785,59, 943,21, 1.414, 1.880 ve 2.305 tondur (ICCAT, 2010; ICCAT, 2012; ICCAT, 2013; ICCAT, 2014; ICCAT, 2017; ICCAT, 2018a; ICCAT, 2019). Türkiye'de her yıl ülke kotasının %0,5'i amatör amaçlı mavi yüzgeçli orkinos avcılığı için tahsis edilir (TOB, 2020b). Türkiye'de orkinos üretimi ise ICCAT tarafından tanınan kota kapsamında 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 ve 2020 yılları için sırasıyla 527,5, 535,5, 551,4, 555, 1.091, 1.324, 1.514,7, 1.283,7, 1.770,8 ve 2.252 ton olacak şekilde gerçekleşmiştir (TÜİK, 2012; TÜİK, 2013; TÜİK, 2014; TÜİK, 2015; TÜİK, 2016; TÜİK, 2017; TÜİK, 2018; TÜİK, 2019; TÜİK, 2020; TÜİK, 2021).

ICCAT Akdeniz'de 2017 yılı itibariyle kılıç balığı avcılığına da kota getirmiştir. Komisyon, 2017 yılından başlanarak, 2031 yılına kadar kılıç balığı stoklarını en az %60 oranında arttırmayı hedeflemiş, 2017 yılı için dünyadaki toplam avlanabilir miktarı 10.500 ton olarak belirlemiştir. Türkiye'ye verilen kota miktarı 441 ton olarak belirlenmiştir. 2018-2022 yılları süresince toplam avlanabilir miktarın her yıl %3 oranında düşürülmesi hedeflenmektedir (ICCAT, 2016). Türkiye'de gerçekleşen kılıç balığı üretim miktarı ise 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 ve 2020 yılları için sırasıyla 189,6, 79,7, 96,8, 55,7, 34,9, 76,5, 441, 427, 414 ve 402,4 ton olarak gerçekleştirilmiş olup, en düşük üretimin 2015 yılında olduğu görülmüştür (TÜİK, 2012; TÜİK, 2013; TÜİK, 2014; TÜİK, 2015; TÜİK, 2016; TÜİK, 2017; TÜİK, 2018; TÜİK, 2019; TÜİK, 2020; TÜİK, 2021). Son dört yılda ise ciddi bir artışla kılıç balığı üretiminin Türkiye'nin kotası doğrultusunda gerçekleştiği görülmektedir.

Türkiye'de mavi yüzgeçli orkinos avcılığı, filosu, taşımacılığı ve yetiştiriciliği (Başaran & Özden, 2004; Perçin & Tanrıkul, 2006; Dağtekin, 2009; Perçin vd., 2009; Yalçın, 2019), kılıç balığı avcılığı ve mevcut durumu (Ceyhan vd., 2012; Aydın & Doyuk, 2012; Ceyhan & Akyol, 2013; Altın vd., 2016), kılıç balığının yaş, üreme ve büyümesi (Alıçlı vd., 2012; Akyol & Ceyhan, 2013; Alver vd., 2016) ve mavi yüzgeçli orkinos avcılığında ICCAT denetimleri (Tanrıverdi, 2018) konularında yapılmış çalışmalar vardır. Bu çalışmalara ilave olarak İspanya'nın kılıç ve mavi yüzgeçli orkinos balıkları için ICCAT Tavsiye Kararlarına uyumu (Raymakers & Lynham, 1998), Akdeniz'de kılıç balığı ve dolanan (sürüklenen) ağlar (OCEANA, 2008), ICCAT Akdeniz kılıç balığı (OCEANA, 2016), ICCAT ve Doğu Atlantik mavi yüzgeçli orkinosu (Gonçalves, 2019), Atlantik mavi yüzgeçli orkinos balığında ticaret krizi (Hosch, 2019), kılıç balığı biyolojisi (Gillespie vd., 2020; Gillespie & Hanke, 2020) ve küresel ölçekteki kılıç balığı avcılığı (Govender vd., 2003) üzerine çalışmalar da mevcuttur.

Bu çalışmada, Türkiye'de ICCAT tavsiye kararları kapsamında mavi yüzgeçli orkinos ve kılıç balığı avcılığındaki ICCAT denetimleri ve Türkiye'nin ulusal mevzuatının ICCAT tavsiye kararlarına uyumunun tespiti amaçlanmıştır.

MATERYAL VE YÖNTEM

Türkiye'de mavi yüzgeçli orkinos ve kılıç balığı avcılığındaki ICCAT denetimleri ve Türkiye'nin ulusal mevzuatı ile ICCAT tavsiye kararları arasındaki uyumun tespiti için Türkiye'de ICCAT tavsiye kararları kapsamında mavi yüzgeçli orkinos ve kılıç balığı avcılığındaki denetimler, Türkiye İstatistik Kurumu (TÜİK) verileri ve Türkiye'nin ulusal mevzuatı ile ICCAT tavsiye kararları incelenmiştir.

BULGULAR

Denetçi Kurumlar

Türkiye'de su ürünleri avcılığının korunması ve kontrolünde görevli kurum Tarım ve Orman Bakanlığı (TOB)'dır (Anonim, 1971; Anonim, 2018). Türkiye'de ulusal mevzuatın ICCAT Tavsiye Kararlarına uyumu, uygulanması ve kontrolü hususlarında yetkili kurum TOB olup, Türkiye denizlerinde başlıca denetim Sahil Güvenlik Komutanlığı (SGK) tarafından gerçekleştirilmektedir (Anonim, 1971; Anonim, 1995). Ayrıca, ICCAT denetimleri Deniz Kuvvetleri Komutanlığı'nca da yapılmaktadır (HB, 2019). SGK tarafından denetimler ise gemi/botlara ilaveten uçak ve helikopterle de gerçekleştirilmektedir (İB-SGK, 2018; İB-SGK, 2019; İB-SGK, 2020).

TOB tarafından denetimler başlıca karaya çıkış noktaları, toptan/perakende satış noktaları ve balık çiftliklerinde yapılmaktadır. Yasa dışı, kayıt dışı ve kural dışı (YKK) balıkçılıkla mücadele kapsamında denetçi kurumlar ise müşterek kontrol ve denetimleri gerçekleştirmektedir.

ICCAT Denetim Esasları

Türkiye'de ICCAT denetçi botları ve denetçi bilgileri her yıl TOB tarafından ICCAT'a bildirilir. Her bir denetçiye 5 yıl süre ile geçerli olacak ICCAT Denetçi Kartı verilir (ICCAT, 2019). Denetçiler ve eğitimciler güncel ICCAT Tavsiye Kararı kurallarına göre TOB tarafından eğitime tabi tutulur. ICCAT denetimleri ICCAT flaması taşıyan denetçi bot ve ICCAT denetçi kartına sahip eğitim almış denetçiler tarafından gerçekleştirilir (ICCAT, 2019).

Elektronik İzleme Araçları

Türkiye'de 12 m ve üstündeki ticari avcılık yapan balıkçı gemilerinde Balıkçı Gemileri İzleme Sistemi (BAGİS) bulundurulması gerekmektedir (TOB, 2021b). Ayrıca uzunluğu 15 m ve üstündeki balıkçı gemilerinde de Otomatik Tanımlama Sistemi (AIS) bulundurulmalıdır (UAB, 2007). Ülkemizde özel tüketim vergisiz yakıt kullanan balıkçı gemileri (Türk Uluslararası Gemi Siciline ve Millî Gemi Siciline kayıtlı balıkçı gemileri) ÖTVBS Tekne Takip Modülü (TTM) bulundurmak zorundadır (HMB, 2015). Balıkçı teknelerinin konum ve hız bilgileri bu sistemler üzerinden takip edilmektedir.

Türkiye'de mavi yüzgeçli orkinos avcılığında kullanılacak av, taşıma ve destek gemileri BAGİS'e sahip olmalı ve balıkçılık sezonu boyunca 7 gün 24 saat boyunca bu sistemi açık tutmalıdırlar (ICCAT, 2018b; ICCAT, 2019; TOB, 2021b). Mavi yüzgeçli orkinos avcılığı kapsamında izin alan yabancı balıkçı gemilerinin de konum ve hız bilgileri BAGİS üzerinden izlenebilmektedir.

Türkiye'de kılıç balığı avcılığı için izin alan gemilerin çoğunluğu 12 m altındaki gemilerden oluşmaktadır. Bu balıkçı gemilerinde AIS ve BAGİS bulundurma zorunluluğu bulunmamaktadır. Kılıç balığı av sezonunda 12 m'den küçük tekneler özel tüketim vergisi (ÖTV) ödemeksizin yakıttan faydalanıyorsa TTM sistemi üzerinden takip edilebilmektedir.

Türkiye'de mavi yüzgeçli orkinos avcılığı hakkında izin ve transfer bilgileri, kılıç balığı için ise izin bilgileri Hayvan Bilgi Sistemi (HBS) üzerinden kontrol edilmektedir (TOB, 2021c). Ayrıca ICCAT'a üye ülkeler tarafından her yıl bildirilen mavi yüzgeçli orkinos ve kılıç balığı avcılığına ait gemi ve mavi yüzgeçli orkinos çiftlik bilgileri de https://www.iccat.int/en/ adresinden de izlenmekte ve kontrol edilmektedir.

Mavi Yüzgeçli Orkinos Avcılığında Yasal Mevzuat

Türkiye'de mavi yüzgeçli orkinos avcılığı kontrolleri ICCAT Tavsiye Kararları kapsamında gerçekleştirilir. ICCAT tarafından 2020 yılı için 19-04 ICCAT Tavsiye Kararı düzenlenmiştir (ICCAT, 2019). 2021 yılında da 19-04 ICCAT Tavsiye Kararı doğrultusunda mavi yüzgeçli orkinos avcılığı gerçekleştirilmiştir.

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos avcılığı için izin alması zorunlu olan ve izin verilen av, taşıma ve destek gemilerinin kayıtlarının ICCAT Sekretaryasına gönderilmesi gerekmektedir (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinos avcılığında av, taşıma ve destek gemileri için izin alınması zorunludur (TOB, 2020a). Mavi yüzgeçli orkinos avcılığı için izin verilen av, taşıma ve destek gemilerinin kayıtları ICCAT Sekretaryasına gönderilir.

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinos avcılığının parakete, tuzak ve gırgır ağları ile yapılabileceği bildirilirken (ICCAT, 2019), Türkiye'de avcılığın gırgır ağları ile gerçekleştirilebileceği ile ilgili düzenlenme mevcuttur (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos avcılığı 26 Mayıs - 01 Temmuz ya da 15 Mayıs - 01 Temmuz arasındaki dönemde yapılabilir (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinos avcılığı 15 Mayıs 2019 tarihi itibariyle 15 Mayıs - 01 Temmuz arasındaki dönemde yapılmaktadır (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre avlanan canlı mavi yüzgeçli orkinosların mücbir sebep olmaksızın 22 Ağustos'a kadar çiftliklere taşınması gerekmektedir (ICCAT, 2019). Türkiye'de de sezonda yakalanan mavi yüzgeçli orkinosların çiftliklere transferi mücbir sebep olmaksızın en geç 22 Ağustos tarihine kadar gerçekleştirilmelidir (TOB, 2021ç).

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinosun minimum avlanma boyu 115 cm (çatal boyu, FL) ve minimum avlanma ağırlığı ise 30 kg olup, küçük boyda (75-115 cm) ve ağırlıkta (8-30 kg) avlanmış olan mavi yüzgeçli orkinoslar için en fazla %5 oranında istisna tanınmasını öngörecek şekilde düzenlenmiştir (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinosun minimum avlanma boyu 115 cm (FL) ve minimum avlanma ağırlığı ise 30 kg'dır. Küçük boyda (75-115 cm) ve ağırlıkta (8-30 kg) avlanmış olan mavi yüzgeçli orkinoslar için en fazla %5 oranında istisna tanınmaktadır (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos aramak amacıyla uçak veya helikopter ya da herhangi bir insansız hava aracı kullanımı yasaktır (ICCAT, 2019): Bu bağlamda, benzer şekilde Türkiye'de de mavi yüzgeçli orkinos aramak amacıyla uçak veya helikopter ya da herhangi bir insansız hava aracı kullanımı yasaktır (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre 15 m ve üstü gemilerin gemi izleme sistemi bulundurması zorunludur (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinos av, taşıma ve destek izni alan gemilerinde BAGİS cihazı bulundurulması zorunludur (TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre av, taşıma, destek ve işleme gemileri elektronik seyir defteri bulundurmak zorundadır (ICCAT 2019). Türkiye'de de av, taşıma ve destek gemileri hem matbu hem de elektronik seyir defteri bulundurmak zorundadır (TOB, 2020a; TOB, 2021b). Av gemilerinde ilaveten mavi yüzgeçli orkinos seyir defteri de bulundurulur (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinosların sayısının ve büyüklüğünün doğru bir şekilde tahmin edilmesini sağlayacak görüntü kayıtları stereoskopik ve konvansiyonel kameralar tarafından yapılır ve video kaydı av ve taşıma gemileri ile birlikte bölgesel ve milli gözlemcide bulunur (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinosların sayısının ve büyüklüğünün doğru bir şekilde tahmin edilmesini sağlayacak görüntü kayıtları stereoskopik ve konvansiyonel kameralar tarafından yapılır ve video kaydı av ve taşıma gemileri ile birlikte bölgesel ve milli gözlemcide bulunur (TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre ICCAT transfer dokümanı (ITD), transfere ait video kaydı ve seyir defterinin ilk nüshası eşliğinde canlı mavi yüzgeçli orkinoslar taşıma kafesleri ile çiftliklere taşınır (ICCAT, 2019). Türkiye'de de benzer şekilde ITD, transfere ait video kaydı ve seyir defterinin ilk nüshası eşliğinde canlı mavi yüzgeçli orkinoslar taşıma kafesleri ile çiftliklere taşınır (TOB, 2021ç). 18-12 ICCAT Tavsiye Kararına göre Elektronik Orkinos Yakalama Dokümanı (eBCD) sisteminin kullanılması zorunludur (ICCAT, 2018b). Türkiye'de de Orkinos Yakalama Dokümanı (BCD) olmaksızın mavi yüzgeçli orkinos gemilerde bulundurulmaz ve gemiler tarafından çekilen kafeslerde taşınamaz (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinosları karaya çıkarma veya aktarma operasyonlarının izin verilen limanlarda yapılabileceği düzenlenmiştir (ICCAT, 2019). Türkiye'de de canlı olmayan mavi yüzgeçli orkinosların denizde gemiden gemiye transferi yasak olup, orkinoslar yasal olarak belirlenmiş karaya çıkış noktalarından karaya çıkarılabilir ya da gemiden gemiye nakledilebilir (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre kotası bulunmayan ve kota fazlası olan mavi yüzgeçli orkinosların avcılığına izin verilmez ve serbest bırakılması için gerekli tedbirler alınır. Orkinoslar ölü ise karaya çıkarılarak ulusal mevzuata uygun takibi yapılır (ICCAT, 2019). Türkiye'nin ulusal mevzuatında da canlı mavi yüzgeçli orkinosların doğaya bırakılacağı, canlı olmayan mavi yüzgeçli orkinosların ise el konularak ticarete konu edilmeksizin hayır kuruluşlarına bağışlanması şeklinde bir düzenleme mevcuttur (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos avcılığında YKK avcılığın yapılması durumunda yasal işlemler taraf ülkenin ulusal mevzuatına göre uygulanır (ICCAT, 2019). Türkiye'de de YKK avcılığın yapılması durumunda yasal işlemler ulusal mevzuata göre uygulanacaktır (Anonim, 1971; Anonim, 1995; TOB, 2020a).

Kılıç Balığı Avcılığında Yasal Mevzuat

ICCAT tarafından 2016 yılında 16-05 ICCAT Tavsiye Kararı düzenlenmiş olup, Türkiye'de kılıç balığı avcılığı kontrolleri 2017 yılından itibaren 16-05 ICCAT Tavsiye Kararı kapsamında gerçekleştirilmektedir.

16-05 ICCAT Tavsiye Kararına göre kılıç balığı avcılığı için izin verilen teknelerin kayıtlarının ICCAT Sekretaryasına gönderilmesi gerekmektedir (ICCAT, 2016). Türkiye'de kılıç balığı avcılığında av gemileri için izin alınması zorunludur (TOB, 2020a). Kılıç balığı avcılığı için izin verilen teknelerin kayıtları ICCAT Sekretaryasına gönderilir.

16-05 ICCAT Tavsiye Kararında 15 m ve altındaki gemilerin tarih, zaman, konum ve av miktarını bildirim yapma zorunluluğu yoktur (ICCAT, 2016). Türkiye'de de kılıç balığı avcılığı yapmak için izin alan 15 m altı gemiler için AIS (UAB, 2007), 12 m altı gemiler için BAGİS ve matbu ya da elektronik seyir defteri bulundurulması zorunlu değildir (TOB, 2021b).

16-05 ICCAT Tavsiye Kararında kılıç balığı avında kullanılacak av aracı parakete olarak belirlenmiştir (ICCAT, 2016). Benzer şekilde, Türkiye'de de kılıç balığı avında

kullanılacak av aracı parakete olarak belirlenmemiştir (TOB, 2020a).

16-05 ICCAT Tavsiye Kararı parakete oltasının uzunluğuna 30 deniz mili (55 km), iğne sayısına (2500 adet) ve iğne büyüklüğüne (iğne yüksekliği; 7 cm'den küçük olamaz) sınırlama getirmiştir (ICCAT, 2016). Türkiye'de ise iğne büyüklüğü iğne ağız açıklığı olarak belirtilmiş olup, 2,8 cm'den küçük iğnelerin kullanımı yasaklanmıştır (TOB, 2020a).

16-05 ICCAT Tavsiye Kararında alt çene çatal boyu (Lower Jaw Fork Length, LJFL) 100 cm'den, toplam ağırlığı 11,4 kg'dan ve solungaçsız ve iç organsız ağırlığı (gilled and gutted weight) 10,2 kg'dan küçük olan kılıç balıklarının avcılığı yasaklanmıştır (ICCAT, 2016). Türkiye'nin ulusal mevzuatında ise 125 cm'den küçük alt çene çatal boyuna sahip bireylerin avcılığına yasaklama getirilmiştir (TOB, 2020a).

16-05 ICCAT Tavsiye Kararında zaman yasağı 01 Ekim – 30 Kasım ve 15 Şubat – 31 Mart dönemleri şeklinde düzenlemiştir (ICCAT, 2016). Türkiye'nin ulusal mevzuatında da zaman yasağı 01 Ekim – 30 Kasım ve 15 Şubat – 15 Mart olarak belirlenmiştir (TOB, 2020a).

16-05 ICCAT Tavsiye Kararında denizde kılıç balıklarının gemiden gemiye aktarılması yasaklanmıştır (ICCAT, 2016). Türkiye'nin ulusal mevzuatında ise avcılık sezonunda denizde gemiden gemiye aktarma yasağı bulunmamakta olup, avcılığın yasaklandığı dönemde gemiden gemiye aktarılması yasaklanmıştır (TOB, 2020a).

16-05 ICCAT Tavsiye Kararına göre karaya çıkış noktalarının belirlenmiş olması gerekmektedir (ICCAT, 2016). Türkiye'de kılıç balığı avında yasal olarak belirlenmiş karaya çıkış noktası bulunmazken, 27 Ağustos 2021 tarihi itibariyle kılıç balığı avcılığı yapacak gemilerin ürünlerini Tarım ve Orman Bakanlığı tarafından belirlenen karaya çıkış noktalarından çıkarması zorunlu hale getirilmiştir (TOB, 2020a).

Türkiye'de YKK avcılığın yapılması durumunda yasal işlemler ulusal mevzuata göre uygulanacaktır. Canlı kılıç balıkları doğaya salınır, canlı olmayanlara ise karaya çıkarılarak el konulur. Tüketiminde sakınca bulunmayan kılıç balıklarının satışı gerçekleştirilir. Küçük boy ve ağırlıkta olanlar perakende olarak satılamaz, yem sanayi ham maddesi olarak satılabilir (Anonim, 1971; Anonim, 1995; TOB, 2020a).

Mavi Yüzgeçli Orkinos Avcılığı Kontrolleri

Mavi yüzgeçli orkinos denetimlerinde av gemisinde izin belgesi, BAGİS cihazının çalışma/arıza durumu, ICCAT Bölgesel Gözlemcisi varlığı, ICCAT Bölgesel Gözlemcisinin kartı, aktarılan mavi yüzgeçli orkinoslara ait orkinos ağırlık ve sayısının doğru bir şekilde tahmin edilmesini sağlayacak netlikte video kaydı bulunurluğu, seyir defteri, mavi yüzgeçli orkinos seyir defteri kontrol edilir. Bunların mevcut olması durumunda da BCD, ITD, av araçları ve soğuk hava deposu kontrol edilir. Belgeler çapraz kontrollere tabi tutulur. Geminin fiilen balıkçılık yapması halinde avlanma faaliyetinin bitmesi beklenerek kontrol gerçekleştirilir (ICCAT, 2019).

Taşıma gemisinde de izin belgesi, BAGİS cihazı çalışma/arıza durumu, ICCAT Milli Gözlemcisi varlığı, ICCAT Milli Gözlemcisinin kartı, aktarılan mavi yüzgeçli orkinoslara ait orkinos büyüklüğü ve sayısının doğru bir şekilde tahmin edilmesini sağlayacak netlikte video kaydı bulunurluğu, mavi yüzgeçli orkinos seyir defterinin bir nüshası, seyir defterinin ilk nüshası, ITD, taşıma kafesi/kafesleri ve soğuk hava deposu kontrol edilir. Belgeler çapraz kontrollere tabi tutulur. Taşıma gemisi denetim amacıyla asla durdurulmaz. Yaklaşık 1 mil hızda seyir halinde iken denetim gerçekleştirilir. Destek gemisinde izin belgesi, BAGİS cihazı çalışma/arıza durumu, seyir defteri ve soğuk hava deposu kontrol edilir.

Denetimler ICCAT Denetim Raporu, tüm izleme sistemleri (AIS, BAGİS, TTM), seyir defteri, ITD ve izin belgeleri üzerinden yapılır. Denetimler esnasında eğer bir ihlal tespit edilirse ihlal ICCAT Denetim Raporunda belirtilir. ICCAT Denetim Raporunun yeşil nüshası balıkçı gemisinin kaptanına, beyaz nüshası denetimin yapıldığı gemiye/bota ve sarı nüshası da TOB tarafından ICCAT Komisyonuna gönderilir (ICCAT, 2019).

Kılıç Balığı Avcılığı Kontrolleri

Kılıç balığı avcılığı yapan gemide izin belgesi, 12 m ve üstü ise BAGİS cihazı çalışma durumu, seyir defteri, av araçları, avlanan ürünler ve eğer varsa soğuk hava deposu kontrol edilir. Geminin fiilen balıkçılık yapması halinde av faaliyetinin bitmesi beklenerek kontrol gerçekleştirilir (ICCAT, 2016).

Denetimler ICCAT Denetim Raporu, tüm izleme sistemleri (15 m ve üstü gemiler için AIS, 12 m ve üstü gemiler için BAGİS ve 12 m ve altı özel tüketim vergisiz yakıt kullanan balıkçı gemileri için TTM) ve izin belgesi üzerinden yapılır. Denetimler esnasında eğer bir ihlal tespit edilirse ihlal ICCAT Denetim Raporunda belirtilir. ICCAT Denetim Raporlarının yeşil nüshası balıkçı gemisinin kaptanına, beyaz nüshası denetimin yapıldığı gemiye/bota ve sarı nüshası da TOB tarafından ICCAT Komisyonuna gönderilir (ICCAT, 2016).

TARTIŞMA

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinos avcılığının parakete, tuzak ve gırgır ağları ile yapılabileceği bildirilirken (ICCAT, 2019), Türkiye'de avcılığın gırgır ağları ile gerçekleştirilebileceği ile ilgili düzenlenme mevcuttur (TOB, 2020a). Dağtekin (2009) ve Başaran & Özden (2004) tarafından da Türkiye'de avcılığın çoğunlukla gırgır ağı ile yapıldığı bildirilmektedir.

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos avcılığı 26 Mayıs - 01 Temmuz ya da 15 Mayıs - 01 Temmuz arasındaki dönemde yapılabilir (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinos avcılığı aynı tarihlerde gerçekleştirilmektedir (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre avlanan canlı mavi yüzgeçli orkinosların mücbir sebep olmaksızın 22 Ağustos'a kadar çiftliklere taşınması gerekmekte olup (ICCAT, 2019), Türkiye'de de benzer şekilde avlanan canlı mavi yüzgeçli orkinosların mücbir sebep olmaksızın 22 Ağustos'a kadar çiftliklere taşınması gerekmektedir (TOB, 2021ç).

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinosun minimum avlanma boyu 115 cm (FL) ve minimum avlanma ağırlığı ise 30 kg olup, küçük boyda (75-115 cm) ve ağırlıkta (8-30 kg) avlanmış olan mavi yüzgeçli orkinoslar için en fazla %5 oranında istisna tanınmaktadır (ICCAT, 2019). Türkiye'de de mavi yüzgeçli orkinosun avcılığında minimum boy ve ağırlıklar aynı şekilde uygulanmaktadır (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos aramak amacıyla uçak veya helikopter ya da herhangi bir insansız hava aracı kullanımı yasak olup (ICCAT, 2019), Türkiye'de de durum benzerdir (TOB, 2020a).

19-04 ICCAT Tavsiye Kararına göre 15 m ve üstü gemilerin gemi izleme sistemi bulundurması zorunludur (ICCAT, 2019). Türkiye'de de 12 m ve üstü mavi yüzgeçli orkinos av, taşıma ve destek izni alan gemilerinde BAGİS cihazı bulundurulması zorunludur (TOB, 2021b; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre av, taşıma, destek ve işleme gemileri elektronik seyir defteri bulundurmak zorunda olup (ICCAT 2019), Türkiye'de de aynı şekilde av, taşıma, destek ve işleme gemilerinin elektronik seyir defteri bulundurması gerekmektedir. İlaveten, Türkiye'de söz konusu bu gemilerde matbu seyir defteri ve av gemilerinde de mavi yüzgeçli orkinos seyir defteri bulundurulması zorunludur (TOB, 2020a; TOB, 2021b; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinosların sayısının ve büyüklüğünün doğru bir şekilde tahmin edilmesini sağlayacak görüntü kayıtları stereoskopik ve konvansiyonel kameralar tarafından yapılır ve video kaydı av ve taşıma gemileri ile birlikte bölgesel ve milli gözlemcide bulunur (ICCAT, 2019). Türkiye'de de bu durum aynı şekilde uygulanmaktadır (TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre ICCAT transfer dokümanı (ITD), transfere ait video kaydı ve seyir defterinin ilk nüshası eşliğinde canlı mavi yüzgeçli orkinoslar taşıma kafesleri ile çiftliklere taşınır (ICCAT, 2019). Türkiye'de de durum benzer olup, bunlara ilaveten mavi yüzgeçli orkinos seyir defterinin bir nüshası eşliğinde orkinos çiftliklerine taşınır (TOB, 2021ç).

18-12 ICCAT Tavsiye Kararına göre Elektronik Orkinos Yakalama Dokümanı (eBCD) sisteminin kullanılması zorunludur (ICCAT, 2018b). Türkiye'de de bu sistemin kullanılması zorunlu tutulmaktadır (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararında mavi yüzgeçli orkinosları karaya çıkarma veya aktarma operasyonlarının izin verilen limanlarda yapılabileceği düzenlenmiştir (ICCAT, 2019). Aynı şekilde Türkiye'de de mavi yüzgeçli orkinosları karaya çıkarma veya aktarma operasyonları sadece izin verilen limanlarda yapılmaktadır (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre kotası bulunmayan ve kota fazlası olan mavi yüzgeçli orkinosların avcılığına izin verilmez ve serbest bırakılması için gerekli tedbirler alınır. Orkinoslar ölü ise karaya çıkarılarak ulusal mevzuata uygun takibi yapılır (ICCAT, 2019). Türkiye'de de durum benzer olup, ulusal mevzuatta canlı mavi yüzgeçli orkinosların doğaya bırakılacağı, canlı olmayan mavi yüzgeçli orkinosların ise el konularak ticarete konu edilmeksizin hayır kuruluşlarına bağışlanması şeklinde bir düzenleme mevcuttur (TOB, 2020a; TOB, 2021ç).

19-04 ICCAT Tavsiye Kararına göre mavi yüzgeçli orkinos avcılığında YKK avcılığın yapılması durumunda yasal işlemler taraf ülkenin ulusal mevzuatına göre uygulanır (ICCAT, 2019). Türkiye'de de uygulama aynı şekildedir (Anonim, 1971; Anonim, 1995; TOB, 2020a).

16-05 ICCAT Tavsiye Kararında 15 m ve altındaki gemilerin tarih, zaman, konum ve av miktarını bildirim yapma zorunluluğu yoktur (ICCAT, 2016). Türkiye'de de 12 m altı gemiler için durum benzerdir. 12 m ve üstü avcılık yapan gemilerde ise BAGİS ve matbu ya da elektronik seyir defteri bulundurulması zorunludur (TOB, 2021b). Avrupa Birliği ve Türkiye'de talep edilirse 12 m'den küçük balıkçı teknelerinde seyir defteri tutma zorunluluğu getirilebilmektedir (EU, 2009; TOB, 2020a). TOB tarafından 21 Ağustos 2021 tarihi itibariyle boy uzunluğuna bağlı olmaksızın balıkçılık faaliyetinde bulunacak gemilere de

BAGİS cihazı taktırılması zorunlu tutulabilecektir (TOB, 2021b). Bununla birlikte, OCEANA (2016) tarafından Avrupa Birliği ve Türkiye'de kılıç balığı avcılığı yapan balıkçı gemilerinin çoğunluğunun 15 m ve 12 m'den küçük teknelerden oluştuğu için elektronik sistem üzerinden takibinin yapılamadığı bildirilmektedir. Türkiye'de sadece özel tüketim vergisiz yakıt kullanan 12 m'den küçük tekneler TTM üzerinden elektronik olarak takip edilebilmekte olup, özel tüketim vergisiz yakıt kullanmayanlar ise izlenememektedir.

16-05 ICCAT Tavsiye Kararında kılıç balığı avcılığında kullanılacak av aracı parakete olarak belirlenmiş iken Türkiye'nin ulusal mevzuatında böyle bir düzenleme bulunmamaktadır. Türkiye'de 12 m'den küçük balıkçı gemileri parakete oltası, sade ve fanyalı uzatma ağları, alamana (voli) ağları, sabit ve çapari oltaları kullanabilirler (Anonim, 1995). Bununla birlikte, 01 Eylül 2020 tarihinden itibaren de 12 m ve üstü balıkçı gemilerinin ruhsat tezkerelerinde birincil av aracı olarak belirtilen dışındaki av araçları ile avcılık faaliyetinde bulunmaları ve birincil av aracı dışında farklı av aracı bulundurmaları yasaklanmıştır (TOB, 2020a). Bu düzenlemeyle de 12 m ve üstünde kullanımına izin verilen trol ve gırgır ağları kullanan balıkçı tekneleri hedeflenmiştir.

16-05 ICCAT Tavsiye Kararında kılıç balığı avcılığında parakete oltasının uzunluğu (30 deniz mili-55 km), iğne sayısı (2500 adet) ve iğne büyüklüğü ile ilgili düzenlenmeler bulunmakta olup, Türkiye'nin ulusal mevzuatında parakete oltasının uzunluğu ve iğne sayısı hususunda bir düzenleme yoktur. 16-05 ICCAT Tavsiye Kararında iğne büyüklüğü iğne yüksekliği olarak belirtilmiştir. Türkiye'nin ulusal mevzuatında ise iğne büyüklüğü iğne ağız açıklığı olarak düzenlenmiştir. Türkiye'de kılıç balığı avcılığında kullanılan parakete oltası için sadece iğne ağız açıklığı hakkında sınırlama vardır. Akyol & Ceyhan (2010) tarafından Türkiye denizlerinde kullanılan pelajik kılıç balığı paraketelerin uzunluğu ve iğne sayısı en fazla sırasıyla 30 km ve 500 adet olarak bildirilmiş olup, Türkiye'nin ulusal mevzuatında parakete uzunluğu ve iğne sayısı hususunda bir düzenlemeye ihtiyaç olmadığı değerlendirilebilir.

16-05 ICCAT Tavsiye Kararında bütün ve solungaçsız ve iç organsız olarak kılıç balığına yönelik minimum ağırlık yasağı bulunurken, Türkiye'nin ulusal mevzuatında böyle bir kısıtlama bulunmamaktadır. Türkiye'de avlanan kılıç balıkları bütün olarak gemilerde bulundurularak karaya çıkarılmakta olup, böyle bir düzenlemeye ihtiyaç olmadığı değerlendirilebilir. Bununla birlikte, ICCAT 16-05 Tavsiye Kararında kılıç balığı avcılığında boy yasağı alt çene çatal boy için minimum 100 cm iken, Türkiye'de 125 cm olarak belirlenmiştir.

16-05 ICCAT Tavsiye Kararı'nda av sezonu dahil denizde kılıç balıklarının gemiden gemiye aktarılması yasaklanmış olup, Türkiye'nin ulusal mevzuatında ise avcılık sezonunda denizde gemiden gemiye aktarma yasağı bulunmamaktadır. Türkiye'de kılıç balığı avcılığı yapan gemilerin çoğunluğu 12 m'den küçük gemilerden oluşmakta ve genellikle günübirlik ya da 2-3 gün denizde kalarak avcılık gerçekleştirilmektedir. Bu bağlamda, böyle bir düzenlemeye ihtiyaç olmadığı değerlendirilebilir.

16-05 ICCAT Tavsiye Kararına göre karaya çıkış noktalarının belirlenmiş olması gerekmekte iken, Türkiye'de kılıç balığı avcılığında yasal olarak belirlenmiş karaya çıkış noktası bulunmamaktaydı. Ancak, 27 Ağustos 2021 tarihi itibariyle kılıç avcılığı yapacak gemilerin ürünlerini Tarım ve Orman Bakanlığı tarafından belirlenen karaya çıkış noktalarından çıkartılması zorunlu hale getirilmiştir.

Türkiye'de YKK avcılığın yapılması durumunda yasal işlemler ulusal mevzuata göre uygulanacaktır (Anonim, 1971; Anonim, 1995; TOB, 2020a).

SONUÇ

Türkiye'de mavi yüzgeçli orkinos avcılığına yönelik ICCAT Tavsiye Kararları Türkiye'nin ulusal mevzuatı ile uyumlu hale getirilmiştir. Bu kapsamda Su Ürünleri Kanunu, Su Ürünleri Yönetmeliği, Su Ürünleri Tebliğlerinde gerekli düzenlemeler yapılmıştır. TOB tarafından da Balıkçılık Yapacak Gemilerin Başvurusuna, Avcılığına, Taşımacılığına, Besiciliğine, İhracat ve İthalatına İlişkin Uygulama Genelgesi ya da Talimatı her yıl yayınlanmaktadır. Türkiye'de ICCAT denetimleri kapsamındaki mavi yüzgeçli orkinos avcılığının 19-04 ICCAT Tavsiye Kararına uygun olarak yapıldığı tespit edilmiştir. Kılıç balığı avcılığında ise 16-05 ICCAT Tavsiye Kararının Türkiye'nin ulusal mevzuatı ile tamamen uyumlu olmadığı gözlenmiştir. 16-05 ICCAT Tavsiye Kararında kılıç balığı avcılığında kullanılacak av aracı parakete olarak belirlenmiş, parakete oltasının uzunluğu ve iğne sayısına sınırlama getirilmiş, kılıç balığında minimum ağırlık yasağı konmuş, av sezonu dahil denizde kılıç balıklarının gemiden gemiye aktarılması yasaklanmış olup, Türkiye'nin ulusal mevzuatında ise söz konusu yasal düzenlenmeler yer almamaktadır. Türkiye denizlerinde kılıç balığı avcılığı yapan gemilerin çoğunluğunun 12 m'den küçük balıkçı gemilerinden oluşması, 12 m ve üstü olan balıkçı gemilerinin ise sadece birincil av aracını kullanabiliyor olması, kullanılan pelajik kılıç balığı paraketelerin uzunluğunun ve iğne sayısının 16-04 ICCAT Tavsiye Kararında belirtilen düzenlemelerin çok altında olması, avlanan kılıç balıklarının bütün olarak karaya çıkarılması, kılıç balığı avcılığı yapan gemilerin çoğunluğunun günübirlik ya da 2-3 gün denizde

kalarak avcılık gerçekleştiriyor olması söz konusu bu düzenlemelerin Türkiye'nin ulusal mevzuatında yer almamasının nedenleri olarak değerlendirilebilir. Türkiye'de kılıç balığı avcılığında ICCAT denetimleri 16-05 ICCAT Tavsiye Kararına göre yapılmaktadır. Kılıç balığı avcılığı izni alan 12 m'den küçük balıkçı gemilerinin TTM üzerinden elektronik ortamda takibi için bahse konu gemilerin özel tüketim vergisiz yakıt kullanması yönünde gerekli bilgilendirme ve teşvikler yapılmalıdır. Kılıç balığı avcılığında kota takibi için bu avcılığı yapan 12 m'den küçük balıkçı gemilerine matbu seyir defteri kullanılması zorunluluğu getirilmelidir. İlaveten 12 m'den küçük kılıç balığı avcılığı yapacak balıkçı gemilerine BAGİS cihazı taktırılması yönünde de bir uygulama gerçekleştirilebilir.

Etik Standartlar İle Uyum

Çıkar Çatışması

Yazar herhangi bir çıkar çatışması olmadığını deklare etmektedir.

Etik Onay

Yazar bu tür bir çalışma için resmi etik kurul onayının gerekli olmadığını bildirmektedir.

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A Review of Reported Bacterial Diseases and Antibiotic Use in Tilapia Culture in the Philippines

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ABSTRACT

Aquaculture has become important to meet the demand for animal food both in local and international markets due to the increasing world population. Tilapias are one of the significant cultured species worldwide, in which the Philippines is one of the leading tilapia-producing countries. Tilapias are the second most preferred fish in the Philippines, constituting about 12% of its total aquaculture production in 2018. Cultivation of tilapias is a practice nationwide, mostly performed in fish ponds and cages in various environments. Despite being an almost hardy fish, the investigation of tilapias for bacterial infections also allowed us to follow the changing bacterial world. In this study, we have reviewed articles that previously reported bacterial diseases and the use of antibiotics in tilapia culture in the Philippines. Streptococcosis, Motile *Aeromonas* Septicemia, and *Pseudomonas* infection caused by *Streptococcus agalactiae* and *S. iniae*, *Aeromonas hydrophila*, and *Pseudomonas fluorescens* and *P. aeruginosa*, respectively, were the identified fish diseases. Chloramphenicol, ampicillin, tetracycline, and erythromycin were among the most commonly used antibiotics in tilapia culture.

INTRODUCTION

Tilapias are a prime aquaculture commodity marketed globally in which the Philippines is among the top tilapia-producing countries (Miao & Wang, 2020). Tilapias are introduced fish in the Philippines, which is now considered as the second most preferred cultured fish after milkfish (*Chanos chanos*). The first tilapia species introduced to the country in 1950 was Mozambique tilapia (*Oreochromis mossambicus*) which was originated from Thailand. In 1972, Nile tilapia (*O. niloticus*) and other species (Wami tilapia *O. hornorum*, blue tilapia *O. aureus*, and blackchin tilapia *Sarotherodon melanotheron*, and Redbelly tilapia *Coptodon zillii*) were introduced (Guerrero III, 2019). Pond culture (freshwater and brackish water), cage culture (dam reservoirs, lakes, and seawater), monosex male tilapia culture, saltwater culture, rice-fish (tilapia) culture, and aquaponics are among the most preferred culturing techniques (Romana-Eguia et al., 2020). In 2018, tilapia production from the aquaculture sector was nearly 277,000 metric tons, constituting around 12% of the total Philippine aquaculture production (PSA, 2019).

There are several main factors limiting the sustainability of aquaculture such as habitat conversion, poor management of aquaculture systems, feed availability and management, degradation of water quality, occurrence of harmful algal

blooms, infectious diseases, lack of capital and government support, etc. (Öztürk & Altınok, 2014; Guerrero III, 2019; Boyd et al., 2020; BFAR, 2021; Tahiluddin & Terzi, 2021). One of the main risks to the sustainability of fish aquaculture globally is the proper control and maintenance of infectious diseases (Rodger, 2016; Terzi, 2018). Despite being somewhat hardy fish (Romana-Eguia et al., 2020), tilapias are still susceptible to diseases such as bacterial, parasitic, fungal, and viral diseases (Amal & Zamri-Saad, 2011; El-Sayed, 2019; Romana-Eguia et al., 2020), even with having antibacterial properties (Sajorne & Mabuhay-Omar, 2020). Triggering stressful factors are poor water quality in the farm environment, increasing intensification, and insufficiency of proper health maintenance (Romana-Eguia et al., 2020).

Bacterial abundance and composition in intestine and gills of healthy tilapia (*O. niloticus*) in brackish water fish ponds in the Philippines have been determined by Pakingking et al. (2015). They revealed that under optimum conditions, the total heterotrophic aerobic bacterial counts were ranged from 10^4 to 10^7 CFU g^{-1} with 31 species dominated by *Aeromonas hydrophila, Pseudomonas fluorescens, Shewanella putrefaciens, Plesiomonas shigelloides, Bacillus* spp., *Vibrio cholerae*, and *Staphylococcus* spp. While in diseased tilapias, the commonly isolated bacteria were *Streptococcus agalactiae, A. hydrophila/caviae*, *A. sobria*, *P. shigelloides*, and *V. cholerae* (Limbauan, 2018).

Bacterial fish diseases in aquaculture are not only a problem in the Philippines but also a severe hurdle in other Southeast Asian countries and worldwide (Boran et al., 2013; Rodger, 2016; Kayansamruaj et al., 2020; Terzi et al., 2021). In the past 20 years, the production of tilapia in the Philippines has decreased, and numerous contributing factors have been pointed out (Guerrero III, 2019). One of the confirmed contributing factors to the reduction in Philippine tilapia production is bacterial diseases (Legario et al., 2020). Baleta et al. (2019) assessed the tilapia cage culture practices in relation to the fish mortality incidence at Magat Reservoir, Philippines. They revealed that, as perceived by the farmers, one of the causes of fish mortalities is diseases alongside other primary triggers like temperature fluctuation, water quality, pollution, predation by birds, and parasite infestation generally occurred during the hot season.

The important bacterial diseases reported globally which has an adverse effect on tilapia aquaculture are Streptococcosis, Motile *Aeromonas* Septicemia, Vibriosis, Staphylococcosis, *Pseudomonas*, Francisellosis, Columnaris disease, Edwardsiellosis, Mycobacteriosis, and others. Pathogens in tilapia were identified as *S. iniae, S. agalactiae, Edwardsiella tarda, Pseudomonas* spp., *Francisella noatunensis, Nocardia seriolae, Aeromonas* spp., and *Flavobacterium* spp. (Rodger, 2016; El-Sayed, 2019; Romana-Eguia et al., 2020; Kayansamruaj et al., 2020).

In the Philippines, the most commonly reported bacterial diseases in tilapia culture were Streptococcosis, Motile *Aeromonas* Septicemia, and *Pseudomonas* infections (Duremdez & Lio-Po, 1988; Yambot, 1998; Limbauan, 2018; Reyes, 2018; Reyes et al., 2019; Legario et al., 2020). This paper reviewed these reported bacterial diseases of tilapia in the Philippines, including antibiotic use and associated antibiotic-resistant bacteria in tilapia culture. Literatures related to this paper published from 1988 to 2021 were considered by searching in Google and Google Scholar databases using keywords such as antibiotics, antibiotic-resistant bacteria, disease, *Oreochromis*, Philippines, and tilapia.

Streptococcosis

Streptococcosis is a worldwide bacterial infection hurdle in numerous cultured and wild fish species in various culturing environments (Rodger, 2016). *S. iniae* and *S. agalactiae* are the identified etiological agents of the disease. Streptococcosis-infected tilapia display gross signs like pop-eye, appetite loss, displacement of the spine, hemorrhages (eye, fin bases, and opercula), and corneal opacity (Amal & Zamri-Saad, 2011).

In the Philippines, Legario et al. (2020) reported that grow-out farms (ponds and cages) and hatcheries of tilapia in different parts of the country (Pampanga, Laguna Lake, Taal Lake, Nueva Ejica, Calauan, Laguna, Batad Iloilo, Silay Negros Occidental, and Panabo Davao del Norte), were infected with Streptococcosis. Noted clinical signs of the disease were hemorrhages, exophthalmia, lethargy, eye opacity, ascites, and erratic swimming. Two species were identified as causative agents: *S. agalactiae* and *S. iniae.* The former was found to be a ubiquitous and geographically predominant aetiological agent, and the latter seemed to be restricted to a particular area. A similar study showed that the *S. agalactiae* count in the tilapia farm, Pampanga, were ranged from 10^4 to 10^5 CFU g^{-1} (Reyes et al., 2019). Besides, about 20% of the 181 bacterial isolates from diseased tilapias in Taal Lake were identified as *S. agalactiae,* which was confirmed as a pathogen through a pathogenicity test (Limbauan, 2018). Streptococcosis in tilapias caused by these pathogens have been reported in neighboring Southeast Asian countries (Anshary et al., 2014; Jantrakajorn et al., 2014; Barkham et al., 2019; Kayansamruaj et al., 2019; Syuhada et al., 2020 in Legario et al., 2020) and worldwide as well (Perera et al., 1994; Li et al., 2014; Liu et al., 2016; Su et al., 2019).

Motile *Aeromonas* Septicemia

Motile *Aeromonas* Septicemia is a bacterial disease mainly caused by *A. hydrophila.* Other causative agents of this infection are *A. veronii*, *A. sobria,* and *A. caviae.* Pathogens of this disease occur globally among various hosts in brackish water and freshwater, periodically in seawater (Öztürk & Altınok, 2014). Clinical signs of the disease are ulcerations, hemorrhages, abscesses, anemia, and ascitic fluid (Stratev & Odeyemi, 2017).

Aeromonas spp. are usually present in the gills and intestines of healthy tilapia, as investigated by Pakingking et al. (2020) in the Philippines' fishponds. The counts of presumptive *Aeromonas* in these tilapia's parts ranged from 10^2 to 10^5 CFU g^{-1}. It was identified that the most predominant species were *A. hydrophila,* followed by *A. sobria* and *A. salmonicida,* constituting 94%, 4%, and 2% of all presumptive counts, respectively, which suggest under stressful environments, could initiate bacterial disease. Likewise, Limbauan (2018) isolated 181 bacterial isolates from disease-infected tilapia in a cage farm in Taal Lake, Luzon, and revealed that about 42% of the isolates were identified as *A. hydrophila/caviae*.

Since *A. hydrophila* is naturally occurring in tilapias, it is not surprising that the outbreak of a disease caused by this pathogen has been observed since the early 1990s. For instance, Yambot (1998) investigated the causative agent of disease outbreaks of Nile tilapia (*O. niloticus*) in several aquaculture farms in Luzon, Philippines, from 1994-1996. The observed disease signs were exophthalmia, dislodged eyeball, eye opacity, ulcerations, mouth sore, body discoloration, skin lesions, fin rot, and sluggishness. In cage farming of tilapia, high death rates were remarkably noted during the cold and rainy seasons when the temperature was low. Through isolation and examination of bacterial isolates from the various tissues of diseased tilapias, the researcher identified the causative agent of the disease as *A. hydrophila* and confirmed through experimental infection that this agent caused septicemia in Nile tilapia. In addition, *A. hydrophila* has been isolated from the diseased tilapias in the grow-out farms in Minalin, Pampanga, Philippines. Most of the sampled tilapias exhibited clinical signs like eye opacity, skin/fin rot, lesion, and abnormal body coloration. The attack rate varied from 31.75% in male tilapias to 62.5% in female tilapias. The source of water and total dependency on feeding were the significant risk factors pointed out for the *A. hydrophila* incidence in a grow-out phase of tilapia in the study area (Reyes, 2018).

Pseudomonas Infection

The first report of *P. fluorescens* infection in the country took place among the fry of Nile tilapia cultured in a hatchery. This disease development intensified under stressful conditions such as overcrowding and poor handling. This causative agent is a Gram-negative and rod bacteria that appeared greenish to yellowish on Pseudosel Agar medium. This bacterium can survive and flourish only in freshwater and brackish rear environments under an optimum temperature of 25-30°C. In both healthy and infected tilapia *O. mossambicus*, this species has been commonly reported to arise mainly in the tilapia's internal organs and tissues (Duremdez & Lio-Po, 1988). Recently, an outbreak of *Pseudomonas* infection in the tilapia grow-out farms in Minalin, Pampanga, Philippines, has been investigated by Reyes (2019). The noted clinical signs of this infection were skin/fin rot, lesion, eye opacity and/or abnormal body coloration. The identified causative agent of this infection was *P. aeruginosa* with a computed attack rate of 54% in the entire municipality.

Antibiotics Treatment and Antibiotic-Resistant Bacteria in Tilapia

In aquaculture, antibiotics have been considered the most utilized chemicals for more than half-century worldwide. Antibiotics are a group of organic or chemical compounds that kill or inhibit the growth of pathogens and are also used as a growth promoter and disease treatment or prevention (Lulijwa et al., 2020). The global use of antibiotics in aquaculture was reviewed by Lulijwa et al. (2020), and they found out that 11 countries utilized 67 antibiotic compounds from 2008 to 2018. They reported that most of the applied antibiotics in aquaculture were florfenicol, sulphadiazine, and oxytetracycline. Out of 50 papers reviewed, 24% were applying antibiotic treatments in tilapia culture. In the culture of tilapia, the utilization of antibiotics for disease surveillance or development of water quality is limited (Boyd, 2004) and needs extra attention.

In the Philippines, there are few reports on the usage of antibiotics in aquaculture. In *Penaeus monodon* (giant tiger prawn) hatcheries in the country, antibiotics used for disease control were erythromycin, tetracycline, chloramphenicol, rifampicin, and nitrofuran with a concentration ranging from 0.1 to 4 ppm on applied every 1, 2, and 3 days (Primavera, 1993; Cruz-Lacierda et al., 2000). Yambot (1998) tested the sensitivity of *A. hydrophila* isolates isolated from diseased tilapias and revealed that all isolates were susceptible to oxolinic acid (2 μg) and chloramphenicol (30 μg). Besides, 68% and 78% of the isolates were sensitive to streptomycin (10 μg) and oxytetracycline (30 μg), respectively. Also,

Limbauan (2018) reported 181 bacterial isolates, predominated by *A. hydrophila/caviae, S. agalactiae, P. shigelloides, A. sobria,* and *V. cholerae* were all exhibited susceptibility to chloramphenicol and ceftriaxone. Furthermore, Reyes et al. (2019) tested various antibiotics on *S. agalactiae*– a bacterium isolated from the soil of tilapia farm in Pampanga, Philippines. Three groups of antibiotic concentrations were tested in antibiogram test a) 10 μg for ampicillin, gentamicin, and penicillin, b) 20 μg for nalidixic acid and amoxicillin and, c) 30 μg for tetracycline, vancomycin, and chloramphenicol. Their findings revealed that four antibiotics (e.g., chloramphenicol, gentamicin, nalidixic acid, and tetracycline) efficiently inhibited the growth of S. *agalactiae* isolates. Thus, these antibiotics were recommended as a treatment for S. *agalactiae* infections in tilapia. Furthermore, they found out that other antibiotics, such as amoxicillin, ampicillin, penicillin, and vancomycin, resulted in intermediate susceptibility.

Antibiotics in tilapia culture are also applied in other nearby Asian countries, such as Thailand. The most commonly used antibiotics were reported as enrofloxacin, oxytetracycline, amoxicillin, and sulfadiazine, potentiated with trimethoprim (Rico et al., 2014). However, antibiotic utilization in aquaculture may give rise to the development of antibiotic resistance bacteria (Capkin et al., 2015; Corum et al., 2020; Terzi et al., 2020). For example, Niu et al. (2019) reported that isolates of *E. tarda* – pathogen causing Edwardsiellosis, obtained from hybrid red tilapias cultured in a cage in Ping River, Thailand, were resistant to colistin sulfate (10 μg), oxolinic acid (2 μg), oxytetracycline (30 μg), sulphamethoxazole/ trimethoprim (25 μg), ampicillin (10 μg), and ceftazidime (30 μg). Also, hatchery-reared tilapia in Indiana, USA, was found to have 30 bacterial isolates resistant to ampicillin isolated from the guts (Karki et al., 2013).

In the Philippines, studies on antibiotic-resistant bacteria in tilapia are inadequate. Yambot (1998) reported that 25 *A. hydrophila* isolates, a causative agent of Motile *Aeromonas* Septicemia, which were isolated from diseased Nile tilapia in Luzon, Philippines, were resistant to ampicillin (10 μg), and 64% of the isolates were also resistant to erythromycin (15 μg). Langaoen et al. (2018) determined antibiotic-resistant bacteria in tilapia *O. niloticus* obtained from Lingayen fish farm in Pangasinan, Philippines. A swab test was employed to isolate bioluminescent vibrios from different fish parts such as gills, intestines, stomach, and eyes. In their results, four strains of bioluminescent vibrios were found to be resistant to ampicillin (10 μg). Moreover, two of these vibrio strains were found to be multiple-drug resistant. Furthermore, 50 out of 181 bacterial isolates obtained from diseased tilapia in the Taal Lake dominated mainly by *A. hydrophila/caviae, P. shigelloides, A. sobria, S. agalactiae*, and *V. cholerae,* were resistant to cefoxitin (Limbauan, 2018).

CONCLUSION

In conclusion, based on the available articles reviewed, tilapias in the Philippines are still prone to bacterial infections despite being hardy fish. Streptococcosis, Motile *Aeromonas* Septicemia, and *Pseudomonas* infection caused by *S. agalactiae* and *S. iniae*, *A. hydrophila,* and *P. fluorescens* and *P. aeruginosa*, respectively, were the reported bacterial diseases in the country. Chloramphenicol, ampicillin, tetracycline, and erythromycin were among the most commonly used antibiotics in tilapia culture. Antibiotic-resistant bacteria in tilapia cultivation have also been reported. Hence, the use of antibiotics in tilapia culture gives rise to the development of antibiotic-resistant bacteria. Further investigations may be conducted in other parts of the country, especially those with fish mortalities incidence. Isolation of antibiotic-resistant bacteria may be done in tilapia farms or hatcheries utilizing antibiotics as disease treatments. Also, antibiotic resistance genes, plasmids, and transferable resistance genes of the bacteria isolated from tilapia and their surrounding environments should be given special attention to determine horizontal gene transfer among pathogenic and non-pathogenic bacteria.

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Compliance With Ethical Standards

Authors' Contribution

ABT and ET conceptualized the study, ABT wrote the first draft of the manuscript, and then ET edited the manuscript. Both authors have read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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The Effects of Mucilage Event on the Population of Critically Endangered *Pinna nobilis* (Linnaeus 1758) in Ocaklar Bay (Marmara Sea, Turkey)

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ABSTRACT

This paper aimed to understand the potential effects of the mucilage event on the critically endangered *Pinna nobilis* in Ocaklar Bay located at the southern Marmara Sea. Underwater surveys were carried out in October 2020 and July 2021. The study area covers 500 m² that was divided into 5 main zones having 100 m² areas (10×10 m). Then, each main zone was separated into sub areas covering 25 m² (5×5 m). The habitat structure, depth, and availability of the mucilage event were observed by SCUBA diving equipment in sub areas. During the underwater observations, the total number of dead and alive individuals was counted as 228 of which 130 individuals were alive and 98 were dead. The minimum and maximum population density (including both dead and alive individuals) of *P. nobilis* was found to be between 10 individuals per 100 m² and 112 individuals per 100 m² in the study area, respectively. The mortality rates were calculated as 35.96% and 16.12% for the years 2020 and 2021, respectively. This paper puts forward that the *P. nobilis* population could be resistant to extreme environmental stress and even juvenile individuals (smaller than 15 cm) were recruited in the study area during the mucilage event.

INTRODUCTION

The fan mussel *Pinna nobilis* is an indigenous species and the largest marine bivalve of the Mediterranean Sea. It can grow up to 1.2 m in length (Zavodnik et al., 1991) and survive up to 45 years (Rouanet et al., 2015). It lives with the tapered anterior buried in the soft bottom (seagrass meadows, mud, sandy mud, or gravel) (Tebble, 1966).

P. nobilis are filter-feeding organisms that can gather substances from their surroundings in order to feed. It is a good and sensitive bio-indicator for Mediterranean littoral and water quality because of this property (Vicente et al., 2002; Natalotto et al., 2015). Many species, including annelids, ascidians, bivalves, bryozoans, cnidarians, crustaceans, echinoderms, macroalgae, gastropods, and sponges, use this species' hard surface as a viable habitat (Rabaoui et al., 2009; Acarli et al., 2010).

However, due to recreational and commercial fishing activities for food, the use of its shell for ornamental purposes, and inadvertent mortality by trawling and anchoring, the population of the fan mussel, which plays an ecological role, has been significantly diminished. The fan

mussel has been listed as an endangered and protected species Under Annex IV of the Habitats Directive (Council Directive 92/43/EEC). However, for the past five years, especially, *Haplosporidium pinnae*, a parasitic *Haplosporidium* species, has negatively affected the population of *P. nobilis* (Vázquez-Luis et al., 2017; Darriba, 2017; Carella et al., 2019; Katsanevakis et al., 2019). Thus, the species' status was upgraded from "vulnerable" to "critically endangered" at national level by the Spanish Sectoral Environmental Conference on July 17, 2017. Some biological aspects of *P. nobilis* such as reproductive cycle (Acarli et al., 2018), growth (Demirci & Acarli, 2019), culture (Acarli et al., 2011a), intraspecific relationships with other species (Acarli et al., 2019) have been studied by several scientists. Mass mortalities have been reported in the western Mediterranean, the Tyrrhenian Sea in Italy, and the Northern Aegean Sea (Catanese et al., 2018; Carella et al., 2019; Katsanevakis et al., 2019; Nebot-Colomer et al., 2021). Meanwhile, numerous surviving individuals have been found in Spain Alfacts Bay (Ebro Delta) (Prado et al., 2020), the East of Corsica Diana Lagoon (Simide et al., 2019), Thau Lagoon (Foulquié et al., 2020), in Kalloni Gulf and Laganas Bay (Zotou et al., 2020) and in Schiaparelli Port-Cros Archipelago Marine Protected Area (Ruitton & Lefebvre, 2021). In Turkish exclusive economic zone, mass mortality has been reported for different locations in the Aegean Sea (Acarli et al., 2020; Öndes et al., 2020a), whereas the Çanakkale Strait, connecting the Aegean Sea and the Marmara, had 100% and 9.2% mortalities in the locations close by, respectively (Acarli et al., 2021).

A strong volume of mucilage organic matter generated by planktonic algal bloom was first detected in mid-autumn 2007 in the Marmara Sea (Aktan et al., 2008). On the other hand, mucilage was observed in greater abundance in the Marmara Sea starting from January 2021 than in previous years (Balkis-Ozdelice et al., 2021). The rising temperature of seawater, agriculture activities, domestic and industrial waste discharges, and overfishing all contribute to planktonic algal blooms (Flander-Putrle & Malej, 2008; Yentur et al., 2013; Savun-Hekimoğlu & Gazioğlu, 2021). Mucilage sinking or accumulating on the bottom has the greatest impact on benthic life (Schiaparelli et al., 2007). Currently, the mucilage event was observed during the study period in 2021 in Ocaklar Bay, Erdek on the southern coasts of the Marmara Sea. The aim of this study was to reveal the effect of mucilage on *P. nobilis* population observed in Ocaklar Bay in the southern Marmara Sea.

MATERIAL AND METHODS

This study was carried out in two different phases both in October 2020 and June 2021 in Ocaklar Bay, coasts in the southern Marmara Sea (Figure 1). The images before the mucilage event in October 2020 and during the

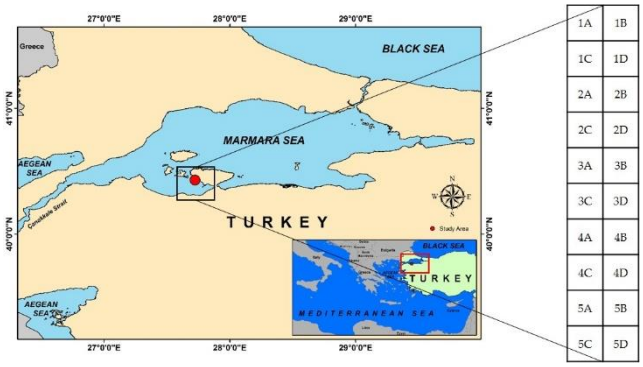

Figure 1. Study area

Figure 2. The surface images before (a) and during (b) the mucilage event, underwater images before (c) and during (d) the mucilage event in Ocaklar Bay

mucilage event in June 2021 were illustrated in Figure 2. A total of nine diving surveys were conducted by SCUBA diving equipment. The study area covered a total of 500 m² which was divided into 5 main zones (zones 1, 2, 3, 4, 5) that have 100 m² area (10×10 m). Then, each main zone was separated into sub areas covering 25 m² (5×5 m). The boundaries of the study area were determined with the help of a rope by driving the aluminium sticks to the seabed (see video from URL-1 at https://youtu.be/OAeoPHlSh-Y). Each sub area has been coded (1A, 1B, 1C, 1D, 2A, 2B, …, 5C, 5D). The numbers of alive and dead individuals in the sub areas were determined after the study area was prepared in October 2020. All dead and alive individuals were counted and measured in the sub areas in June 2021. The temperature and the depth of the sub areas were recorded by Oceanic GEO2. The habitat structure of the sub areas was noted to the underwater slate during the underwater surveys.

The maximum shell width (dorso-ventral) of all individuals (alive and dead) in sub areas was measured by in situ measurements without removing any dead/alive individuals. Measurements were performed using a scale with a precision of 0.1 mm and immediately recorded on the underwater writing slate (see video from URL-2 at https://youtu.be/NMcGOmt-7NY). The data of the measured shell width of the individuals were used to calculate the total length of the individuals by adapting the equation which used raw data of Acarli et al. (2018).

$$TL = 2.7479W + 2.0128 \ (r^2 = 0.7454) \quad (1)$$

In this formula, *TL* is the total length, *W* is the shell width of the individuals.

Table 1. Habitat structure, depth and temperature of the sub areas in the study area

Sub Areas	Habitat Structure	Min. Depth (m)	Max. Depth (m)	Temperature in June 2021 (°C)
1A	Boulder (20%), Sandy (80%)	1.8	2.1	27.8
1B	Boulder (25%), Sandy (75%)	1.5	2.1	26.1
1C	Boulder (10%), Sandy (90%)	2.1	2.4	25.6
1D	Sandy	2.1	2.4	25.6
2A	Sandy	2.4	2.7	25.6
2B	Sandy	2.4	3.0	25.6
2C	Covered by *Mytilus galloprovincialis*	2.7	3.7	25.6
2D	Covered by *Mytilus galloprovincialis*	3.0	3.7	25.6
3A	*Cymodocea nodosa* bed	3.7	4.6	25.6
3B	*Cymodocea nodosa* bed	4.0	4.9	25.6
3C	*Cymodocea nodosa* bed	4.6	5.5	25.0
3D	*Cymodocea nodosa* bed	4.9	5.5	25.0
4A	*Cymodocea nodosa* bed	5.5	6.1	24.4
4B	*Cymodocea nodosa* bed	5.5	6.1	24.4
4C	*Cymodocea nodosa* bed	6.1	7.0	24.4
4D	*Cymodocea nodosa* bed	6.1	7.0	24.4
5A	*Cymodocea nodosa* bed	7.9	8.8	23.9
5B	*Cymodocea nodosa* (40%), Sandy (60%)	7.9	8.8	23.9
5C	Sandy	8.8	9.4	22.2
5D	Sandy	8.8	9.4	22.2

RESULTS

The temperature ranged between 22.2°C and 27.8°C during the underwater surveys. The habitat structure, depth and temperature of the sub areas were presented in Table 1. The depth of the surveyed areas changed from 1.8 m to 9.4 m. The structure of the habitat consisted of boulders in the shallow waters while it was replaced with sandy and seagrass sediments in the deeper waters, and it was covered with sandy sediment in the deepest water of the study area.

During the underwater observations, the total number of dead and alive individuals was counted as 228 in October 2020. Among dead individuals, 73 were counted before the mucilage event while 25 dead individuals were counted after the mucilage. A total of 98 dead individuals was observed during the underwater observations. On the other hand, 130 alive individuals were observed in June 2021 in the study area. It has been determined that 25.51% of the mortality rate occurred in 2021. In addition, it has been determined that two juvenile individuals (smaller than 15 cm) have recruited to the population during the mucilage event.

The number of individuals observed in each sub area, and the minimum and maximum length of alive and dead individuals are given in Table 2. No (dead or alive) *P. nobilis* individuals were encountered in sub areas 1D and 2B. However, no viable individuals were seen in sub areas 5C and 5D. On the other hand, *P. nobilis* individuals, which were observed to be dead during the mucilage event in the Marmara Sea, were found in sub areas 2D, 3A, 3B, 3C, 3D, 4A, 4B, 4C, and 4D. The total length of the dead individuals that died during the mucilage event were ranged between 32.24 cm and 52.85 cm. On the other hand, the minimum and maximum lengths of alive individuals were measured as 14.65 cm and 58.62 cm, respectively (Table 2).

Table 2. Total numbers and total length measurements of *P. nobilis* in the sub areas observed in October 2020 and June 2021

Sub Areas	N	Alive in June 2021		Dead in October 2020			Dead in June 2021		
		TL_{min}(cm)	TL_{max}(cm)	N	TL_{min}(cm)	TL_{max}(cm)	N	TL_{min}(cm)	TL_{max}(cm)
1A	2	37.19	39.93	-	-	-	-	-	-
1B	6	14.93	39.11	-	-	-	-	-	-
1C	2	35.26	35.81	-	-	-	-	-	-
1D	-	-	-	-	-	-	-	-	-
2A	2	14.65	19.05	-	-	-	-	-	-
2B	-	-	-	-	-	-	-	-	-
2C	3	39.38	54.77	-	-	-	-	-	-
2D	4	39.66	49.83	1	44.61	44.61	1	44.88	44.88
3A	25	33.06	55.32	13	39.11	54.22	4	40.76	49.83
3B	21	38.29	58.62	7	40.76	45.43	2	49.28	50.38
3C	11	38.29	51.75	11	40.76	51.75	2	41.58	49.00
3D	10	23.45	49.28	5	39.11	54.77	6	40.76	51.20
4A	7	42.96	49.83	11	39.11	57.80	2	45.98	52.85
4B	7	32.79	49.00	5	35.54	52.02	5	41.86	49.00
4C	9	38.01	48.73	8	34.99	51.48	1	32.24	32.24
4D	14	29.77	54.22	6	32.24	50.10	2	43.23	51.48
5A	5	41.86	47.90	2	47.35	48.73	-	-	-
5B	2	47.63	48.73	1	51.48	51.48	-	-	-
5C	-	-	-	1	56.97	56.97	-	-	-
5D	-	-	-	2	38.83	45.98	-	-	-
Total		**130**			**73**			**25**	

Note: *N*: sample size; TL_{min}: minimum total length; TL_{max}: maximum total length

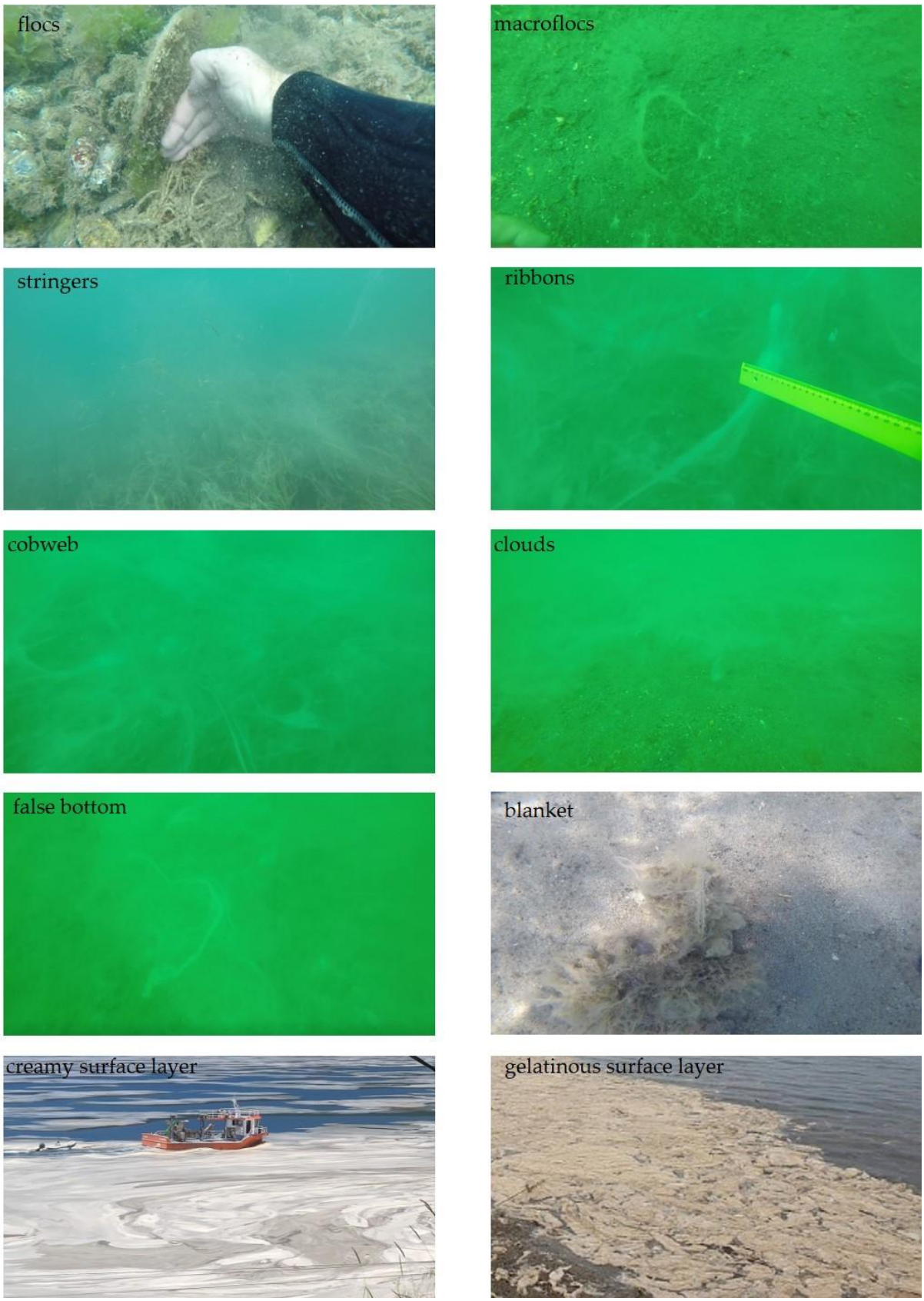

Figure 3. Types of mucilage observed in Ocaklar Bay during study period

The mucilage types were classified during the underwater observation as blanket type, cobweb, ribbons, stringers, flocs, macroflocs, cloud, and false bottom in June 2021. In addition, the mucilage types covering the sea surface were also observed as creamy surface layer and gelatinous surface layer (Figure 3). During the underwater observations, it was determined that the mucilage event had a lively filamentous appearance at depths of 8 m and above with dense sandy ground and that they moved towards the shore with the current. It was observed that the dead form of the

mucilage settled on the *Cymodocea nodosa* meadows. The divers could easily clear the dead forms on *C. nodosa* with simple hand movements (see video from URL-3 at https://youtu.be/QiJ-_-Uurlc). It was generally observed that the mucilage could not reach shallow waters by accumulating on the *C. nodosa* meadows lying parallel to the coast in the study area.

It is promising that the survival rate was found to be 100% in 5 sub areas (1A, 1B, 1C, 2A, 2C) in the study area. Unfortunately, no live individuals were found in the sub areas 5C and 5D. However, all deaths in the sub areas 5C and 5D were determined to occur during the mucilage event. It was determined that dead individuals detected during the underwater observations carried out in October 2020 before the mucilage event were observed intensively between zones 3 and 4 (Figure 4). The population density (dead and alive individuals) of *P. nobilis* was found to be between 10 individuals per 100 m² and 112 individuals per 100 m² in the study area (Figure 5).

DISCUSSION

This is the first study reporting the impacts of the mucilage events on *P. nobilis* populations in a previously unaffected marine area along the coast of Ocaklar Bay in the southern Marmara Sea. The presence of temperature anomalies with hydrodynamic regime (i.e., current speed and water mass turnover) may trigger the increasing frequency of mucilage outbreaks (Danovaro et al., 2009). Savun-Hekimoğlu & Gazioğlu (2021) indicated that the temperature in the Marmara Sea had risen by 2 to 2.5°C over the last 20 years, well above the global norm. Likewise, Acarli & Ayaz (2015) reported that sea surface temperature (SST) was recorded as 22°C and 21°C in July 2011 and July 2012 in Ocaklar Bay, respectively. In the present study, the temperature of seawater ranged between 22.0°C and 27.8°C in accordance with the depth. The variation in the temperature of seawater on the bottom was greater than Acarli & Ayaz (2015) and supported the findings of Savun-Hekimoğlu & Gazioğlu (2021) which reported an increase in the temperature of seawater in the Marmara Sea. Balkis-Ozdelice et al. (2021) noted that the mucilage event was found to be more extreme in 2021 than in previous years. Therefore, it can be concluded that the rise in the temperature of seawater has triggered the mucilage event.

Stachowitsch et al. (1990) defined mucilage types that are macroflocs, stringers, clouds, creamy surface layers, and gelatinous surface layers. This classification was taken into account not only on the size and shape, but also takes relative position in the water, stability, behaviour, and effect on benthos in consideration. On the other hand, Precali et al. (2005) described the mucilage types as blanket type, cobweb, ribbons, stringers, flocs, macroflocs, cloud, and false bottom, creamy surface layers and gelatinous surface layers in the Adriatic Sea. Mr. Engin Algan, the head of Marmara Island Fisheries Cooperative in Turkey, informed that the mucilage event was appeared firstly in October 2020 and clings to purse-seine nets in the fishing gears used by fishermen in Marmara Island (Personal communication).

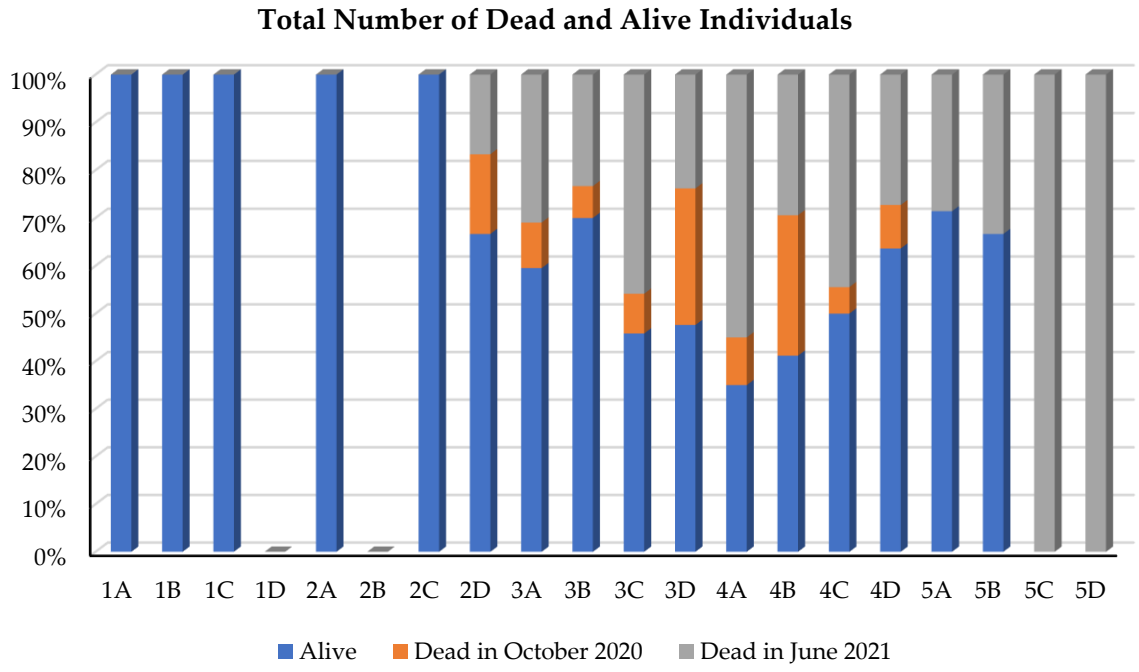

Figure 4. Total number of dead and alive individuals in sub areas

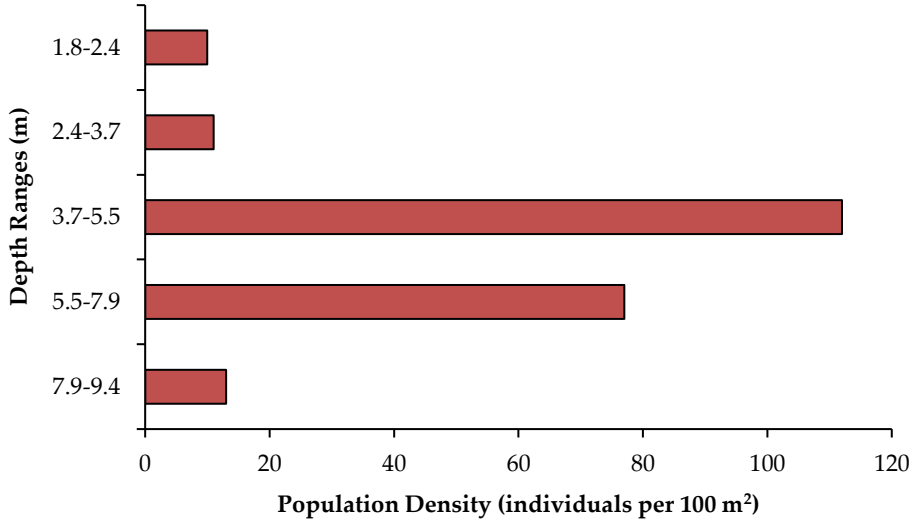

Figure 5. The population density (dead and alive individuals) of *P. nobilis* in Ocaklar Bay

When the first mucilage event occurred, it was described as the creamy surface layer type in the sea surface of Ocaklar Bay in March 2021. Subsequently, the mucilage types were also classified during the underwater observation as blanket type, cobweb, ribbons, stringers, flocs, macroflocs, cloud, and false bottom in June 2021 as defined by Precali et al. (2005). Altın et al. (2015) reported that by covering the benthic habitat and generating anoxic conditions, blanket type mucilage could induce a decrease in the amount of food in the bottom or prohibit food intake in the benthic welling. In addition, the benthic organisms include the communities of bivalve, echinoids, crustacean, polychaetas holothurians and sipunculids, sponges, sea squirts, sea stars and barnacles could be affected due to anoxic conditions caused by mucilage (Stachowitsch, 1980; Rinaldi et al., 1995; Pellegrini et al. 2003; Schiaparelli et al., 2007). The hypoxia-sensitive groups are fish, crustaceans, echinoderms, molluscs (most to least) (Gray et al., 2002). Ascidians, anthozoans and molluscs are distinctly more tolerant than polychaetas, decapods, and echinoderms to hypoxia (Riedel et al., 2014). In this study, the mortality rate was found to be 16.12% in the *P. nobilis* population in July 2021 during the mucilage event. On the other hand, Crustacean species such as *Eriphia verrucosa* and *Carcinus aestuarii* were not seen during underwater surveys carried out according to the data obtained through citizen science. Higher resistance of mollusc species than other species to the environmental stress could cause the occurrence or absence in the study area.

Katsanevakis (2007) documented that the natural mortality rate is lower in *P. nobilis* population. However, some authors noted that death was encountered in *P. nobilis* populations due to human activities, including tourism and fishing activities (Deudero et al., 2015; Öndes et al., 2020b). It has been observed that there is no tourism-related damage on the stocks. The damage caused by the mooring anchors was not observed in the study area. The mortality rate of old dead was calculated as 35.96% in the present study. When the inner shell surface of the dead individuals was examined, it was determined that many macrobenthic organisms settled on these dead individuals. Considering the density and size of these macrobenthic organisms (Bivalve, Gastropod, tragana [described by Acarli & Ayaz, 2015]), the death of *P. nobilis* was predicted to be long time ago. Deaths that occurred before the year 2020 are not thought to be due to the disease. Because it has been determined that healthy individuals perform the closure of the shells quickly during underwater surveys. However, Acarli et al. (2021) highlighted that the closure of the shells of infected individuals was quite slow in *P. nobilis* stocks in the Çanakkale Strait where high mortality occurred. It can be concluded that anthropogenic activities could cause higher mortality than natural mortality although the mucilage event has already influenced the population in the study area. It was mentioned that individuals up to 15 cm in length are less than 1-year-old in some studies (Kožul et al., 2011; Acarli et al., 2011b; Demirci & Acarli, 2019). Katsanevakis (2006) pointed out that individuals in the group of the youngest age had the highest densities in the bathymetric zone between 1 and 3 m depth, and the density of the youngest age group was higher in poorly sorted sediments (the quartile deviation of grain size distribution is larger than 1). The author has also noted that no *P. nobilis* individual has been reported deeper than 22 m depth. It was promising that recruited individuals were also observed in the study area. Healthy juvenile individuals were found between 1.8 m and 2.4 m in June 2021 although they were not observed during the underwater surveys in 2020 (see video from URL-4 at https://youtu.be/F1NBga3mFgM). The total lengths of healthy juvenile individuals were measured as 14.65 cm and

14.93 cm. It can be concluded that juvenile individuals attached to the ground and grow up during the mucilage event. Moreover, no dead *P. nobilis* was observed until 3.0 m water depth. There was only one dead individual in sub area 2D (depth ranged between 3.0 m and 3.7 m) before the mucilage event. Then, one more *P. nobilis* individual was found to be dead in the sub area 2D during the mucilage event. Adult *P. nobilis* individuals (larger than 15 cm) were observed to become denser after the depth of approximately 3 m. It suggests that adverse environmental effects such as mucilage event in the coastal waters up to 3 meters may not have a negative effect on the survival rate of the fan mussel alone. It's possible that at low depths, simple wave movement and tidal currents were enough to disperse the mucilage (Devescovi & Iveša, 2007). The fact that the effect in this bathymetric zone is lower than at other depths suggests that the effect of mucilage may have been further reduced due to wave activity at these depths.

Although there are several documents reporting mass mortality in *P. nobilis* population in the Marmara Sea (Çınar et al., 2021), the results of the present paper are promising for ensuring the sustainability of *P. nobilis* stocks in the Marmara Sea. Transplantation applications of the *P. nobilis* as recommend by Acarli (2021) must be acted to ensure the sustainability of healthy stocks. *Therefore*, further researches must remain to carry out to monitor the establishment and maintenance of healthy *P. nobilis* populations although several impacts of natural, environmental, and/or anthropogenic factors on the population have occurred.

CONCLUSION

Healthy *P. nobilis* populations were found at different locations in Ocaklar Bay, along the coasts of Kapıdağ Peninsula. In order to revitalize the damaged *P. nobilis* populations, it is very important to identify healthy populations or populations that are resistant to disease and mucilage and to protect these areas. Spats should be collected via collectors from healthy and/or resistant populations and they should be reared under controlled environment. Then, transplanting the juveniles collected from healthy and/or resistant populations to a new location and/or regions with collapsed populations would be effective in revitalizing the population. The survival of the juvenile individuals (smaller than 15 cm) during the mucilage event is promising in terms of ensuring the sustainability of the stocks. Herewith, a very important finding was obtained that the *P. nobilis* stock in the study area could be maintained despite the mucilage event.

Although the present study is a micro-study investigating the effects of mucilage event on *P. nobilis* population, it puts forward that *P. nobilis* population could be resistant to the extreme environmental stress although it could not survive the disease caused by *Haplosporidium pinnae* parasite., Thus, studies should be continued for the monitoring of *P. nobilis* population in nearby areas (i.e., Kapıdağ Peninsula) affected by mucilage event.

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Compliance With Ethical Standards

Authors' Contributions

DA and SA designed the study and carried out underwater observations. SK managed the draft of the manuscript, statistical analyses and data management. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Length-Weight Relationships of Four *Symphodus* Species (Perciformes: Labridae) off Gökçeada Island (Northern Aegean Sea, Turkey)

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ABSTRACT

The present work provides length-weight relationships (LWRs) of four *Symphodus* species off Gökçeada Island (Northern Aegean Sea, Turkey). The sampling was ensured between November 2013 and December 2014 from commercial fishmongers. This study presents the most recent and the broadest analysis of the LWRs for the following studied species: *Symphodus ocellatus*, *Symphodus tinca*, *Symphodus mediterraneus*, *Symphodus rostratus*. The *b* value varied between 2.81 and 3.37, whereas r^2 aligned from 0.89 to 0.95.

INTRODUCTION

Some morphometric relationships such as length-weight relationships (LWRs), maximum size and length-girth relationships (LGRs) are important to grasp the fishes' condition in their environmental conditions such as history of life, growth pattern, fish fatness, habitat conditions, and general health, (Froese, 2006; Paruğ & Cengiz, 2020; Cengiz 2021). LWRs have been commonly used by fisheries managers and aquatic biologists to appraise the fish stocks, the fisheries ecology and the population dynamics in aquatic ecosystems, and semi-controlled aquatic environments (Ricker, 1968). Over and above, the productivity level and ecological health of aquatic ecosystems could be assessed via length-weight models (Deekae & Abowei, 2010). These models help to evaluate the well-being and the growth patterns of fishes (Muchlisin et al., 2010; Ndiaye et al., 2015).

Labridae has 504 species in the world (Parenti & Randall, 2011), there are 20 species in Turkish coasts (Bilecenoğlu et al., 2014). *Symphodus* species distributed in the Eastern Atlantic, Black Sea and Mediterranean with a depth of 1-50 m, near rocks and eel-grass beds (İlhan et al., 2008). In addition, the sex reversal and the sexual dimorphism could monitor in some species (Whitehead et al., 1986; İlhan et al., 2008). The studies on *Symphodus* fishes have been carried out in assorted areas of the world (Nival, 1966; Stergiou & Moutopoulos, 2001; Pallaoro & Jardas, 2003; Kalaycı et al., 2007; İlhan et al., 2008; Raposeiro & Azevedo, 2009; Škeljo et al., 2015; Kasapoglu et al., 2016; Aydın, 2020; Onay, 2021), in epitome. Torres et al. (2012) underlined that LWRs could change spatially and/or temporarily, therefore these works must be regularly renewed for each discrete population. From this point of view, this study provides new values concerning the relationship between the length and weight of four *Symphodus* species (*S. ocellatus*, *S. tinca*, *S. mediterraneus*, *S. rostratus*) captured from Gökçeada Island (Northern Aegean Sea, Turkey).

MATERIAL AND METHODS

The northern Aegean coasts of Turkey are divided into sub-regions as Saros Bay, Gallipoli Peninsula, Gökçeada Island, Bozcaada Island, and Edremit Bay (Cengiz & Paruğ,

2020, 2021). The northern Aegean areas are described to be an extended continental shelf, smooth muddy/sandy bases and upper nutrient concentrations (Maravelias & Papaconstantinou, 2006) and have higher phytoplankton and zooplankton abundance compared with the southern Aegean Sea (Theocharis et al., 1999). Therewithal, upwellings significantly affected the northern Aegean Sea. It happens in the Aegean Sea (Metaxas, 1973) by virtue of strong northerly winds in summers between August and September, generally. On the ground of the subsurface cool water upwellings, surface temperature changes form a thermal front between the western and eastern regions of the northern Aegean Sea (Zodiatis & Balopoulos, 1993). In addition, The Black Sea inlet is possibly a significant element within the variations in environmental conditions. The Black Sea water led to strong stratification, which facilitates free communication to the shallow waters (Olson et al., 2007). For these reasons, Gökçeada Island (Figure 1) displays the diversity in terms of the species' composition (Keskin & Ünsal, 1998; Karakulak et al., 2006; Altın et al., 2015) and the fishing activity is rather vital for the Island (Cengiz, 2020).

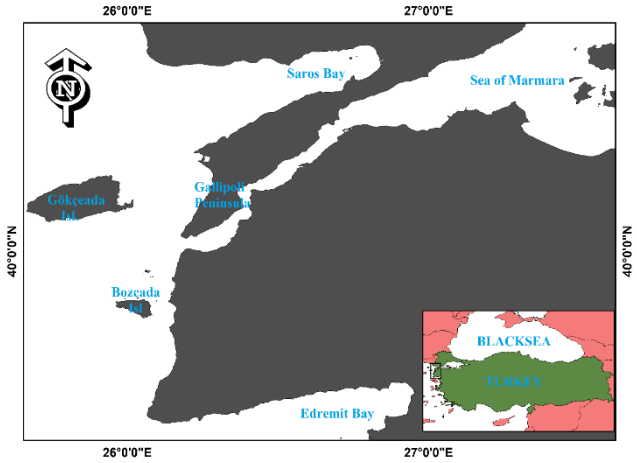

Figure 1. Gökçeada Island and the northern Aegean coasts of Turkey

Four *Symphodus* species were obtained, monthly, from commercial fishmongers around Gökçeada Island between November 2013 and December 2014. Fish were identified according to Mater et al. (2003). Checking the scientific name for each species has been performed in accordance with Froese & Pauly (2021). The individuals were measured to the nearest 1 mm (total length), weighed to the nearest 0.01 g (total weight). The length-weight relationship was uncovered by fitting an exponential curve, $W = aL^b$ (Le Cren, 1951). In this equation, the parameters a and b of the exponential curve were predicted by linear regression analysis over log-transformed data by using the logarithmic transformation equation, $\log W = \log a + b \log L$. In this equation, L is the total length (cm), W is the total weight (g), a is the intercept, and b is the slope or allometric coefficient, using the least-squares method. Growth types of these species were determined using t-test at significance level of 5% according to $t_s = \frac{b-3}{SE_b}$, where t_s is a t-test value, b is a slope, and SE_b is the standard error of the slope (Dutta et al., 2012). Hereby, $b > 3$ indicates a positive allometric growth, while value $b < 3$ displays a negative allometric growth. It is isometric growth when value b is equal to 3 (Bagenal & Tesch, 1978).

RESULTS

In the present study, LWRs of four *Symphodus* species [(*S. mediterraneus* (n=23), *S. ocellatus* (n=23), *S. rostratus* (n=34), *S. tinca* (n=22)] were analyzed. The sample size, minimum and maximum lengths and weights, estimated parameters of LWR (a and b), 95% confidence intervals of b and coefficient (r^2) are given in Table 1 for each species, respectively.

All regressions were highly significant ($p < 0.01$), with the coefficient of determination (r^2) ranging from 0.89 to 0.95. About the type of growth, while one species (*S. rostratus*) showed positive allometry growth, two species (*S. ocellatus, S. tinca*) displayed negative allometry growth. In addition, one species (*S. mediterraneus*) indicated isometric growth. The b values ranged between 2.81 and 3.37, whereas a values varied between 0.0061 to 0.0342 (Figure 2).

Table 1. Length-weight relationships of four *Symphodus* species off Gökçeada Island (Northern Aegean Sea, Turkey)

Species	N	Length range (cm)		Weight range(g)		*a*	*b*	*95% CI of b*	r^2
		L_{min}	L_{max}	W_{min}	W_{max}				
S. mediterraneus	23	10.1	13.7	17.18	44.00	0.0148	3.05	2.36 – 3.72	0.89
S. ocellatus	23	10.5	15.1	18.46	54.61	0.0342	2.68	2.42 – 2.94	0.95
S. rostratus	34	8.8	14.7	8.91	47.78	0.0061	3.37	2.95 – 3.79	0.90
S. tinca	22	10.5	17.1	20.26	80.57	0.0261	2.81	2.54 – 3.08	0.95

Note: *N*: Sample size; L_{min}: minimum length; L_{max}: maximum length; W_{min}: minimum weight; W_{max}: maximum weight; a and b: intercept and slope of length-weight relationships; *CI*: confidence interval; r^2: the coefficient of determination.

Table 2. LWRs of four *Sympodus* species from different areas

Species	References	Area	N	Length range (cm)	*a*	*b*
S. mediterraneus	Petrakis & Stergiou (1995)	South Euboikos Gulf (Greece)	19	6.3 – 13.6	0.000014	3.01
	Valle et al. (2003)	Western Mediterranean (Spain)	41	4.8 – 12.3	0.0212	2.87
	Karakulak et al. (2006)	Gökçeada Island (Turkey)	39	9.8 – 16.4	0.0173	2.90
	Özaydın et al. (2007)	İzmir Bay (Turkey)	39	4.9 – 20.2	0.0127	3.08
	İlhan et al. (2008)	İzmir Bay (Turkey)	62	4.9 – 20.2	0.0147	3.00
	Bilge et al. (2014)	Southern Aegean (Turkey)	38	4.7 – 16.6	0.0139	3.00
	Altın et al. (2015)	Gökçeada Island (Turkey)	72	2.0 – 12.2	0.0100	3.15
	This study	Gökçeada Island (Turkey)	23	10.1 – 13.7	0.0148	3.05
S. ocellatus	Petrakis & Stergiou (1995)	South Euboikos Gulf (Greece)	31	4.4 – 9.9	0.000005	3.22
	Valle et al. (2003)	Western Mediterranean (Spain)	456	3.0 – 9.0	0.0091	3.17
	Özaydın et al. (2007)	İzmir Bay (Turkey)	216	4.7 – 9.2	0.0085	3.22
	İlhan et al. (2008)	İzmir Bay (Turkey)	328	4.7 – 9.2	0.0091	3.18
	Gürkan et al. (2010)	Candarlı Bay (Turkey)	10	4.3 – 6.6	0.0041	3.47
	Keskin & Gaygusuz (2010)	Erdek Bay (Turkey)	575	1.8 – 10.7	0.0102	3.10
	Bilge et al. (2014)	Southern Aegean (Turkey)	274	4.6 – 9.0	0.0102	3.13
	Altın et al. (2015)	Gökçeada Island (Turkey)	1922	1.4 – 18.5	0.0070	3.22
	Onay (2021)	Eastern Black Sea (Turkey)	384	8.2 – 16.4	0.0100	3.21
	This study	Gökçeada Island (Turkey)	23	10.5 – 15.1	0.0342	2.68
S. rostratus	Petrakis & Stergiou (1995)	South Euboikos Gulf (Greece)	70	8.0 – 12.0	0.000001	3.48
	Valle et al. (2003)	Western Mediterranean (Spain)	1156	1.5 – 14.3	0.0176	2.80
	Karakulak et al. (2006)	Gökçeada Island (Turkey)	19	9.6 – 12.7	0.0177	2.83
	Özaydın et al. (2007)	İzmir Bay (Turkey)	36	7.1 – 10.9	0.0049	3.46
	İlhan et al. (2008)	İzmir Bay (Turkey)	167	7.0 – 11.4	0.0070	3.29
	Bilge et al. (2014)	Southern Aegean (Turkey)	42	6.7 – 12.5	0.0048	3.41
	Altın et al. (2015)	Gökçeada Island (Turkey)	1016	1.2 – 17.7	0.0070	3.19
	This study	Gökçeada Island (Turkey)	34	8.8 – 14.7	0.0061	3.37
S. tinca	Petrakis & Stergiou (1995)	South Euboikos Gulf (Greece)	31	12.7 – 20.8	0.000011	3.06
	Pallaoro & Jardas (2003)	Adriatic Sea (Croatia)	1443	8.6 – 42.5	0.0220	2.81
	Valle et al. (2003)	Western Mediterranean (Spain)	56	11.4 – 30.4	0.02584	2.78
	Karakulak et al. (2006)	Gökçeada Island (Turkey)	248	10.0 – 26.8	0.0109	3.04
	Özaydın et al. (2007)	İzmir Bay (Turkey)	89	6.7 – 23.0	0.0183	2.90
	İlhan et al. (2008)	İzmir Bay (Turkey)	277	6.7 – 24.3	0.0184	2.90
	Keskin & Gaygusuz (2010)	Erdek Bay (Turkey)	41	2.5 – 15.5	0.0111	3.09
	Bilge et al. (2014)	Southern Aegean (Turkey)	110	6.6 – 22.0	0.0180	2.92
	Altın et al. (2015)	Gökçeada Island (Turkey)	27	3.0 – 18.5	0.0070	3.26
	Dimitriadis & Fournari-Konstantinidou (2018)	Southern Ionian Sea (Greece)	83	12.4 – 25.3	0.0260	2.76
	Miled-Fathalli et al. (2019)	Gulf of Tunis (Tunusia)	60	11.6 – 25.0	0.0190	2.84
	Onay (2021)	Eastern Black Sea (Turkey)	17	6.5 – 12.8	0.0160	2.99
	This study	Gökçeada Island (Turkey)	22	10.5 – 17.1	0.0261	2.81

Note: *N*: Sample size; *a* and *b*: intercept and slope of length-weight relationships.

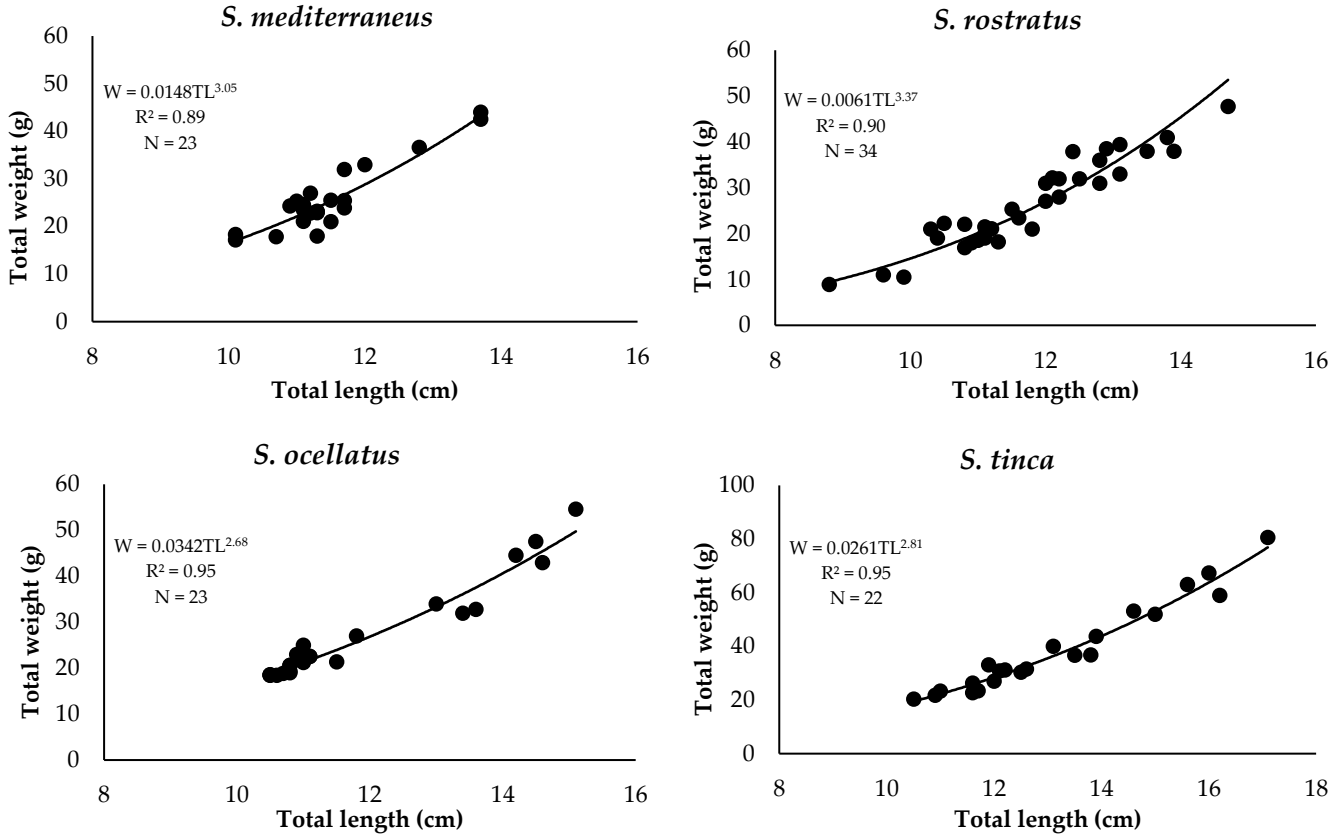

Figure 2. The curves of length-weight relationships for four *Symphodus* species off Gökçeada Island (Northern Aegean Sea, Turkey)

DISCUSSION

In the present study, 102 individuals belonging to four species were examined. Table 2 summarizes the previous studies on LWRs for four *Sympodus* species. The *b* values in LWRs fall between 2.5 and 3.5 (Froese, 2006) or 2 to 4 (Tesch, 1971). In this study, *b* values of the studied fish species were within these expected ranges. The *b* value for *S. mediterraneus* varied between 2.87 and 3.15 in other studies, whereas this value ranged from 3.10 to 3.47 for *S. ocellatus*. The b value for *S. rostratus* was calculated as 3.37. While this value differs from the studies of Valle et al. (2003) and Karakulak et al. (2006), it is similar to other researches. The *b* value for *S. tinca* was estimated to be 2.81. While the ones differ from Petrakis & Stergiou (1995), Karakulak et al. (2006), Keskin & Gaygusuz (2010), Altın et al. (2015) and Onay (2021), it shows similarity with some related works (Table 2).

The length-weight relationships may be changed between different seasons and are affected by factors such as size, temperature, maturity, salinity and food availability. Furthermore, the degree of sexual maturity, diet, fullness or emptying gut and sampling techniques, number and duration of sampling can affect its value (Yıldırım et al., 1999; Wootton, 2003; Abbasi et al., 2019; Eagderi et al., 2020).

Altın et al. (2015) reported the LWRs of seven *Symphodus* species from shallow waters of Gökçeada Island using a beach seine and beam trawl. Cengiz et al. (2011, 2012) underlined that the diversity of species within an area and/or among areas could be relevant to environmental conditions and sundry fishing gears in the sampling. The likely reason for differences in the variety of species between Altın et al. (2015) with this study is presumably by virtue of diversified fishing gears that the commercial fishermen used.

CONCLUSION

In conclusion, this study provided new information about LWRs for four *Sympodus* species from Gökçeada Island (Northern Aegean Sea, Turkey) and added further data to those previously reported species, which will be helpful in biological studies.

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Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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Effects of Annual Grass with the Mixtures of Legume on Agronomic Growth of Plants

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ABSTRACT

This study has been carried out in order to determine the variations in the vegetative characteristics of the mixtures of legume and cereal crops. Experiments were conducted according to the randomized complete block design using three replications of flowerpots. In the experiment; 1, 2 and 4 annual grass, Hungarian vetch and hairy vetch along with their double mixtures have been taken from per flowerpot. Effects of lean and mixed cultivation on plant characteristics (plant height, number of branches, total wet and dry weight and total root weight) and nutritional characteristics (NDF, ADF, ADL, crude protein, crude ash, digestibility of dry and organic matter, and total fiber) of crops were examined in this study. According to the results of our research work, as the number of plants per flowerpot increased the total wet and dry weight and root mass increased, too, in terms of plant characteristics particularly, in mixed sowing, the amount of upper soil surface and underground organic mass increased. Ratios of NDF, ADF and fiber in the mixture of cereals with legumes have decreased, while the digestibility of crude protein, crude ash, dry and organic matter has increased in case of nutritional characteristics. On the other hand, the ratios of NDF and ADF have increased, while there was a decrease in crude protein and crude ash ratios in the mixture of legumes with cereals. This indicates that annual grass along with hairy vetch and Hungarian vetch can be cultivated in winter both for obtaining higher grass production as well as to provide more organic matter to soil. It is concluded that the most suitable mixing ratios to be the two-fold and four-fold ratios of perennial grass along with the single ratio of vetches.

Tek Yıllık Çim ile Baklagil Karışımlarının Bitkilerin Agronomik Gelişimlerine Etkileri

MAKALE BİLGİSİ

Makale Geçmişi
Geliş: 13.05.2021
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Anahtar Kelimeler:
Besleme özellikleri
Botanik özellikler
Ham protein
ADF
Buğdaygil

ÖZET

Bu çalışma baklagil ve buğdaygil karışımlarında karışıma giren bitkilerin vejetatif özelliklerinde meydana gelen değişimleri belirlemek amacıyla yürütülmüştür. Araştırma tesadüf parselleri deneme desenine göre 3 tekerrürlü saksı çalışması olarak yürütülmüştür. Denemede saksı başına 1, 2 ve 4 adet tek yıllık çim, macar fiğ ve tüylü fiğ ile bunların ikili karışımları ele alınmıştır. Çalışmada yalın ve karışık yetiştiriciliğin bitkisel (bitki boyu, kardeş veya dal sayısı, toplam yaş ve kuru ağırlıklar ile toplam kök ağırlığı) ve besleme (NDF, ADF, ADL, ham protein, ham kül, kuru ve organik maddenin sindirilebilirliği ve toplam lif) özelliklerine olan etkileri incelenmiştir. Araştırmadan elde edilen verilere göre; bitkisel özelliklerde saksı başına bitki sayısı arttıkça toplam yaş ve kuru ağırlıklar ile kök kütlesi artmış, özellikle karışık ekimlerde toprak üstü ve toprak altı organik madde miktarı artmıştır. Besleme özelliklerinde ise buğdaygillerin baklagillerle karışımında NDF, ADF ve lif oranları düşerken; ham protein, ham kül, kuru ve organik maddenin sindirilebilirliği artmıştır. Baklagillerin buğdaygillerle karışımında ise NDF ve ADF oranları artarken; ham protein ve ham kül oranlarında ise düşüşler olmuştur. Bu durum daha yüksek ot üretimi ve toprağa daha çok organik madde temini için tek yıllık çim ile tüylü fiğ ve macar fiğinin kışlık olarak yetiştirilebileceğini göstermektedir. En uygun karışım oranları ise çok yıllık çimin ikili ve dörtlü oranlarının fiğlerin birli oranıyla karışıma sokulması uygun bulunmuştur.

GİRİŞ

Ülkemizdeki mevcut hayvan varlığının kaliteli kaba yem açığı %60 düzeyindedir (Semerci & Kurt, 2006). Hayvansal üretimin yetersiz olmasına neden olan sorunların başında kaliteli kaba yem açığı gelmektedir (Ayan vd., 2006). Bu nedenle yem bitkileri tarımı yapılan alanlar bir yandan artırılırken, diğer yandan birim alandan daha fazla verim ve kaliteli ürün alınmasına yönelik çalışmalar yapılmalıdır (Tosun, 1996). Birim alandan daha fazla verim ve kaliteli ürün alınmasının önemli bir yolu ise baklagil ve buğdaygillerin karışım halinde yetiştirilmesidir. Ülkemizde yetiştirilen yem bitkilerinin büyük çoğunluğunu yalın ekim olarak baklagiller teşkil etmekte, üreticiler yeterince bilgilendirilmemesi ve ekimde karşılaşılan sorunlar sebebiyle karışık ekim sınırlı olarak yapılmaktadır. Oysa karışık ekimlerin ürettiği yem, çeşitli besin maddeleri içerdiği için karbonhidrat-protein dengesinin sağlanmasında faydalıdır. Karışık ekimlerde bitkiler toprağı daha iyi ve hızlı kapladıkları için yabancı otların çıkmasını engellemesiyle beraber erozyonu önlemede de daha etkilidir (Ramret & Lennartsson, 2002; Szumigalski & Rene, 2005). Karışımdaki bitkilerin kökleri farklı derinliklere ineceği için, toprak profilinin her tabakasından daha iyi yararlanmış olurlar. Baklagillerin karışık ekimlerdeki en büyük avantajı kendisinin ve buğdaygillerin ihtiyacı olan azotu köklerindeki *Rhizobium* bakterileri sayesinde toprağa bağlayabilmeleridir (Hiebsch & McCollum, 1987; Berg, 1990). Ayrıca baklagiller kazık köklü bitkiler oldukları için suyun toprağa geçişini artırır ve toprağın fiziksel yapısını düzenler (Rao vd., 1997). Buğdaygillerin daha düşük protein içeriğine sahip olmalarının olumsuzluğu, hayvanlara protein içeriği yüksek katkı maddeleri vermek yerine protein oranı yüksek baklagillerle karışık ekimle giderilmiş olmaktadır (Robinson, 1969; Caballero vd., 1995; Anil vd., 1998; Yağmur & Kaydan, 2006).

Bu çalışmanın amacı baklagil ve buğdaygil yem bitkilerinin karışık yetiştirilmesine bir seçenek olacak tek yıllık çim ile macar fiği ve tüylü fiğin farklı oranlarda karışık olarak yetiştirilerek, yalın ekimlere göre botanik ve otun besleme özelliklerindeki değişimi tespit etmek olmuştur.

MATERYAL VE YÖNTEM

Bu araştırma Çanakkale Onsekiz Mart Üniversitesi Tarla Bitkileri Bölümü'nün bitki yetiştirme ünitesinde yürütülmüştür. Çalışmada bitki materyali olarak tek yıllık çimin (*Lolium multiflorum* L.) Caramba, macar fiğin (*Vicia pannonica* L.) Ege Beyazı 79 ve tüylü fiğin (*Vicia villosa* Roth.) Efes 79 çeşitleri kullanılmıştır. Deneme 25,0×25,0×22,5 cm ebadında plastik saksılarda (hacmi 14 dm^3) tesadüf parselleri deneme planına göre 3 tekerrürlü olup 27 uygulama şeklinde yürütülmüştür. Çalışma tek yıllık çim ile macar fiğ ve tüylü fiğ bitkilerinin birli, ikili ve dörtlü sayılarda birbiri ile karışımlarını içermiştir. Saksılara 1/3 ham toprak, 1/3 elenmiş sığır gübresi ve 1/3 kum karışımından oluşan materyal konulmuştur. Bitkilerin kuraklık stresine girmelerini önleyecek şekilde ihtiyaç duyuldukça sulama yapılmıştır.

Bitki boyu; deneme sonunda bitkilerin toprak seviyesi ile en uç kısmının ölçülmesi ile elde edilmiştir. Çimlerde kardeş ve dal sayısı; denemenin sonunda saksılardaki bütün çim ve fiğlerin kardeş ve dal sayıları sayılmak suretiyle bulunmuştur. Toplam yaş ve kuru ağırlıkların hesaplanması için; saksılardan hasat edilen bitkiler (çimde başaklanma, tüylü fiğe çiçeklenme dönemlerinde) hemen tartılarak yaş ot verimleri, daha sonra önce açık havada sonra da 65°C'ye ayarlı fırında 24 saat kurutulup (Cook & Stubbendieck, 1986) tartılarak kuru ağırlıklar bulunmuştur. Ham protein ve ham kül oranları AOAC (1990)'a ve NDF, ADF ve ADL oranları ise Van Soest vd. (1991)'e göre yapılmıştır. Kuru madde ve organik maddenin sindirilebilirliği ile toplam lif oranı NIRS cihazında (SAS) okutularak elde edilmiştir. Araştırmada alınan veriler deneme desenine uygun şekilde SAS v9.0 istatistik paket programında analiz edilmiştir. İncelenen özellikler arasındaki farklar Tukey testi ile karşılaştırılmıştır.

BULGULAR VE TARTIŞMA

Bitki Boyu

Karışım şekillerine göre ortalama bitki boyları fiğlerde istatistiki olarak önemli bulunurken ($p<0,001$), tek yıllık çimde önemsiz bulunmuştur (Çizelge 1). Ortalama en yüksek bitki boyu (99,6 cm) tüylü fiğde, en düşük (47,7 cm) ise tek yıllık çimde belirlenmiştir. Macar fiğinde ortalama bitki boyu ise 82,0 cm olmuştur. Macar fiğinde en yüksek bitki boyu 102,6 cm ile 1M (macar fiği) yalın ekimlerinde, en düşük ise 66,6 cm ile 4Ç4M ekilen saksılarda tespit edilmiştir. Tüylü fiğde en yüksek bitki boyu 134,6 cm 2T (tek yıllık) yalın ekimlerde, en kısa ise 75,0 cm ile 4Ç2T bulunan saksılarda ölçülmüştür. Genel olarak saksılardaki bitki sayısının artmasına bağlı olarak bitki boyunun düştüğü görülmüştür. Tek yıllık çim ve macar fiğde en yüksek bitki boyuna saksıda 2, tüylü fiğ 1 bitkide, en düşük ise macar fiği ve tüylü fiğde saksı başına 4 bitkide, tek yıllık çimde ise 1 bitkide elde edilmiştir. Tek yıllık çim, macar fiği ve tüylü fiğ kullanılarak yürütülen bu karışım denemesinde çim bitkilerinde önemli olmamakla birlikte, genel olarak her iki fiğ türünde de saksı başına bitki sayısı arttıkça bitki boyunda bir azalma görülmüştür. Esasen sık ekimlerde bitkiler ışıktan daha iyi yararlanmak amacıyla oksin üretimini arttırarak daha fazla boylanır (Taiz & Zeiger, 2008). Ancak fiğler yatık geliştikleri için genelde saksıların yan taraflarına doğru büyümüşlerdir. Bu sebeple ışıklanma konusunda bir sorun yaşamadıkları

Çizelge 1. Karışım şekillerine göre bitkilerdeki boy ve kardeş sayılarındaki değişim

Karışım Şekli	Bitki Boyu (cm)			Kardeş/Dal Sayısı (adet)		
	Çim	*Macar fiği*	*Tüylü fiğ*	*Çim*	*Macar fiği*	*Tüylü fiğ*
1Ç	51,0			5,6^{a}		
2Ç	49,3			3,0^{ab}		
4Ç	51,0			2,6^{ab}		
1M		102,6^{a}			20,0^{a}	
2M		90,0^{ab}			10,3^{bcd}	
4M		75,0^{ab}			6,8^{d}	
1T			127,3^{ab}			12,3^{ab}
2T			134,6^{a}			5,8^{bc}
4T			116,6^{abc}			3,5^{c}
1Ç1M	52,0	85,3^{ab}		3,0^{ab}	16,0^{abc}	
1Ç2M	48,3	98,0^{ab}		3,0^{ab}	10,8^{bcd}	
1Ç4M	44,3	85,0^{ab}		1,6^{b}	9,3^{cd}	
1Ç1T	41,3		103,0^{abc}	3,3^{ab}		15,6^{a}
1Ç2T	44,6		94,3^{bcd}	3,6^{ab}		6,0^{bc}
1Ç4T	48,0		89,3^{cd}	1,0^{b}		3,4^{c}
2Ç1M	50,8	75,0^{ab}		2,3^{b}	17,3^{ab}	
2Ç2M	49,6	80,3^{ab}		2,2^{b}	12,6^{bcd}	
2Ç4M	39,0	68,3^{ab}		1,8^{b}	9,7^{cd}	
2Ç1T	54,3		103,6^{a-d}	1,8^{b}		9,7^{abc}
2Ç2T	47,3		95,6^{bcd}	2,3^{b}		6,0^{bc}
2Ç4T	46,0		89,0^{cd}	1,5^{b}		3,6^{c}
4Ç1M	50,0	81,3^{ab}		1,2^{b}	11,3^{bcd}	
4Ç2M	43,3	77,0^{ab}		1,0^{b}	10,3^{bcd}	
4Ç4M	42,0	66,6^{b}		1,2^{b}	7,5^{d}	
4Ç1T	50,0		88,0^{cd}	1,0^{b}		12,0^{ab}
4Ç2T	43,3		75,0^{d}	1,0^{b}		5,2^{bc}
4Ç4T	55,3		78,6^{d}	1,3^{b}		2,8^{c}
Ortalama	47,7	82,0	99,6	2,2	11,8	7,2

Not: Aynı sütunda farklı harfle işaretlenen ortalamalar arasındaki fark %5 düzeyinde önemlidir.

düşünülmektedir. Tek yıllık çimler ise fazla kardeş oluşturmadığı için (Çizelge 3), bu bitkiye sarılarak gelişme göstermemişlerdir. Bu durum bitkilerde yetersiz ışıklanma yaşanmamasına sebep olmuştur. Boy azalması ise saksılarda bitki sayısının artması ile bitkilerin daha yoğun köklenmesiyle birbirleri ile rekabete girmelerinden ileri geldiği düşünülebilir.

Kardeş/Dal Sayısı

Farklı karışım şekillerine göre ortaya çıkan kardeş ve dal sayıları bütün bitkilerde istatistiki olarak önemli ($p<0,001$) çıkmıştır (Çizelge 1). Yalnız ekilen tek yıllık çim bitkileri 2,6-5,6 adet arasında kardeş meydana getirirken, 2 veya 4 çimin fiğlerle birlikte ekilmeleri sonucunda bitki başına ortalama kardeş sayısı 1,0-2,3'e kadar düşmüştür. Genel olarak en yüksek dal (16-20 adet) 4Ç1M dışında (Ç: çok yıllık çim) 1M bitkisi bulunan saksılarda, en az dal (6,8-9,7 adet) ise gerek yalın gerekse karışım halinde saksı başına 4M yalın ekimlerde belirlenmiştir. Bitki başına en düşük dal sayısı, tüylü fiğin yalın ya da karışım halinde dört bitki ile temsil edildiği saksılarda çıkmıştır. Örneğin, dört fiğin yalnız ekildiği saksılarda tüylü fiğin ortalama dal sayısı 3,50, 1,2 ve 4 tek yıllık çim ile karışık ekimlerinde ise sırasıyla 3,4, 3,6 ve 2,8 dal oluşturmuştur. Diğer taraftan, her saksıda bir tüylü fiğin bulunduğu yalın veya karışım ekimlerde bitkiler en çok dal meydana getirmişlerdir. Nitekim sadece bir tüylü fiğin bulunduğu saksılardaki bitkilerde ortalama 12,3 adet; 1T+1, 2 ve 4Ç oluşan karışımlarda ise aynı sıra ile 15,6, 9,7 ve 12,0 adet dal oluşması bu durumu desteklemektedir (Çizelge 1).

Yalın olarak yetiştirilen saksılarda bitki başına kardeş sayısı karışık ekimlere göre daha yüksek bulunmuştur. Bunun yanı sıra saksı başına düşen bitki sayısı arttıkça dal sayısında azalma olduğu tespit edilmiştir. Buğdaygillerde kardeşlenme genetik özellikleri yanında çevre (iklim ve toprak) faktörleri, yetiştiricilik faktörleri (gübreleme, sulama) ve bitki sıklığı ile bağlantılıdır (Dougherty vd., 1974). Sık ekimlerde bitkiler kendilerine yeterli yaşam alanı bulamayacakları ve su, besin elementi ve ışık gibi büyüme faktörlerine yeterince sahip olamayacakları için daha az kardeşlenirler (Malik, 1969; Dubey & Lal, 1970). Bu yüzden bu çalışmada da saksı başına bitki sayısı arttıkça kardeş ve dal sayısı da azalmıştır. Gerek tek yıllık çimin gerekse macar ve tüylü fiğin bitki başına kardeş sayıları saksıdaki bitki sayısının artması ile azalmıştır. Bitkiler daha rekabetçi şartlarda yaşamak zorunda kaldıkları zaman kendini besleyebilecek yeterli sürgün oluşturmamaktadır. Zira büyüme faktörleri bitkiler için yetersiz kalmakta, bu durumda kardeş/dal sayısı azalmaktadır. Bitki başına tek yıllık çimde yalnız ekimlerde, macar fiğinde ise 4 macar fiğin tek yıllık karışık ekimlerinde daha yüksek olmuştur. Tüylü fiğde ise değişim önemli olmamakla birlikte düzenli bir değişim gözlenmiştir. Bu durum tek yıllık çim + macar fiği karışımlarında macar fiği daha güçlü gelişerek çimi bastırdığını göstermektedir. Bu hususun ortaya çıkmasında bitkilerin genetik yapıları yanında çevre faktörlerinin de macar fiğ için daha uygun olması etkili olmuş olabilir (Konak vd., 1997).

Toplam Yaş Ağırlık ve Kuru Ağırlık

Farklı karışım oranlarına göre toplam yaş ve kuru ağırlıklarda karışım şekillerine göre ortalamalar arasındaki farklılıklar istatistiki olarak önemli ($p<0,001$) bulunmuştur (Çizelge 2). Saksı başına toplam en yüksek yaş ağırlık (74,6 g) 1Ç4M saksılarında, en düşük ise sırasıyla 1, 2 ve 4Ç yalın ekilen (12,0, 10,6 ve 16,1 g) saksılarda belirlenmiştir. Farklı karışım oranlarına göre saksı başına toplam kuru ağırlık bakımından karışımların ortalamaları arasındaki farklılıklar istatistiki olarak önemli ($p<0,001$) bulunmuştur (Çizelge 2). Macar fiğin yalın ve karışım ekimlerinde toplam kuru ağırlıklardaki değişimler genelde yaş ağırlıklara benzer olmuştur. En yüksek kuru ağırlık çoğunlukla 4M yer alan saksılarda belirlenmiştir. Örneğin 4 macar fiğin 1, 2 ve 4. çimle karışımlarında sırasıyla 18,9, 16,1 ve 13,7 g; yalnız ekimlerde ise 14,4 g gibi en yüksek değerler elde edilirken buna karşılık en düşük kuru ağırlıklar (10,4 ve 10,9 g) 4Ç1M karışımı ile 1M ekimlerinden sağlanmıştır.

Toplam Kuru Kök Ağırlığı

Farklı karışım oranlarına göre toplam kuru kök ağırlığı bakımında karışımların ortalamaları arasındaki farklılıklar istatistiki olarak önemli ($p<0,001$) bulunmuştur (Çizelge 2). Saksı başına yaş ve kuru ağırlıklar arasında önemli farklar ortaya çıkmıştır. Genelde yalın ekimlerde daha az organik kütle meydana gelirken, karışımlarda daha fazla toprak üstü kütlesi belirlenmiştir. Bu durum iki sonucu ortaya çıkarmaktadır: (a) saksı başına bitki sayısının artması bitki kütlesini arttırmaktadır ve (b) baklagil + buğdaygil karışımları bu türlerin yalnız ekimlerinden daha çok organik kütle oluşturmaktadır. Belirli sınırlar dahilinde birim alandaki bitki sayısının artması, toplam üretimi yükseltecektir. Zira bu durumda toplam üretime katılan bitki sayısı da artacaktır. Yine birçok araştırmada (Altın, 1987; Altın & Gökkuş, 1988) da kaydedildiği gibi, baklagiller ve buğdaygiller çok iyi uyum sağladıkları için, bu bitki gruplarının karışım ekimlerinde daha yüksek verim elde edilmektedir. Denemede saksı başına bitki sayısı ile toplam kök ağırlığı arasında olumlu ilişki ortaya çıkmıştır. Bitki sayısı arttıkça kök ağırlığı da artmıştır. Bu durum toplam kök ağırlığına her bir türün belirli oranlarda katkı sağlamaları ile bağlantılıdır. En yüksek kuru kök ağırlığı (14,30 g) 2Ç4M, en düşük ise 4,22 g ile 1M bulunan saksılarda tespit edilmiştir (Çizelge 2).

Çizelge 2. Karışım şekillerine göre toplam yaş ve kuru ağırlıklar ile kök ağırlıklarındaki değişimler

Karışım	Toplam Yaş Ağırlık (g)			Toplam Kuru Ağırlık (g)			Toplam Kuru Kök Ağırlığı (g)		
	Çim	*Macar*	*Tüylü*	*Çim*	*Macar*	*Tüylü*	*Çim*	*Macar*	*Tüylü*
1Ç	12,0^{f}			2,6^{g}			3,5^{ef}		
2Ç	10,6^{f}			2,4^{g}			2,3^{f}		
4Ç	16,1^{ef}			3,7^{g}			7,3^{b-f}		
1M		41,9^{cd}			10,9^{bc}			4,2^{c}	
2M		42,9^{bcd}			11,8^{bc}			8,0^{abc}	
4M		52,8^{bcd}			14,4^{abc}			6,2^{bc}	
1T			48,0^{ab}			13,5^{de}			7,0^{cd}
2T			39,9^{b}			13,9^{cde}			5,3^{d}
4T			56,7^{ab}			18,0^{abc}			9,6^{a-d}
1Ç1M	46,9^{bcd}	46,9^{bcd}		12,6^{def}	12,6^{bc}		6,4^{c-f}	6,4^{bc}	
1Ç2M	62,4^{abc}	62,4^{ab}		15,2^{a-f}	15,2^{abc}		8,9^{a-e}	8,9^{abc}	
1Ç4M	74,6^{a}	74,6^{a}		18,9^{abc}	18,9^{a}		10,9^{a-c}	10,9^{abc}	
1Ç1T	58,2^{a-d}		58,2^{ab}	14,5^{b-f}		14,5^{cde}	4,9^{def}		4,9^{d}
1Ç2T	66,5^{ab}		66,5^{a}	16,6^{a-d}		16,6^{a-d}	7,0^{c-f}		7,0^{cd}
1Ç4T	51,0^{bcd}		51,0^{ab}	19,9^{a}		19,9^{a}	7,4^{b-f}		7,4^{cd}
2Ç1M	45,2^{bcd}	45,2^{bcd}		11,1^{ef}	11,1^{bc}		10,0^{a-d}	10,0^{abc}	
2Ç2M	53,7^{a-d}	53,7^{bcd}		12,5^{def}	12,5^{bc}		9,1^{a-e}	9,1^{abc}	
2Ç4M	60,0^{abc}	60,0^{abc}		16,1^{a-e}	16,1^{ab}		14,3^{a}	14,3^{a}	
2Ç1T	50,0^{bcd}		50,0^{ab}	12,9^{def}		12,9^{de}	7,4^{b-f}		7,4^{cd}
2Ç2T	50,7^{bcd}		50,7^{ab}	15,0^{a-f}		15,0^{b-e}	9,8^{a-d}		9,8^{a-d}
2Ç4T	54,1^{a-d}		54,1^{ab}	19,1^{ab}		19,1^{ab}	13,2^{ab}		13,2^{ab}
4Ç1M	36,3^{de}	36,3^{d}		10,4^{f}	10,4^{c}		9,5^{a-e}	9,5^{abc}	
4Ç2M	45,1^{bcd}	45,1^{bcd}		12,3^{def}	12,3^{bc}		11,6^{abc}	11,6^{ab}	
4Ç4M	46,6^{bcd}	46,6^{bcd}		13,7^{def}	13,7^{abc}		10,3^{a-d}	10,3^{abc}	
4Ç1T	41,1^{cd}		41,1^{b}	11,7^{def}		11,7^{e}	11,5^{abc}		11,5^{abc}
4Ç2T	49,8^{bcd}		49,8^{ab}	13,8^{c-f}		13,8^{cde}	9,2^{a-e}		9,2^{bcd}
4Ç4T	40,0^{bcd}		44,0^{ab}	15,0^{a-f}		15,0^{b-e}	14,5^{a}		14,5^{a}

Not: Aynı sütunda farklı harfle işaretlenen ortalamalar arasındaki fark %5 düzeyinde önemlidir.

Tek Yıllık Çimin Bitkisel Özelliklerindeki Değişimler

Yapılan varyans analizi sonunda incelenen özelliklerde kardeş sayısı, toplam yaş ağırlık, saksı başına toplam kuru ağırlık ve toplam kuru kök ağırlığı bakımında karışımların ortalamaları arasındaki farklar önemli ($p<0,001$) olurken, bitki boyunun önemsiz olduğu belirlenmiştir (Çizelge 1). Saksılardaki çimlerin ortalama yaş ağırlıkları 2,5-16,1 g, kuru ağırlıkları ise 2,4-19,9 g arasında yer almıştır. Bilhassa çimin yalnız ekildiği saksılardaki yaş ağırlık diğer ekimlerden önemli seviyede yüksek olmuştur. Buna karşılık 4Ç4T karışımındaki yaş ağırlıklar diğer karışık ekimlerdeki çimin yaş ot ağırlıklarına göre daha düşük çıkmıştır (2,5-9,3 g). Ancak, bitki başına yaş ağırlık olarak bakıldığında en yüksek değer (16,1 g) tek çimin bulunduğu saksılardan elde edilmiştir. Toplam yaş ağırlık ile saksı başına toplam çim verimleri ele alındığında; saksılardaki karışımın tipine göre saksı başına çim verimleri arasındaki önemli farklılıklar ortaya çıkmıştır. Saksı başına tek yıllık çimin toplam kuru ağırlıkları küçük değişimlerle beraber, önemli ölçüde benzerlik göstermiştir. Toplam kuru ağırlıklarda da en düşük değerler (2,4 ve 2,6 g) çimin ikili ve birli olarak yalın halde ekildiği parsellerde tespit edilmiştir. Diğer taraftan, çimin en yüksek kuru ağırlığı (19,9 g) 1Ç4T karışık ekildiği saksılarda belirlenmiştir. En yüksek kök ağırlığı (14,5 g) 4Ç4T bulunan saksılarda tartılmıştır. Ancak, genel olarak toplam bitki sayısının fazla olduğu saksılarda kök ağırlığı daha fazla olmuştur. En az kök ağırlığı 2 ve 1Ç ekili saksılarda ortaya çıkmıştır. Bu saksıların toplam kök ağırlıkları sırasıyla 2,3 ve 3,5 g olmuştur (Çizelge 1). Yalnız ya da macar fiği ile birlikte ekilen çok yıllık çimin bitki boyunun büyüme dönemi içindeki değişimleri; saksı başına bir çimin iki ve dört macar fiği ile karışımlarında büyüme süreci içerisinde, son gelişme zamanı hariç yalın ekilen çimin bitki boyu karışımlardakilerden daha yüksek seyretmiştir. Karışımdaki çimin boyu ise genellikle birbirine yakın değerlerde olmuştur. Bu durum iki ve dört çimin yer aldığı saksılarda da benzer şekilde tespit edilmiştir.

Karışım oranının ot kalitesi üzerine yapmış olduğu etki bütün parametrelerde istatistiki olarak önemli ($p<0,001$) bulunmuştur (Çizelge 2). En yüksek NDF oranı çimin ikili ve tekli (%53,6-52,2), en düşük NDF oranı ise 2Ç1M ile 4Ç1M (%36,5) karışımlarında bulunmuştur. ADF oranı NDF oranı değerleri ile benzerlik göstermiştir. Nitekim en yüksek ADF oranı tek yıllık çimin ikili ve tekli (%39,6-37,2); en düşük ise 2Ç1M (%23,3) ile 4Ç1M (%25,3) karışımlarında belirlenmiştir. En düşük ADL oranları tek yıllık çimin yalın ekilen birli, ikili ve üçlü ekimlerinden (%4,8, 5,8, 4,9); en yüksek ise 1Ç2M (%8,8) ve 2Ç4M (%8,7) ekimlerinde belirlenmiştir. En yüksek hücre çeperi bileşenleri tek yıllık çimin yalın ekimlerinde tespit edilmiştir. Karışıma baklagillerin girmesiyle çimin hücre çeperi bileşenlerinde düşüşler olmuştur (Avcıoğlu, 1979; Büyükburç & Karadağ, 2002; Taş, 2010). Ottaki NDF, ADF ve ADL hücrenin çeper maddelerinden oluşmaktadır. NDF selüloz, hemiselüloz ve lignin oranını ifade ederken, ADF selüloz ve lignini, ADL de sadece lignini kapsamaktadır. Baklagiller buğdaygillere nazaran daha az hücre çeperine sahip oluğundan sindirilebilirlikleri daha yüksektir ve baklagillerin epidermis hücre çeperleri buğdaygillerden zayıf ve yuvarlak olduğu için parçalanması ve çiğnenmesi daha kolaydır (Wilson, 1993). Ayrıca baklagillerin mezofil hücreleri buğdaygillere nazaran daha gevşek dizildiği için sindirim bakterilerinin yaprak içerisine girişi daha kolay olmakta ve bundan dolayı sindirimi kolaylaşmaktadır (Hanna vd., 1973). Yine baklagil gövdelerinde sindirimi zor olan ligninleşme daha azdır. Buğdaygillerden farklı olarak baklagillerdeki kollenkima hücreleri kalın çeperli olmalarına rağmen bu hücrelerin sindirilmesi kolaydır. Buğdaygillerde ise sindirimi zorlaştıran demet kını hücreleri bulunmaktadır (Akin vd., 1983).

Tek yıllık çimin ham protein oranları yalın ekimlerine göre fiğlerle yapılan ikili ve dörtlü karışımlardan daha yüksek bulunmuştur. En yüksek ham protein oranı 2Ç1T (%18,7) ve 4Ç1M karışımlarından (%17,4) elde edilmiştir. En düşük ham protein oranı ise tek yıllık çimin yalın ekimlerinde (%7,1-9,6) tespit edilmiştir. Tek yıllık çimin fiğlerle karışımından elde edilen otun ham protein içeriği yükselmiştir. Nitekim buğdaygillerin baklagillerle karışıma sokulmasıyla otun protein oranında literatürde de bildirildiği gibi (Lunnan, 1989; Moreira, 1989; Roberts vd., 1989; Aydın & Tosun, 1991; İptaş & Yılmaz, 1998; Altınok & Hakyemez, 2002; Büyükburç & Karadağ, 2002; Taş, 2010) artışlar olmuştur.

Yalın ve karışık yetiştirmede ham kül değerleri değişkenlik göstermiştir. En yüksek ham kül değerleri çimin tekli (%16,5) ve tek çim ve tek macar fiği karışımında, en düşük ise 2Ç4M (%5,9) ile 1Ç ve 2M karışımlarında (%6,2) belirlenmiştir. Yapılan çalışmalarda fiğlerle karışımın ham kül içeriğini artırdığı belirtilmiştir (Avcıoğlu & Avcıoğlu, 1982; Konak vd., 1997). Kuru ve organik maddenin sindirilebilirliğinde 2Ç1T %49,7 ve 50,7 değerleri ile çimin 4'lü yalın ekiminden (%49,9 ve 50,8) düşük bulunmuştur. En düşük lif oranı %23,3 ile 2Ç1T ve %26,0 ile çimin 4'lü yalın parsellerinde belirlenmiştir. Tek yıllık çimin macar ve tüylü fiğ ile karışıma sokulmasıyla NDF ve ADF oranlarında %3-7 oranında düşüşler sağlanmıştır. Ham protein oranında ise %5-6 oranında artışlar kaydedilmiştir. Bunun yanında çimin fiğlerle karışıma sokulmasıyla otun kuru maddesinde ve organik maddenin sindirilebilirliğinde ise %15 civarında düşüşler olduğu tespit edilmiştir. Bu hususlar göz önüne

alındığında tek yıllık çimin tüylü fiğ ile yapmış olduğu karışımlar daha ön plana çıkmıştır. Tek yıllık çimin tüylü fiğ ile yapmış olduğu karışımlar içinden ise 2Ç1T karışımının üstün olduğu sonucuna varılmıştır.

Macar Fiğinin Bitkisel Özelliklerindeki Değişimler

Yapılan varyans analizi sonucunda incelenen bitkisel özellikler bakımından karışım oranları arasında istatistiki olarak önemli farklılıkların olduğu belirlenmiştir ($p<0,001$) (Çizelge 3). Karışım oranı bakımından incelenen özellikler içinde ham kül oranı ($p=0,2402$) hariç, diğer bütün parametrelerde istatistiki olarak önemli bir etkiye sahip olmuştur ($p<0,001$) (Çizelge 4). Macar fiğinin tek yıllık çim ile karışıma sokulmasıyla (yalın macar fiğine göre) NDF ve ADF oranları artmıştır (%1-4). En yüksek NDF oranı sırasıyla; 1C1M, 1C2M ve 4C2M (%51,2, 51,7 ve 52,4) karışımlarında belirlenirken, en düşük NDF oranı ise %39,2 değeri ile 4'lü yalın macar fiği parsellerinde bulunmuştur. En yüksek ADF oranı 1C2M (%36,7) karışımında, en düşük ise 2C1M (%25,8) karışımında belirlenmiştir. ADL oranı ise macar fiğinin tek yıllık çim ile karışıma sokulmasıyla düşmüştür. En yüksek ADL oranı 2M ve 1C2M (%8,8); en düşük ise 2C1M (%7,1) ve 4C1M (%7,2) karışımlarında tespit edilmiştir. Macar fiğinin hücre çeperi bileşenleri tek yıllık çim ile karışıma sokulması sonucunda artmıştır. Bunun nedeni buğdaygillerin hücre çeperi bileşenleri baklagillerden fazla olmasıdır. Nitekim yapılan çalışmalarda da benzer sonuçlara rastlanılmıştır (Avcıoğlu, 1979; Büyükburç & Karadağ, 2002; Taş, 2010).

Macar fiğinin ham protein oranı çim ile karışıma girdikten sonra %3,4 oranında düşmüştür. Nitekim en yüksek ham protein oranları yalın macar fiği parsellerinde %15,9 iken, karışım parsellerinde bu oran %12,5 olmuştur. Baklagillerin ham protein içeriği buğdaygillere nazaran daha yüksektir. Macar fiğinin otundaki ham protein içeriği tek yıllık çim ile karışıma sokulmasıyla düşmesinin nedeni bu nedene dayandırılabilir. Yapılan önceki çalışmalar, bu çalışmada bulunan sonuçları destekler niteliktedir (Lunnan, 1989; Moreira, 1989; Roberts vd., 1989; Aydın & Tosun, 1991; İptaş & Yılmaz, 1998; Altınok & Hakyemez, 2002; Büyükburç & Karadağ, 2002; Taş, 2010).

Çizelge 3. Tek yıllık çimin fiğlerle yapmış olduğu karışımlara ait ot kalitesi özellikleri (%)

Karışım	HP	HK	LİF	NDF	ADF	ADL	KMS	OMS
C1	7,1^{f}	16,5^{a}	27,5^{efg}	52,2^{ab}	37,2^{ab}	4,8^{e}	47,1^{abc}	47,1^{abc}
C2	9,6^{def}	9,7^{b-e}	28,6^{d-g}	53,6^{a}	39,6^{a}	5,8^{e}	44,9^{a-d}	45,1^{a-d}
C4	9,0^{ef}	10,2^{a-e}	26,0^{fg}	45,9^{ab}	36,4^{abc}	4,9^{e}	49,9^{a}	50,8^{a}
C1M1	9,6^{def}	7,7^{cde}	37,7^{ab}	51,2^{ab}	32,3^{bcd}	8,3^{abc}	18,8^{hi}	16,6^{gh}
C1M2	11,4^{b-f}	6,2^{e}	38,7^{a}	51,7^{ab}	34,2^{a-d}	8,8^{a}	16,4^{i}	14,6^{h}
C1M4	13,9^{b-e}	6,6^{de}	33,4^{a-e}	44,0^{bc}	29,8^{c-f}	8,1^{a-d}	24,7^{e-i}	27,1^{e-h}
C1T1	14,2^{b-e}	15,5^{ab}	32,0^{a-f}	47,7^{ab}	30,4^{b-e}	7,8^{a-d}	36,2^{b-e}	34,8^{b-e}
C1T2	12,5^{b-e}	12,0^{a-e}	34,7^{a-d}	50,0^{ab}	32,6^{bcd}	8,3^{abc}	29,2^{e-h}	27,4^{e-h}
C1T4	13,9^{b-e}	13,4^{abc}	32,3^{a-f}	48,4^{ab}	31,2^{b-e}	8,1^{a-d}	32,8^{d-g}	31,9^{def}
C2M1	16,3^{bc}	11,4^{a-e}	26,6^{fg}	36,5^{c}	23,3^{f}	7,1^{d}	48,5^{ab}	48,1^{ab}
C2M2	11,6^{b-f}	8,5^{cde}	35,1^{a-d}	48,8^{ab}	31,0^{b-e}	8,1^{a-d}	28,1^{e-i}	27,1^{e-h}
C2M4	11,2^{c-f}	5,9^{e}	37,2^{abc}	50,4^{ab}	32,9^{a-d}	8,7^{a}	23,4^{f-i}	21,7^{e-h}
C2T1	18,7^{a}	8,6^{cde}	23,3^{g}	44,4^{abc}	32,5^{bcd}	7,3^{bcd}	49,7^{a}	50,9^{a}
C2T2	13,9^{b-e}	9,5^{b-e}	32,5^{a-f}	49,2^{ab}	32,1^{b-e}	8,2^{a-d}	29,2^{e-h}	28,5^{efg}
C2T4	13,5^{b-e}	13,0^{a-d}	31,9^{a-f}	48,0^{ab}	30,8^{b-e}	7,7^{a-d}	32,4^{d-g}	31,5^{ef}
C4M1	17,4^{b}	9,4^{b-e}	27,3^{efg}	36,5^{c}	25,3^{ef}	7,2^{bcd}	47,7^{ab}	48,4^{a}
C4M2	9,1^{ef}	9,7^{b-e}	37,5^{abc}	52,4^{ab}	32,8^{bcd}	8,3^{a-d}	21,0^{ghi}	19,5^{fgh}
C4M4	12,0^{b-e}	8,9^{cde}	35,3^{abc}	47,4^{ab}	31,9^{b-e}	8,3^{a-d}	25,4^{e-i}	24,4^{e-h}
C4T1	15,2^{bcd}	10,6^{a-e}	31,6^{b-f}	44,8^{abc}	27,7^{def}	7,8^{a-d}	34,6^{c-f}	34,6^{cde}
C4T2	13,2^{b-f}	8,0^{cde}	33,7^{a-d}	48,7^{ab}	32,0^{b-e}	8,4^{ab}	28,1^{e-i}	27,9^{e-h}
C4T4	12,9^{b-f}	9,1^{b-e}	30,9^{c-f}	48,4^{ab}	29,7^{c-f}	8,1^{a-d}	34,1^{def}	34,5^{cde}

Not: HP; ham protein, HK; ham kül, KMS; kuru maddenin sindirilebilirliği, OMS; organik maddenin sindirilebilirliği, ($p<0,001$). Aynı sütunda farklı harfle işaretlenen ortalamalar arasındaki fark %5 düzeyinde önemlidir.

Çizelge 4. Macar fiğinin tek yıllık çimle yapmış olduğu karışımlara ait ot kalitesi özellikleri (%)

Karışım	HP	HK	LİF	NDF	ADF	ADL	KMS	OMS
M1	17,3^{a}	9,8	29,9^{bcd}	42,3^{abc}	29,4^{bcd}	8,1^{abc}	40,5^{a}	38,8^{a}
M2	13,9^{abc}	6,1	36,4^{ab}	48,3^{abc}	35,5^{ab}	8,8^{a}	23,0^{a-d}	21,2^{c}
M4	16,5^{ab}	7,5	30,0^{bcd}	39,2^{c}	29,8^{a-d}	8,2^{abc}	37,7^{abc}	37,6^{ab}
C1M1	9,6^{c}	7,7	37,7^{ab}	51,2^{a}	34,8^{abc}	8,3^{ab}	18,8^{cd}	16,6^{c}
C1M2	11,4^{bc}	6,2	38,7^{a}	51,7^{a}	36,7^{a}	8,8^{a}	16,4^{d}	14,6^{c}
C1M4	13,9^{abc}	6,6	33,4^{a-d}	44,0^{abc}	32,3^{a-d}	8,1^{abc}	28,0^{a-d}	23,8^{abc}
C2M1	16,3^{ab}	11,4	26,6^{d}	40,1^{bc}	25,8^{d}	7,1^{c}	38,5^{ab}	38,1^{ab}
C2M2	11,6^{bc}	8,5	35,1^{abc}	48,8^{abc}	33,5^{abc}	8,1^{abc}	28,1^{a-d}	27,1^{abc}
C2M4	11,2^{bc}	5,9	37,2^{ab}	50,4^{ab}	35,4^{ab}	8,7^{a}	23,4^{a-d}	21,7^{abc}
C4M1	17,4^{a}	9,4	27,3^{cd}	39,8^{bc}	27,8^{cd}	7,2^{bc}	41,0^{a}	37,4^{ab}
C4M2	9,1^{c}	9,7	37,5^{ab}	52,4^{a}	35,3^{ab}	8,3^{ab}	21,0^{bcd}	22,8^{abc}
C4M4	12,0^{abc}	8,9	35,3^{abc}	47,4^{abc}	34,4^{abc}	8,3^{ab}	25,4^{a-d}	24,4^{abc}

Not: HP; ham protein, HK; ham kül, KMS; kuru maddenin sindirilebilirliği, OMS; organik maddenin sindirilebilirliği, (p ham kül=0,2402), (p<0,001). Aynı sütunda farklı harfle işaretlenen ortalamalar arasındaki fark %5 düzeyinde önemlidir.

Çizelge 5. Tüylü fiğin tek yıllık çimle yapmış olduğu karışımlara ait ot kalitesi özellikleri (%)

Karışım	HP	HK	LİF	NDF	ADF	ADL	KMS	OMS
T1	17,4	10,0^{b-e}	32,7^{a}	45,7	34,2	8,2^{ab}	33,2	32,4
T2	16,2	8,6^{de}	32,4^{a}	45,2	33,1	8,3^{ab}	32,7	32,3
T4	15,2	7,5^{e}	33,9^{a}	43,8	34,3	8,8^{a}	27,4	26,7
C1T1	14,2	15,5^{a}	32,0^{a}	47,7	32,2	7,8^{ab}	36,2	34,8
C1T2	12,5	12,0^{a-d}	34,7^{a}	50,0	34,4	8,3^{ab}	29,2	27,4
C1T4	13,9	13,4^{ab}	32,3^{a}	48,4	33,0	8,1^{ab}	32,8	31,9
C2T1	16,7	8,6^{cde}	23,3^{b}	47,7	32,5	7,3^{b}	36,3	37,6
C2T2	13,9	9,5^{b-e}	32,5^{a}	49,2	33,9	8,2^{ab}	29,2	28,5
C2T4	13,5	13,0^{abc}	31,9^{a}	48,0	32,6	7,7^{ab}	32,4	31,5
C4T1	13,5	10,6^{b-e}	28,3^{ab}	44,8	29,5	7,8^{ab}	27,9	28,0
C4T2	13,2	8,0^{de}	33,7^{a}	48,7	33,8	8,4^{ab}	28,1	27,9
C4T4	12,9	9,1^{b-e}	30,9^{ab}	48,4	31,5	8,1^{ab}	34,1	31,2

Not: HP; ham protein, HK; ham kül, KMS; kuru maddenin sindirilebilirliği, OMS; organik maddenin sindirilebilirliği, (p ADL=0,0136), (p HK<0,001), (p lif=0,0050), (p NDF=0,2249), (p ADF=0,2883), (p HP=0,0528), (p KMS=0,2314), (p OMS=0,1343). Aynı sütunda farklı harfle işaretlenen ortalamalar arasındaki fark %5 düzeyinde önemlidir.

En yüksek sindirilebilir kuru madde ve organik madde oranı macar fiğinin tekli yetiştiriciliğinde (%40,5 ve 38,8) iken, en düşük ise 1C2M oranlarında (%16,4 ve 14,6) tespit edilmiştir. Yalın ekimlerin ortalama sindirilebilir kuru madde oranı %33,7 iken, bu oran karışık ekimlerde %26,7'ye düşmüştür. Ayrıca sindirilebilir organik madde oranı yalın ekimlerde %32,5 iken, karışık ekimle beraber %25,2'ye düşmüştür. Baklagillerin sindirilme oranı buğdaygillerden daha fazladır. Dolayısıyla yalın macar fiğinin parsellerine ait otun sindirilebilir kuru madde ve organik madde oranları yüksek iken, tek yıllık çim karışımı ile elde edilen otun sindirilebilir kuru madde ve organik madde değerleri düşmüştür.

Macar fiğine ait toplam lif oranı karışık ekimle birlikte %2,2 artmıştır. En yüksek lif oranı 1C2M karışımında (%38,7), en düşük ise 2C1M karışımında (%26,6) bulunmuştur. Baklagiller ince duvarlı hücrelerden oluştukları için otlarının besleme değeri yüksektir. Baklagillerin epidermis hücre duvarları zayıf ve yuvarlak oldukları için, çiğnenerek

parçalanması ve sindirilmesi kolay olmaktadır (Wilson, 1993). Mezofil hücreler baklagillerde daha gevşek dizilmiştir. Bu da sindirimin kolay olmasına neden olmaktadır (Hanna vd., 1973; Sleper & Roughan, 1984). Baklagillerin gövdelerinde bulunan parankima hücreleri ligninleşme olmaması nedeniyle sindirimleri buğdaygillere göre daha kolaydır. Floem dokuları baklagillerde buğdaygillerden daha fazla orandadır. Floem dokularının içerisinde asimilat maddeleri taşındığı için besleme değeri ve sindirilme oranı daha yüksektir. Bunların yanı sıra baklagillerde hücresel bileşik fazla, hücre duvarı maddesi ise azdır (Moore & Cherney, 1986). Ayrıca olgunlaşmaya bağlı olarak baklagillerde besin değeri kaybı daha düşük olmaktadır (Sanderson & Weddin, 1989). Macar fiğinin tek yıllık çim ile yapılan karışımlarında ot kalitesi özellikleri dikkate alındığında 4C+1M ve 2C+1M karışım oranlarının diğer karışımlara göre daha üstün olduğu belirlenmiştir.

Tüylü Fiğin Bitkisel Özelliklerindeki Değişimler

İncelenen bütün bitkisel özelliklerin ortalamaları istatistiki olarak önemli ($p<0,001$) olmuştur (Çizelge 5). Bitki başına en yüksek yaş ağırlık (60,8 g) 1Ç2T bulunan saksılarda, en düşük (31,2 g) ise 4Ç1T ekilen saksılarda tartılmıştır. Saksı başına toplam kuru ağırlıklara ait ortalama değerlere göre, en çok kuru ot (11,9 g) 1Ç4T; en az kuru ot (11,7 g) ise 4Ç1T saksılarda tespit edilmiştir. En yüksek kuru kök ağırlığı 4 tüylü fiğ ile 4 ve 2 çim karışımlarının ekildiği saksılarda (sırasıyla 14,50 ve 13,20 g); en düşük ise (4, 86 g) ise 1Ç1T karışımlarında olduğu belirlenmiştir. Tüylü fiğin yalın ekimleri ve çim ile farklı oranlarda karışımlarındaki boy olarak değişimleri incelendiğinde, genel olarak yalın tüylü fiğ ekimleri ile tek yıllık çim karışımındaki tüylü fiğin boylarındaki değişimlerin birbirine yakın olduğu görülmüştür. Ancak tüylü fiğin 4 çim karışımlarındaki bitki boyu diğer yalın ekim ve karışımlara oranla daha düşük olmuştur. En iyi gelişim 1T1Ç karışımında olmuştur.

Tüylü fiğin tek yıllık çim ile yapmış olduğu karışımlarında incelenen özelliklerden ADL ($p=0,0136$), ham kül ($p<0,001$) ve toplam lif oranları ($p=0,0050$) istatistiki olarak önemli olmuştur. Fakat NDF ($p=0,2249$), ADF ($p=0,2883$), ham protein ($p=0,0528$), kuru ($p=0,2314$) ve organik maddenin sindirilebilirliği ($p=0,1343$) özellikleri önemsiz bulunmuştur (Çizelge 5). En yüksek ADL oranı %8,8 ile 4'lü yalın tüylü fiğ ekiminden, en düşük ADL ise %7,3 ile 2Ç1T karışım oranından elde edilmiştir.

Ham kül oranı yalın ekimlere nazaran karışık ekimlerde daha fazla olmuştur. Yalın ekimlerde ortalama ham kül oranı %8,7 olurken, bu oran karışık ekimlerde %11,1'e yükselmiştir. En düşük ham kül oranı tüylü fiğin 4'lü yalın ekiminde, en yüksek ise C1T1 karışımında belirlenmiştir. Ham kül içeriği karışık ekimle birlikte artış göstermiştir. Nitekim yapılan çalışmalarda fiğlerin karışımın ham kül içeriğini artırdığı belirtilmiştir (Avcıoğlu & Avcıoğlu, 1982; Konak vd., 1997). Toplam lif oranı yalın ekimler ve karışımlarda değişkenlik göstermiştir. Nitekim en yüksek lif oranı %34,7 ile 1Ç2T karışımından, en düşük ise %23,3 ile 2Ç1T karışımında belirlenmiştir. Yapılan bu değerlendirmeler sonucunda tüylü fiğin tek yıllık çim ile yapacağı en uygun karışım oranlarının 2 veya 4 çim ile 1 tüylü fiğ olacak şekilde düzenlenmesi şeklinde olacaktır.

SONUÇ

Araştırmada bir buğdaygil (tek yıllık çim) ile iki baklagilin (macar fiği ve tüylü fiğ) yalnız ve karışık ekimleri ele alınmıştır. Özellikle karışık ekimlerde toprak üstü ve toprak altı organik madde miktarı yükselmiştir. En uygun karışım şekillerinin tek yıllık çimin tekli ve dörtlü oranları, macar fiğinin dörtlü oranı ve tüylü fiğin ise ikili ve dörtlü karışım oranları oldukları belirlenmiştir. Ot kalitesi özellikleri bakımından ise en uygun karışımların tek yıllık çimin ikili macar fiği ve tüylü fiğin ise tekli karışımları ile yapacağı ekimler uygun bulunmuştur. Bu durum daha yüksek ot üretimi ve toprağa daha fazla organik madde katkısı bakımından için tek yıllık çimin macar fiği ve tüylü fiğ ile kışlık olarak ve karışık yetiştirilebileceğini göstermektedir. Ancak, bu tür çalışmaların tarla şartlarında da yürütülerek çiftçi şartlarındaki yetiştiricilik için benzer sonuçların alınmasında yarar vardır.

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Etik Standartlar İle Uyum

Çıkar Çatışması

Yazarlar herhangi bir çıkar çatışması olmadığını beyan etmektedir.

Etik Onay

Yazarlar bu tür bir çalışma için resmi etik kurul onayının gerekli olmadığını bildirmektedir.

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Fish Consumption Preferences and Habits in Babaeski and Demirköy Districts of Kırklareli

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ABSTRACT

Fish consumption is very important for a healthy and balanced diet. It is recommended to consume fish for the development of the brain and immune system from a young age. In order to avoid or overcome diseases such as heart, atherosclerosis and cholesterol in later ages, the importance of fish consumption should be increased. In this context, it is necessary to take measures to determine fish consumption habits and accordingly. For these reasons, this study was carried out to determine fish consumption and habits of people living in Demirköy and Babaeski districts of Kırklareli province. Within the scope of quantitative research origin, survey method was used. A questionnaire was used to determine fish consumption and habits as a data collection tool. After the applications with a total of 250 people, the data were analyzed with the SPSS 25 program. Analysis data were evaluated by tabulating frequency and percentage. In addition, the relationship between the monthly income of the participants from both districts and the frequency of fish consumed in a month was determined by chi-square analysis. It was determined that there were similarities in the fish preferences of the people participating in the study from Demirköy and Babaeski. In determining fish consumption preferences and habits, monthly income level, number of people in the family, hunting season, and freshness of the fish were also evaluated. It was concluded that the places to buy fish were different in both districts, and there was a relationship between monthly income and the amount of fish consumed in a month. It is thought that fish consumption can be increased with the opening of markets where people can buy fresh fish in all seasons, and the fish prices should be determined by associating them with monthly income.

Kırklareli'nin Babaeski ve Demirköy İlçelerinde Balık Tüketimi Tercihleri ve Alışkanlıkları

MAKALE BİLGİSİ

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ÖZET

Balık tüketimi sağlıklı ve dengeli beslenme açısından çok önemlidir. Küçük yaşlardan itibaren beyin ve bağışıklık sisteminin gelişimi için balık tüketilmesi önerilmektedir. İlerleyen yaşlarda kalp, damar sertliği, kolesterol gibi hastalıklara yakalanmamak ya da daha kolay üstesinden gelebilmek için balık tüketimine verilen önem arttırılmalıdır. Bu gerekçelerle bu çalışma, Kırklareli ili Demirköy ve Babaeski ilçelerinde yaşayan insanların balık tüketimi ve alışkanlıklarının belirlenmesi amacıyla yürütülmüştür. Nicel araştırma kökeni kapsamında alan taraması yönteminden yararlanılmıştır. Veri toplama aracı olarak balık tüketimleri ve alışkanlıklarını belirlemek amacıyla anket yöntemi kullanılmıştır. Toplam 250 kişiyle gerçekleştirilen uygulamalardan sonra veriler SPSS 25 programıyla analiz edilmiştir. Analiz verileri frekans ve yüzde olarak tablolaştırılarak değerlendirilmiştir. Ayrıca her iki ilçeden katılanların aylık gelirleri ile bir ayda tükettikleri balık sıklığı arasındaki ilişki ki kare analiziyle belirlenmiştir. Demirköy ve Babaeski'den çalışmaya katılan kişilerin balık tercihlerinde benzerlikler olduğu belirlenmiştir. Balık tüketim tercihleri ve alışkanlıklarının belirlenmesinde; aylık gelir düzeyi, ailedeki kişi sayısı, av mevsimi, balığın tazelik durumu konusundaki düşünceler de değerlendirilmiştir. Her iki ilçede balık satın alma yerlerinin farklı olduğu, aylık gelir ve bir ayda tüketilen balık miktarı arasında ilişki olduğu sonucuna varılmıştır. İnsanların taze ve her mevsimde balık alabilecekleri marketlerin açılması, balık fiyatlarının aylık gelirle ilişkilendirilerek belirlenmesi gerektiği gibi düzenlemelerle balık tüketimlerinin arttırılabileceği düşünülmektedir.

GİRİŞ

İnsanların beslenmelerinde hayvansal proteinler oldukça önemli yer tutmaktadır. Bu oran günlük %40 civarındadır. Bu günlük oranın karşılanmasında balık önemli bir yer tutmaktadır. Türkiye üç tarafı denizle çevrili olan bir ülkedir. Denize kıyısının olmasının yanında çok sayıda doğal göl, baraj gölü ve sulama göleti bulunmaktadır (Adıgüzel vd., 2009). Durum böyle olunca insanların beslenme alışkanlıklarında ve besin tüketiminde ilk akla gelen balık tüketimidir. Ülkemizde balık tüketiminin bu sebeplerden dolayı oldukça iyi olacağı düşünülmektedir. Ancak yapılan çalışmalar incelendiğinde, oldukça besleyici, vitamin, mineral ve protein bakımından zengin olan balık tüketiminin beklenen düzeyde olmadığı belirlenmiştir (Abdikoğlu, 2015; Karakaya vd., 2018; Bayraktar vd., 2019; Saka & Bulut, 2020). Birleşmiş Milletler Gıda ve Tarım Örgütü'nün raporuna göre kişi başı balık tüketimi dünya ortalaması 20 kg/yıl, Avrupa Birliği (AB) ortalaması 25 kg/yıl ve Türkiye'de ise 8,6 kg/yıl'dır (FAO, 2018). Bu oran Türkiye'de 5,5 kg/yıl seviyelerine kadar düşmüştür (TÜİK, 2020).

Günümüzde nüfusun çoğalması ile, sanayileşme ve kentleşmenin artmasıyla insanların sağlığını tehdit eden birçok unsur ortaya çıkmıştır. Özellikle son 1,5 yıldır dünyanın mücadele ettiği Covid-19 pandemi dönemi insanların sağlığını önemli ölçüde tehdit etmektedir. Bu dönemde insanların omega-3 balık yağı tüketmeleri bağışıklık sistemini güçlendirmekte, kalp damar rahatsızlıkları gibi hastalıklarla mücadele etmelerine yardımcı olmaktadır (Wang vd., 2009; Eskici, 2020; Kartal vd., 2020; Çelikkaya, 2021; Küçükcankurtaran & Özdoğan, 2021). Bu bakımdan

balık tüketiminin yüksek olması gereklidir. Yapılan araştırmalar, ülkemizde balık tüketiminin dünya ortalamasının altında kaldığını göstermektedir (FAO & WHO, 2021). Ülkemizin denize kıyısı olmasına rağmen balık tüketimi bölgelere, yerleşim yerlerinin denize yakınlığı, uzaklığına göre farklılıklar göstermektedir. Doğu Anadolu, İç Anadolu, Güneydoğu Anadolu gibi denize kıyısı olmayan bölgelerde balık tüketim miktarları ve alışkanlıkları Karadeniz, Akdeniz, Ege ve Marmara Bölgelerine göre daha düşüktür (Dağtekin & Ak, 2007; Orhan & Yüksel, 2010; Bashimov, 2017; Karakulak vd., 2019; Bayraktar vd., 2019; Selvi vd., 2019; Arslan & Avcıoğlu, 2020; Yıldız & Arslan, 2021). Türkiye'de kişi başına düşen yıllık balık tüketim miktarı İç Anadolu, Doğu ve Güneydoğu Anadolu Bölgelerinde düşükken, Karadeniz, Akdeniz ve diğer kıyı bölgelerinde bu miktar daha yüksektir (Uzundumlu & Dinçel, 2015). Örneğin Karadeniz Bölgesi'nde kişi başına yılda 25 kg civarında balık tüketimi olurken, Doğu ve Güney Doğu Anadolu Bölgelerinde bu değer 1 kg'ın bile altına düşmektedir (Deniz & Sarıözkan, 2020). Balık tüketimi bölgelere göre değişebileceği gibi farklı sebeplerden dolayı da değişiklik gösterebilir. Bunlar mevsim farklılıkları, kültürel ve sosyal farklılıklar, alışkanlıklar, denize uzaklık, yakınlık, ekonomik durum, bilinç ve farkındalık gibi sebepler de olabilir (Bayraktar vd., 2019; Deniz & Sarıözkan, 2020; Genç vd., 2020). Kırklareli konumu itibarıyla ilçelerinin bazıları denize kıyısı olan ve bazılarının kıyısı olmayan illerden biridir. Ülkemizde birçok ilde balık tüketimi üzerine gerçekleştirilmiş çalışmalar mevcuttur (Hatırlı vd., 2004; Adıgüzel vd., 2009; Aydın & Karadurmuş, 2013; Balık vd., 2013; Gürel vd., 2017; Beyazbayrak, 2014; Abdikoğlu, 2015; Bashimov, 2017; Bayraktar vd., 2019; Cengiz & Özoğul, 2019; Güvenin, 2019; Deniz & Sarıözkan, 2020; Saka & Bulut, 2020). Ancak Kırklareli il ve ilçelerinde balık tüketimi ve alışkanlıkları açısından herhangi bir çalışma mevcut değildir. Bu bakımdan ilgili çalışma, Kırklareli ilçelerinden Demirköy (denize yakınlığı 27 km) ve Babaeski (denize yakınlığı 124 km) ilçelerinde yaşayan insanların balık tüketim alışkanlıklarının ve tercihlerinin belirlenmesi ve etki eden faktörlerin tespit edilmesi amacıyla gerçekleştirilmiştir. Bu bağlamda bu çalışma Kırklareli ilinin denize kıyısı olan ve olmayan iki farklı ilçesindeki balık tüketim alışkanlıklarının ve tercihlerinin belirlenmesi üzerine yapılan ilk çalışmadır. Karadeniz'de 60 km'lik kıyı şeridine sahip Demirköy ve kıyısı olmayan Babaeski ilçelerinde balık tüketiminin belirlenmesi bulgularının literatüre önemli bir katkı sağlayacağı düşünülmektedir. Bu konuda çalışma yapan bilim insanlarına katkı sağlayacağı gibi, burada yaşayan insanların balık tüketimleriyle ilgililere önemli bilgiler sağlayacak ve buna göre nasıl önlemler alınması gerektiğiyle ilgili önerilerde bulunulacaktır. Bu bakımdan çalışma önem oluşturmaktadır. Kırklareli'nde böyle bir çalışmanın gerçekleştirilmesi, mevcut durumun belirlenmesi ve insanlara bununla ilgili bilgiler sunulması, insanların bilinçlendirilmesi, farkındalık oluşturulması anlamlıdır. Bu bilgilere ulaşabilmek için çalışmanın ana problemine bağlı olarak alt problemleri,

Kırklareli'nin denize kıyısı olan Demirköy ilçesinde yaşayan insanların balık tüketimi ve alışkanlıkları ne durumdadır?

Kırklareli'nin denize kıyısı olmayan Babaeski ilçesinde yaşayan insanların balık tüketimi ve alışkanlıkları ne durumdadır? şeklindedir.

MATERYAL VE YÖNTEM

Kırklareli ili Babaeski ve Demirköy ilçelerinde (Şekil 1) yaşayan insanlar üzerinde yürütülen bu çalışma nicel araştırmalardan alan taraması yöntemiyle yürütülmüştür. Bu iki ilçede iç su kaynakları ve balıkçılık faaliyetleri yapılmamaktadır. İnsanların balık ihtiyaçları daha çok denizden karşılanmaktadır. Alan taraması çalışmaları mevcut durumu belirlemek, tanımlamak, tasvir etmek, betimlemek amacıyla yürütülen araştırma türleridir (Tanrıöğen, 2012; Çepni, 2014). Bu çalışmalarda veri toplamak için anket ve ölçeklerden yararlanılmaktadır. Mevcut çalışmada her iki ilçede yaşayan kişilerle yüz yüze görüşme yoluyla anketler uygulanarak veriler toplanmış ve mevcut durum belirlenmiştir.

Evren ve Örneklem

Araştırmada Babaeski ve Demirköy ilçelerinde yaşayan ve balık tüketen kişilerle yürütülmüştür. Evrenden örneklem seçiminde amaçlı örneklem seçim yöntemiyle literatürde bulunan formüllerden yararlanılarak anket uygulanacak kişi sayısı belirlenmiştir (Çepni, 2014). Burada amaçlı örneklem

olmasının nedeni balık tüketen kişilerin seçilmesinden dolayıdır. Demirköy denize kıyısı olan bir ilçe iken, Babaeski'nin denize kıyısı yoktur ve deniz kıyısından 124 km uzaklıktadır (Anonim, 2021).

Çalışmaya katılacak olan kişi sayısı literatürde yaygın olarak kullanılan formülden (Denklem 1) yararlanılarak teorik olarak hesaplanmıştır (Collins, 1986; Çepni, 2014).

Şekil 1. Demirköy ve Babaeski ilçelerinin konumu (Anonim, 2021).

$$n = \frac{N \times t^2 \times p \times q}{d^2(N-1)+(t^2 \times p \times q)} \quad (1)$$

Bu formülde; *N*=evrendeki birey sayısı (Babaeski: 47065; Demirköy: 8829), *n*=örnekleme alınacak birey sayısı, p=incelenecek olayın görülüş sıklığı (olasılığı) (0,5 kabul edilmiştir), q=incelenecek olayın görülmeyiş sıklığı (1-p=0,5 olarak hesaplanmıştır), *t*=belirli serbestlik derecesinde ve saptanan yanılma düzeyinde t tablosunda bulunan teorik değer (1,65 olarak belirlenmiştir), *d*=olayın görülüş sıklığına göre yapılmak istenen ± sapma olarak simgelenmiştir (0,05). Buna göre hesaplanan değerler Tablo 1'de verilmiştir.

Ulaşılan örneklem sayısı Babaeski için 150 ve Demirköy için 100 kişi olarak gerçekleşebilmiştir. Bilimsel çalışmalarda evrenden örneklem sayısının belirlenmesine yönelik yararlanılan formülle gerekli örneklem sayıları belirlenmiştir. Ancak, çalışmanın yürütüldüğü dönemde Covid-19 salgını nedeniyle ulaşılabilen kişi sayısıyla çalışma tamamlanmış ve bu sayılarla genelleme yapılması planlanmıştır.

Veri Toplama Aracı

Örnekleme uygulanan anket Babaeski ve Demirköy ilçelerinde yaşayan kişilerin balık tüketimini belirlemek amacıyla geliştirilmiş olup, toplam 19 maddeden oluşmaktadır. Mevcut çalışma 2020 yılında bahar dönemi Mart-Nisan-Mayıs aylarında yürütülmüştür. Tüketicilerin yaş, cinsiyet, medeni durum, öğrenim durumu, meslek, aylık gelir durumu, hanedeki kişi sayısı, balık tüketim tercihleri, sebepleri, alışkanlıkları, tüketim şekilleri ve balık çeşitleri gibi sorulardan oluşmaktadır.

Verilerin Analizi

Her iki ilçeye uygulanan anketler toplandıktan sonra SPSS 25 istatistiki programına yüklenmiş ve betimsel analizler gerçekleştirilmiştir. Bu analizler sonucunda elde edilen veriler tablolara dönüştürülerek frekans ve yüzde oranlarına göre sunulmuştur. Ayrıca her iki ilçenin verileri ki-kare analiziyle karşılaştırılmış karşılaştırma sonuçları tablalar halinde sunulmuştur.

BULGULAR

"Kırklareli'nin denize kıyısı olan Demirköy ilçesinde yaşayan insanların balık tüketimi ve alışkanlıkları ne durumdadır?" sorusuna cevap olarak yapılan betimsel istatistik analiz bulguları Tablo 2 ve Tablo 3'te verilmiştir. Demirköy'den çalışmaya katılan kişilerin demografik özellikleri ve sosyoekonomik durumları Tablo 2'de verilmiştir.

Anketi cevaplayan kişilerin %22'si kadın, %78'i erkek olup, yaş aralığı en yüksek olan grup %38 ile 30-40 yaş aralığındadır. 60 yaş ve üstü %24, 18-29 yaş aralığında %20, 50-59 yaş aralığında ise %18 oranındadır. Çalışmaya her yaş grubundan kişinin katılması istenilen bir durumdur. Öğrenim durumları %27 ilköğretim, %25 lise, %18 yüksek öğrenim, %16 lisans, %10 ön lisans ve %4 ise okuryazar olmadığı belirlenmiştir. Meslekleri değerlendirildiğinde, %31 memur, %20 işçi, %18 çiftçi, %14 emekli, %8 ev hanımı ve %9 öğrenci durumundadır.

Demirköy ilçesinden katılan kişilerin aylık gelir açısından değerlendirilmesinde, %29'u 5001 TL ve üstü, %28'i 2001- 3000 TL, %18'i 3001-4000 TL, %15'i 0-2000 TL, %10'u 4001-5000 TL arasında gelire sahiptirler. Hanede bulunana kişi sayısı, en fazla %50'si 3-4 kişilik, %31'i 1-2 kişilik, %19'u 5 ve üstü sayıya sahiptir.

Tablo 1. Nüfusa göre gerekli ve ulaşılan örneklem büyüklüğü

Yerleşim Yeri	Nüfus	Gerekli Minimum Örneklem Sayısı	Ulaşılan Örneklem Sayısı
Babaeski	47065	270	150
Demirköy	8829	263	100

Tablo 2. Demirköy'den katılan kişilerin demografik özellikleri ve sosyoekonomik durumları

Özellikler	Frekans	Oran (%)
Cinsiyet		
Kadın	22	22
Erkek	78	78
Yaş		
18-29 yaş arası	20	20
30-49 yaş arası	38	38
50-59 yaş arası	18	18
60 yaş ve üstü	24	24
Öğrenim Durumu		
Okuryazar Değil	4	4
İlköğretim	27	27
Lise	25	25
Ön Lisans	10	10
Lisans	16	16
Yüksek Öğretim	18	18
Meslek		
Memur	31	31
İşçi	20	20
Öğrenci	9	9
Emekli	14	14
Ev Hanımı	8	8
Çiftçi	18	18
Aylık Gelir Durumu		
0- 2000 TL arası	15	15
2001 TL – 3000 TL arası	28	28
3001 TL – 4000 TL arası	18	18
4001 TL – 5000 TL arası	10	10
5001 TL üstü	29	29
Hanedeki Kişi Sayısı		
1-2	31	31
3-4	50	50
5 ve Üstü	19	19

Demirköy'den çalışmaya katılan kişilerin balık tüketim tercihleri ve alışkanlıklarına yönelik bulgular Tablo 3'te sunulmuştur.

Ankete katılan kişilerin bir ayda tükettiği balık sıklığı değerlendirildiğine %52'si ayda 1-2, %25'i 3-5, %21'i 5 ve üstü defa, %2'si ise hiç balık tüketmediğini belirtmiştir. Balık tercihini %41'i fiyatına göre, %59'u mevsimine göre tercih ettiğini açıklamışlardır. Balık fiyatları konusundaki düşünceleri incelendiğinde, %58'i pahalı, %27'si normal, %15'i ucuz olarak değerlendirmiştir. Balık tutma satın alma konusunda, %74'ü satın aldığını, %19'u hem tuttuğunu hem satın aldığını, %7'si kendisinin tuttuğunu açıklamıştır. Balık alma yeri olarak düşünceleri sorulduğunda, %52'si pazarda balık satılan pazar tezgahından, %30'u seyyar satıcıdan, %18'i balık satan marketlerden aldıklarını belirtmişlerdir. Balık alırken özen gösterme durumları araştırıldığında, %41'i mevsim/sezona uygun olmasına, %40'ı taze olmasına, %19'u ucuz olmasına göre olduğunu belirtmişlerdir.

Ailenin bir öğünde tükettiği ortalama balık miktarı sorulduğunda, %34'ü 1001-2000 g, %31'i 100-500 g, %27'si 501-1000 g, %4'ü 2001-3000 g ve %4'ü 3001 g ve üstü balık tükettiğini açıklamıştır. Balık tüketiminde pişirme açısından uyguladıkları yöntem sorulduğunda, %62'si kızartma, %17'si fırında pişirme, %15'i ızgarada, %6'sı buğulamayı tercih ettiğini belirtmiştir. Balık tüketimi mevsimi konusundaki fikirleri sorulduğunda, %51'i sonbahar mevsiminde, %47'si kış mevsiminde, %2'si yaz mevsiminde tükettiğini belirtirken, ilkbaharda balık tüketen hiç kimse olmamıştır. Katılımcıların en çok tüketilen balık türleri araştırıldığında, lüfer %33, palamut %35, hamsi %18, tekir %6, mezgit %4, levrek %1, barbunya %2 ve kalkan %1 oranında tüketildiği tespit edilmiştir.

"Kırklareli'nin denize kıyısı olmayan Babaeski ilçesinde yaşayan insanların balık tüketimi ve alışkanlıkları ne durumdadır?" sorusuna cevap olarak yapılan analiz bulguları aşağıda belirtilmiştir. Babaeski'den çalışmaya katılan kişilerin demografik özellikleri ve sosyoekonomik durumları Tablo 4'te verilmiştir.

Tablo 3. Demirköy'den katılan kişilerin balık tüketim tercihleri ve alışkanlıkları

Balık tüketimi ve alışkanlıkları	Frekans	Oran (%)
Bir ayda balık tüketim sıklığı		
1-2	52	52
3-5	25	25
5 ve üstü	21	21
Tüketmiyorum	2	2
Balık alırken tercih sebebi		
Fiyatına göre	41	41
Mevsime göre	59	59
Balık fiyatlarına yönelik düşünceleri		
Ucuz	15	15
Pahalı	58	58
Normal	27	27
Balığı tutma ya da satın alma durumu		
Satın alıyorum	74	74
Kendim tutuyorum	7	7
Hem satın alıyorum hem kendim tutuyorum	19	19
Balığınızı satın alma tercih yeri		
Pazarda balık satılan pazar tezgâhından	52	52
Balık satan marketlerden	18	18
Seyyar satıcıdan	30	30
Balık alırken özen gösterme durumu		
Mevsim/sezona uygun olması	41	41
Taze olması	40	40
Ucuz olması	19	19
Ailenizin bir öğünde ortalama balık tüketim miktarı		
100 – 500 g	31	31
501 – 1000 g	27	27
1001 – 2000 g	34	34
2001-3000 g	4	4
3001g ve üstü	4	4
Balık tüketiminde en çok tercih edilen pişirme yöntemi		
Kızartma	62	62
Fırında pişirme	17	17
Buğulama	6	6
Izgara	15	15
Balık tüketimi mevsimi tercihi		
Sonbahar mevsimi	51	51
Kış mevsimi	47	47
İlkbahar mevsimi	-	-
Yaz mevsimi	2	2
En çok tüketilen balık türleri		
Lüfer	33	33
Palamut	35	35
Barbunya	2	2
Sardalye	-	-
Tekir	6	6
Levrek	1	1
Hamsi	18	18
Uskumru	-	-
Sazangiller	-	-
Kalkan	-	-
Mezgit	1	1
İstavrit	4	4
Alabalık	-	-
Çipura	-	-

Tablo 4. Babaeski'den katılan kişilerin demografik özellikleri ve sosyoekonomik durumları

Özellikler	Frekans	Oran (%)
Cinsiyet		
Kadın	12	8
Erkek	138	92
Yaş		
18-29 yaş arası	7	4,7
30-49 yaş arası	102	68
50-59 yaş arası	21	14
60 yaş ve üstü	20	13,3
Öğrenim Durumu		
Okuryazar Değil	1	0,7
İlköğretim	63	42,0
Lise	55	36,7
Ön Lisans	9	6,0
Lisans	14	9,3
Yüksek Öğretim	8	5,3
Meslek		
Memur	34	22,7
İşçi	54	36,0
Öğrenci	7	4,7
Emekli	5	3,3
Ev Hanımı	3	2,0
Çiftçi	47	31,3
Aylık Gelir Durumu		
0- 2000 TL arası	9	6,0
2001 TL – 3000 TL arası	19	12,7
3001 TL – 4000 TL arası	40	26,7
4001 TL – 5000 TL arası	53	35,3
5001 TL üstü	29	19,3
Hanedeki Kişi Sayısı		
1-2	13	8,7
3-4	110	73,3
5 ve üstü	27	18,0

Ankete Babaeski'den katılanların %8'i kadın, %92'si erkektir. Yaş grupları değerlendirildiğinde, %68'i 30-40 yaş, %14'ü 50-59 yaş, %13,3'ü 60 yaş ve üstü, %4,7'si 18-29 yaş arasındadır. Öğrenim durumları incelendiğinde, %42'si ilköğretim, %36,7'si lise, %9,3'ü lisans, %6'sı ön lisans, %5,3'ü yüksek öğrenim, %0,7'si okuryazar olmadığı seçeneğini işaretlemeyi tercih etmiştir. Meslek durumları değerlendirildiğinde, %36'sı işçi, %22,7'si memur, %4,7'si öğrenci, %3,3'ü emekli, %2'si ev hanımıdır. Aylık gelir durumları incelendiğinde, %35,3'ü 4001-5000 TL, %26,7'si 3001-4000 TL, %19,3'ü 5001 TL ve üstü, %12,7'si 2001-3000 TL, %6'sı 0-2000 TL arasında aylık gelire sahiptirler. Hanede yaşayan kişi sayısına bakıldığında, %73,3'ü 3-4 kişilik, %18'i 5 ve üstü, %8,7'si 1-2 kişilik olduğu belirlenmiştir.

Babaeski'den ankete katılan kişilerin balık tüketim tercihleri ve alışkanlıklarına yönelik bulgular Tablo 5'te sunulmuştur.

Babaeski'den katılan kişilerin aylık ortalama balık tüketim sıklığı %64,7'si 3-5, %30'u 1-2, %4,7 5 ve üstü, %0,7'si tüketmediğini belirtmişlerdir. Balık alma tercihleri incelendiğinde, %66'sı fiyatına göre, %34'ü mevsimine göre seçeneğini işaretlemişlerdir. Balık fiyatları konusundaki fikirleri değerlendirildiğinde, %56'sı pahalı, %38,7'si normal, %5,3'ü ucuz bulmuşlardır. Balık tutma ya da satın almaları

Tablo 5. Babaeski'den katılan kişilerin balık tüketim tercihleri ve alışkanlıkları

Balık Tüketimi ve Alışkanlıkları	Frekans	Oran (%)
Bir ayda balık tüketim sıklığı		
1-2	45	30
3-5	97	64,7
5 ve üstü	7	4,7
Tüketmiyorum	1	0,7
Balık alırken tercih sebebi		
Fiyatına göre	99	66
Mevsime göre	51	34
Balık fiyatlarına yönelik düşünceleri		
Ucuz	8	5,3
Pahalı	84	56
Normal	58	38,7
Balığı tutma ya da satın alma durumu		
Satın alıyorum	134	89,3
Kendim tutuyorum	2	1,3
Hem satın alıyorum hem kendim tutuyorum	14	9,3
Balığınızı satın alma tercihi		
Pazarda balık satılan pazar tezgâhından	63	42
Balık satan marketlerden	62	41,3
Seyyar satıcıdan	25	16,7
Balık alırken özen gösterme durumu		
Mevsim/sezona uygun olması	26	17,3
Taze olması	104	69,3
Ucuz olması	20	13,3
Ailenizin bir öğünde ortalama balık tüketim miktarı		
100 – 500 g	30	20
501 – 1000 g	98	65,3
1001 – 2000 g	20	13,3
2001 -3000 g	2	1,3
3001 ve Üstü	-	-
Balık tüketiminde en çok tercih edilen pişirme yöntemi		
Kızartma	89	59,3
Fırında pişirme	45	30
Buğulama	5	3,3
Izgara	11	7,3
Balık tüketimi mevsimi tercihi		
Sonbahar mevsimi	13	8,7
Kış mevsimi	132	88
İlkbahar mevsimi	4	2,7
Yaz mevsimi	1	0,7
En çok tüketilen balık türleri		
Lüfer	11	7,3
Palamut	57	38
Barbunya	2	1,3
Sardalye	2	1,3
Tekir	10	6,7
Levrek	1	0,7
Hamsi	43	28,7
Uskumru	1	0,7
Sazangiller	-	-
Kalkan	-	-
Mezgit	-	-
İstavrit	5	3,3
Alabalık	15	10
Çipura	-	-
	3	2

Tablo 6. Demirköy ve Babaeski'den katılanların aylık gelir ve bir aydaki balık tüketim sıklığına yönelik bulguları

İlçe	Aylık Gelir Düzeyi	Tüketim Sıklığı		
		1-2	3-4	5 ve üstü
Demirköy	0-2020 TL	10	0	5
	2021-3000 TL	8	12	8
	3001-4000 TL	11	3	4
	4001-5000 TL	4	5	1
	5001 TL üstü	19	7	3
Babaeski	0-2020 TL	1	7	1
	2021-3000 TL	6	12	1
	3001-4000 TL	14	26	0
	4001-5000 TL	16	36	1
	5001 TL üstü	8	16	5

Tablo 7. Aylık gelir seviyesine göre her iki ilçedeki bir aylık balık tüketim sıklığı için ki-kare testi sonuçları

İlçe	Parametreler	Değer	Serbestlik Derecesi	Önem Derecesi (*p*)
Demirköy	Pearson Chi-Square (ki-kare testi)	18,584[a]	8	0,017
	Likelihood Ratio (olasılık oranı)	22,676	8	0,004
	Linear-by-Linear Association (doğrusal ilişki)	3,517	1	0,061
	N of Valid Cases (geçerli durumların sayısı)	100		
Babaeski	Pearson Chi-Square (ki-kare testi)	13,802[a]	8	0,087
	Likelihood Ratio (olasılık oranı)	13,644	8	0,092
	Linear-by-Linear Association (doğrusal ilişki)	0,092	1	0,762
	N of Valid Cases (geçerli durumların sayısı)	150		

Not: [a]: ki-kare değerini ifade etmektedir.

konusunda %89,3'ü satın aldığını, %9,3'ü hem satın aldığını hem kendi tuttuğunu, %1,3'ü kendi tuttuğunu belirtmişlerdir. Balık alma yeri hakkında düşünceleri incelendiğinde, %42'si pazarda balık satılan pazar tezgahından, %41,3'ü balık satan marketlerden, %16,7'si seyyar satıcıdan aldığını açıklamıştır. Balık alırken özen gösterme durumda ise %69,3'ü taze olması, %17,3'ü mevsim/sezona uygun olması, %13,3'ü ucuz olması durumuna özen gösterdiğini belirtmiştir. Ailenin bir öğünde ortama tükettiği balık miktarları %65,3'ü 501-1000 g, %20'si 100-500 g, %13,3'ü 1001-2000 g, %1,3'ü 2001-3000 g arasında olduğunu söylemişlerdir. Balık tüketiminde tercih edilen pişirme durumları değerlendirildiğinde, %59,3'ü kızartma, %30'u fırında pişirme, %7,3'ü ızgara, %3,3'ü buğulama olduğunu açıklamışlardır. Balık tüketim mevsimi olarak katılımcılar %88'i kış mevsiminde, %8,7'si sonbahar mevsiminde, %2,7'si ilkbahar mevsiminde, %0,7'si yaz mevsiminde olduğunu açıklamışlardır. En çok tüketilen balık türü ise, %38'si palamut, %28,7'si hamsi, %10'u istavrit, %7,3'ü lüfer, %6,7'si tekir, %3,3'ü mezgit, %2'si çipura, %1,3'ü barbunya, %1,3'ü ise sardalye olduğu belirlenmiştir.

Demirköy ve Babaeski ilçelerinden çalışmaya katılanların aylık gelir ile ayda tükettikleri balık

miktarı arasındaki ilişki incelenmiş ve buna bağlı olarak ulaşılan bulgular Tablo 6 ve Tablo 7'de verilmiştir. Bu bulgulara bağlı olarak yapılan ki-kare analiz bulguları Tablo 7'de verilmiştir.

Demirköy ve Babaeski ilçelerinden çalışmaya katılanların aylık gelirleri ile bir aylık balık tüketim sıklıkları arasındaki ilişki incelendiğinde, Demirköy ilçesi için anlamlı bir ilişki olduğu ($p<0,05$), Babaeski ilçesi için anlamlı bir ilişki olmadığı ($p>0,05$) belirlenmiştir.

TARTIŞMA

Denize yakın hatta kıyısı olan Demirköy ilçesinin demografik özellikleri değerlendirildiğinde, tüketicilerin %22'si kadın, %78'i erkektir. Katılımcıların %38'i 30-49 yaş aralığında iken %24'ünün 60 yaş ve üstü olduğu belirlenmiştir. 18-29 yaş aralığı ise %20 olarak tespit edilmiştir. Burada katılımcıların çoğunluğunun erkek olması literatürde bulunan diğer çalışmaların sonuçlarıyla benzerlik gösterirken bazı çalışmalarla örtüşmemektedir (Aydın & Karadurmuş, 2013; Gürel vd., 2017). Ancak tüketiciler arasında küçük yaş gruplarının az olması bazı çalışmaların sonuçlarıyla benzer bazılarınınkiyle çelişmektedir (Çiçek vd., 2014; Bayraktar vd., 2019). Tüketicilerin öğrenim durumları açısından en yüksek oran %27 ile ilköğretim ve meslekleri değerlendirildiğinde %31 memur ve %20 işçi olduğu belirlenmiştir. Bu durumda her öğrenim seviyesinden ve her meslekten kişilerin balık tükettiği sonucuna ulaşılabilir. Aylık gelirleri incelendiğinde katılımcıların %10'unun 4001-5000 TL geliri olduğu, hanedeki kişi sayısının da %50 oranla 3-4 kişilik olduğu tespit edilmiştir. Ülkemizde balık fiyatları ile hanedeki kişi sayısı ilişkilendirildiğinde kişi sayısının fazla olması ve aylık gelirin düşük olması balık tüketimini etkilemektedir. Literatürde balık tüketimi ve ailedeki kişi sayısı arasında ilişkinin araştırıldığı çalışmalarda ailenin gelir durumu düştükçe ve ailede yaşayan kişi sayısı arttıkça balık tüketimin düştüğü belirlenmiştir (Karakaya & Kırıcı, 2016; Kaplan vd., 2019; Aydın & Bashimov, 2020). Bu çalışmada da gerek Demirköy gerek Babaeski ilçelerindeki katılımcıların hanedeki kişi sayısı arttıkça balık tüketimi miktarının azaldığı sonucuna varılmıştır. Nitekim bir ayda balık tüketim sıklığının %52 oranla 1-2 kez olduğu ve ailede bir öğünde ortalama balık tüketim miktarının %34 oranla 1001-2000 g olduğu tespit edilmiştir. Buradan Demirköy denize kıyısı olmasına rağmen yakınlıkla balık tüketiminin tamamen ilişkili olmadığı, ailenin geliri ve ailedeki kişi sayısıyla da ilişkili olduğu sonucuna varılmıştır.

Demirköy'den çalışmaya katılan kişilerin balık fiyatları konusundaki görüşleri incelendiğinde katılımcıların %58'i fiyatları pahalı bulmakta ve %41'i balık alırken fiyatına göre karar verdiğini bildirmektedir. Katılımcılar balık fiyatlarını yüksek buldukları için balığın fiyatına göre satın alma tercihlerini belirlediklerini ifade etmektedir. Balığı çoğu satın almakta ve küçük bir oranda (%7) ise kendisi avlamaktadır. Satın alınan yerlerin de daha çok pazarda balık satılan pazar tezgahından (%52) olduğu tespit edilmiştir. Katılımcıların %30'u ise seyyar satıcılardan balık almaktadır. Balık satan marketlerden balık alımının az olduğu tespit edilmiştir (%18). Demirköy'de balık marketlerinin az olmasından dolayı, daha çok pazarlarda ve seyyar satıcılar tarafında balık satıldığı anlaşılmış ve insanların balık ihtiyaçlarını buralardan karşılamaları gerektiği tespit edilmiştir. Katılımcılar arasında balık avlayan kişi oranının az olması da katılımcıların çoğunluğunun memur ve işçi olmasından kaynaklanıyor olabilir. Balık alırken mevsim/sezona uygun olması ve taze olması durumuna özen gösterildiği (%41 ve %40), ucuz olmasının (%19) geri planda olmasının tercih edilmesi sağlık açısından önemlidir. İnsanların buna dikkat etmesi bilinçli olduklarını göstermektedir. Balık tüketim şekli konusunda Demirköy'de daha çok kızartma (%62), fırında pişirme (%17), ızgara (%15) ve en az buğulama (%6) tercih edilmektedir. Literatürde de insanların balık pişirme tercihinin en çok kızartma olduğunu belirten çalışmalar mevcuttur (Şen vd., 2008; Arslan & İzci, 2016; Özer vd., 2016; Bolat & Telli, 2019; Karakulak vd., 2019; Arslan, 2019; Arslan & Avcıoğlu, 2020; Karakaya, 2020; Yıldız & Arslan, 2021).

Demirköy denize kıyısı olmasına rağmen çalışmaya katılanlar sonbahar ve kış mevsiminde balık tükettiğini, en çok da palamut, lüfer, hamsi tercih ettiklerini belirtmişlerdir. Bu mevsimlerde en çok çıkan balık türleri bunlar olduğu için en çok bu balıkların tüketilmesi beklenen bir durumdur. Her yörenin kendine yakın denizinde hangi balık daha çok

çıkıyorsa kişiler daha uygun ücrette ve tazelikte mevsimine uygun balığı tercih etmektedirler. Ancak, ilkbahar mevsiminde de balık bulunmaktadır. Bu mevsimlerde satılan balıklar daha çok kültür balıkları olduğu için pahalıdır ve insanlar bu balıkları tercih etmek yerine daha çok ucuz olan yiyecekleri bu mevsimlerde tercih ediyor olabilirler. Nitekim literatürde de bu şekilde olduğu belirtilen çalışmalar mevcuttur (Saygı vd., 2006; Alageyik vd., 2020; Qasim vd., 2020).

Denize kıyısı olmayan Babaeski ilçesindeki katılımcıların demografik özellikleri değerlendirildiğinde, çoğunluğun (%92) erkek olduğu, yaş aralığı değerlendirildiğinde çoğunluğun (%68) 30-49 yaş aralığında olduğu tespit edilmiştir. Her iki ilçede de bu durumlar benzerdir. Öğrenim düzeyleri karşılaştırıldığında %42'si ilköğretim, %36,7'si lise mezunu olduğu belirlenmiştir. Meslek açısından değerlendirildiğinde katılımcıların %36'sının işçi, %31,3'ünün çiftçi ve %22,7'sinin memur olduğu tespit edilmiştir. Demirköy ile karşılaştırıldığında çiftçi ve işçi sayısı daha fazladır. Öte yandan, katılımcıların öğrenim seviyesi Demirköy'deki katılımcılara kıyasla daha düşüktür. Gelir durumlarına bakıldığında, katılımcıların %35,3'ünün 4001-5000 TL arasında aylık gelir düzeyine sahip olduğu belirlenmiştir. Demirköy'le karşılaştırıldığında Babaeski'deki katılımcıların gelir düzeyinin daha yüksek olduğu anlaşılmaktadır. Babaeski'de hanedeki kişi sayısı değerlendirildiğinde %73,3 oranında 3-4 kişiliktir. Demirköy'deki katılımcılar için ise hanedeki kişi sayısı %50 olarak belirlenmiştir.

Her iki ilçeden katılımcıların demografik özellikleri birbirine benzerdir. Balık tüketimleri incelendiğinde, bir ayda balık tüketim sıklığının %64,7'sinin 3-5 kez, yine Babaeski'deki katılımcıların Demirköy'de olduğu gibi balık alırken fiyatına göre (%66) balık tercihinde bulundukları belirlenmiş ve katılımcıların %56'sı ise balık fiyatlarını pahalı bulduklarını belirtmişlerdir. Balık ihtiyaçlarını satın alarak karşıladıklarını ve Demirköy'den farklı olarak balık almayı balık satan marketlerden ve Demirköy'deki gibi pazarda balık satılan pazar tezgahından aldıklarını belirtmişlerdir. Burada her iki ilçede balık alma yerlerinde farklılıklar bulunmuştur. Babaeski Demirköy'e göre daha büyük ve gelişmiş bir ilçe olduğu için balık satan marketlerden de balık almayı tercih etmiş olabilirler. Dolayısıyla insanların güvenebilecekleri balık marketler olduğunda balık alma tercihinin buralar olabileceği sonucuna varılmıştır.

Babaeski'deki katılımcılar balık alırken daha çok taze olmasına (%69,3) özen gösterdiklerini, Demirköy'deki katılımcılar ise daha çok mevsim/sezona uygun olması ve taze olmasına özen gösterdiklerini belirtmişlerdir. Babaeski denize uzak olduğu için insanlar balığın tazeliği konusunda daha hassas davranmış olabilirler. Demirköy denize kıyısı olduğu için gelen balık zaten tazedir düşüncesinde olabilirler. Bir öğünde ortalama balık tüketim miktarları incelendiğinde, Babaeski'deki katılımcıların Demirköy'e göre daha az balık tükettikleri görülmüştür. Bunun sebebinin denize uzaklıktan kaynaklandığı söylenebilir. Nitekim literatürde bu sonuçlarla benzer sonuçlara sahip çalışmalar mevcuttur (Balık vd., 2013). Balık pişirme şekilleri incelendiğinde, %59,3 oranında kızartma yaptıkları görülmüştür. Bu açıdan Demirköy ilçesi ile benzerlik göstermektedir. Ancak fırında pişirmeyi tercih edenler Demirköy'den daha fazladır. Demirköy'de ise ızgara pişirmeyi tercih edenler Babaeski'ye göre daha fazladır. Demirköy'de bahçeli evlerin olması kişilerin ızgarayı tercih etmelerine sebep olmuş olabilir. Balık tüketimi bu ilçede de en fazla kış ve sonbahar mevsimlerinde tercih edilmektedir. Babaeski'de yaşayan insanların yazın ve ilkbaharda bulunan balıkları tercih etmedikleri söylenebilir. Bu tercihe etki eden birçok sebep olabilir. Pahalı olması en önemli sebeptir (Dağtekin & Ak, 2007; Karakaya & Kırıcı, 2016; Kaplan vd., 2019; Selvi vd., 2019). Her iki ilçeden çalışmaya katılan katılımcıların aylık gelirlerinin düşük olması literatürde bulunan bu önemli sebeple örtüşmektedir. Nitekim aylık gelir ve bir ayda tüketilen balık miktarı arasındaki ilişki incelenmiş ve anlamlı ilişki olduğu bulunmuştur. Aylık gelir artıkça ayda tüketilen balık sıklığı artmaktadır. En çok tüketilen balık türü incelendiğinde, Demirköy'de olduğu gibi palamut, lüfer ve hamsiden farklı olarak istavrit ve çipura da tükettikleri belirlenmiştir.

SONUÇ

Kırklareli ilinin denize farklı uzaklıkta bulunan iki farklı ilçesinde yürütülen bu çalışmada, denize

uzaklığın balık tüketimi tercihleri ve alışkanlıkları konusundaki farklılık gösterip göstermediği araştırılmıştır. Balık seçim türü, tercih mevsimi, pişirme çeşidi, balık fiyatları konusundaki düşüncelerinin benzer olduğu sonucuna varılmıştır. Ancak ayda balık alma sıklıkları, satın alma yerleri, bir öğünde tükettikleri miktarlar açısından farklılıklar olduğu sonucuna varılmıştır. Demirköy denize kıyısı olmasına rağmen balık alma sıklıkları az ama bir öğünde kişi başına düşen miktar fazladır. Babaeski daha gelişmiş ve daha büyük nüfuslu bir ilçe ve burada balık satılan marketlerin olması onların buralara yönelmelerine sebep olduğu sonucuna varılmıştır.

Üç tarafı denizlerle çevrili olan ülkemizde balık tüketimi ve tercihi konusunda insanların bilgilendirilmeleri gerekmektedir. Balık protein, vitamin ve mineral bakımından çok önemli bir besin maddesidir (Can vd., 2015; Gürel vd., 2017; Lee & Nam, 2019). Bu kapsamda toplumun her kesiminin sürekli olarak bilgilendirilmesi gerekmektedir. Küçük merkezlerde balık satışlarının artması için balık marketlerin açılması ve taze balığı insanların her zaman bulabilecekleri imkanların sunulması önerilmektedir. İnsanların her mevsimde balık alabileceği olanaklar sunulmalı ve tüm balıkların fiyatlarının ülkemizdeki her kesimden insanın alabileceği fiyatlarda olması önerilmektedir. Bundan sonra yapılacak araştırmalarda, insanların balık tüketimi ve alışkanlıklarıyla ilgili görüşlerinin alındığı nitel araştırmaların da yapılması, daha derinlemesine araştırmalara öncelik verilmesine önem verilmelidir.

TEŞEKKÜR

Bu çalışma ilk yazarın yüksek lisans tezinin bir kısmından üretilmiştir.

Etik Standartlara Uyum

Yazarların Katkısı

Bu çalışma ilk yazarın yüksek lisans tezinin bir kısmından üretilmiştir. MB çalışmayı planlamış, gerçekleşmesi için danışmanlık yapmıştır. ST sahada anketleri uygulamış, elde edilen verileri düzenlemiş, istatistiksel analizleri gerçekleştirmiş ve makalenin ilk halini yazmıştır. Her iki yazar da makalenin son halini kontrol etmiş ve onaylamıştır.

Çıkar Çatışması

Yazarlar herhangi bir çıkar çatışması olmadığını beyan etmektedir.

Etik Onay

Yazarlar bu tür bir çalışma için resmi etik kurul onayının gerekli olmadığını bildirmektedir.

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ACTA NATURA ET SCIENTIA

In Memoriam: Prof. Dr. Yılmaz Emre (1957-2021)

This volume is dedicated to our editorial board member and colleague Prof. Dr. Yılmaz EMRE who was devoted to aquaculture, fisheries, marine and freshwater biology, and microplastics.

In Antalya, Turkey, on August 22, at the age of 64, Prof. Dr. Yılmaz EMRE, a scientist at the Faculty of Science at Akdeniz University, Turkey, passed away due to the Covid-19 pandemic. The departure of our colleague, who was a member of the editorial board of our journal, represents a major loss for the Turkish scientific community.

Dr. Yılmaz EMRE was born on February 1, 1957 in Şanlıurfa, Turkey. He graduated from Selçuk University, Faculty of Science and Arts (Bachelor of Science Degree in Biology, 1982). He obtained a Master of Science degree in Medical Biology at Selçuk University, Department of Medical Biology (at the Faculty of Medicine), 1987, and earned a Philosophy of Doctorate degree in Biology at Bursa Uludağ University, Department of Biology, 1992. He became a full professor in 2016.

He worked as a biologist in the Bursa Fisheries Regional Directorate (Turkey) between 1982-1985, Bursa Provincial Directorate (Ministry of Agriculture and Rural Affairs, Turkey) between 1985-1989, Antalya Kepez Fisheries Production Directorate between 1989-2003. He also served as a founding director at the Mediterranean Fisheries Research, Production and Training Institute (Ministry of Agriculture and Forestry, Turkey) from 2005 to 2013. He worked as the Deputy General Manager of Fisheries and Aquaculture (Ministry of Agriculture and Forestry, Turkey) in 2016. He worked as the dean of the Faculty of Science at Akdeniz University between 2016-2017, and he worked as an academic at Akdeniz University from 2013 to 2021. He was the Turkey correspondent of the European Inland Fisheries Advisory Commission (EIFAC) (Food and Agriculture Organization (FAO) of the United Nations) for seven years.

His main areas of interest were aquaculture, fisheries, marine and freshwater biology. He has published more than 130 original scientific papers, studies and reports. He shared his knowledge and scientific experiences with young researchers throughout his life and trained many young researchers. Therefore, Dr. Yılmaz Emre's passing created an unfillable void for his family, loved ones, and friends.

We would like to express the sadness of the loss of Dr. Yılmaz Emre, a great mentor and scientist. We hope that he enjoys a lovely and peaceful afterlife. Dr. Yılmaz Emre was also loved and will be respected by his worldwide academic family who will remain forever grateful.

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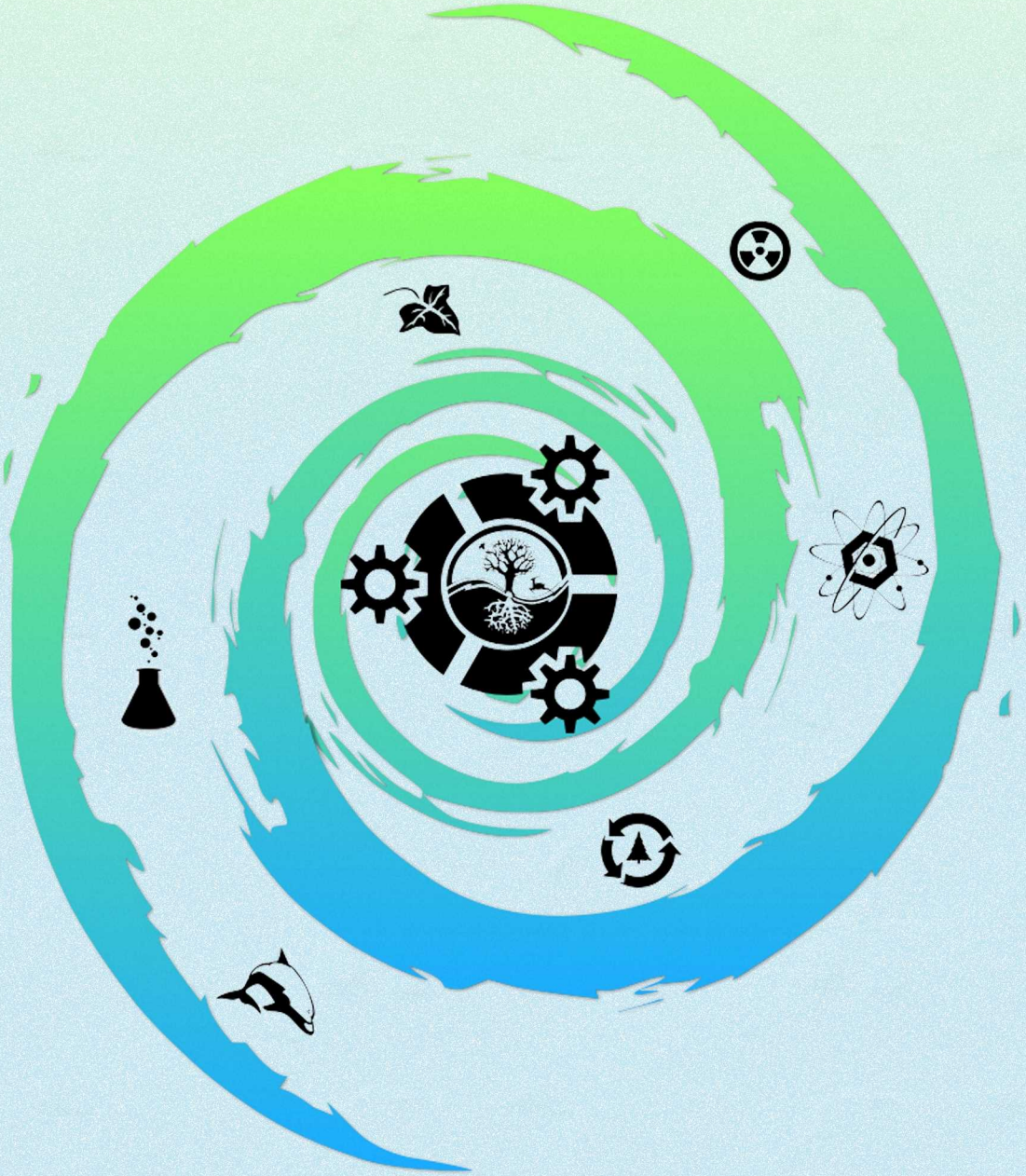

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