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Contentes

Chapter 1

THE ROLE AND IMPORTANCE OF FOOD COOPERATIVES IN THE SUSTAINABILITY OF FOOD SUPPLY

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1. INTRODUCTION

In the modern era, as concerns about food security, environmental sustainability, and equitable access to nutritious food continue to escalate, alternative food systems such as food cooperatives have emerged as significant players in shaping the landscape of food supply. Food cooperatives, commonly referred to as co-ops, are member-owned organizations that operate for the mutual benefit of their members, often prioritizing principles of sustainability, social responsibility, and community engagement (Bastias, 2013).

Food cooperatives have a rich history dating back to the 19th century, where communities banded together to address issues of food access and affordability. These grassroots initiatives have evolved over time into sophisticated models of consumer cooperation, characterized by democratic decision-making processes and a commitment to ethical sourcing practices. According to Thilmany et al., (2008) food cooperatives typically emphasize principles of environmental stewardship, such as supporting local farmers, reducing food miles, and promoting organic and fair-trade products.

One of the primary functions of food cooperatives is to mitigate the vulnerabilities inherent in conventional food systems. Conventional agri-food systems are often characterized by centralized control, long supply chains, and reliance on fossil fuels, leading to environmental degradation, food waste, and socio-economic inequalities (Hinrichs, 2000; Demirbaş, 2024). In contrast, food cooperatives offer a decentralized and community-oriented approach to food provisioning, which enhances food security, fosters resilience, and promotes social cohesion (Guthman, 2008).

Moreover, food cooperatives play a crucial role in promoting sustainable consumption patterns by raising awareness about the environmental and social impacts of food production and consumption (Hinrichs, 2000). Through educational programs, transparent labeling, and advocacy efforts, co-ops empower consumers to make informed choices that align with their values and contribute to a more sustainable food system (Lyson and Guptill, 2004). This study seeks to explore the multifaceted contributions of food cooperatives to the sustainability of food supply chains.

2.WHAT ARE THE FOOD COOPS?

A food co-op represents a community-owned grocery store, distinguishing itself from corporate chains by its complete independence and ownership by local community members. These establishments prioritize community interests over investor concerns, emphasizing accessibility to nourishing options tailored to various budgets and culinary preferences (Co+op, 2024a). By fostering relationships with local farmers and family-owned businesses, co-op stores showcase the best local produce, thereby contributing to the sustainability of regional economies. Participation in a food co-op extends beyond mere shopping; it involves membership ownership, offering financial benefits and a voice in the decision-making process. The inclusive nature of co-ops welcomes all individuals to shop, dine, and engage, fostering a sense of belonging and shared responsibility. Moreover, co-op principles emphasize collaboration, emphasizing the collective pursuit of equitable access to quality food.

Cooperation lies at the heart of the co-op model, facilitating the alignment of economic, social, and cultural needs. Through collaboration, co-ops forge robust connections between suppliers and consumers, reshaping conventional business practices to prioritize community welfare. These enterprises often serve as exemplars of environmental and social responsibility, setting standards for ethical business conduct. Despite their shared ethos, food co-ops exhibit considerable diversity in their operations. Variations are evident in product offerings, operating hours, sales methods, and locations. While some focus on fresh produce, others specialize in organic wholefoods or offer a range of dairy and meat products. Operational schedules vary widely, ranging from weekly markets to daily storefront operations. Moreover, co-ops adopt diverse sales models, encompassing veg bag schemes, market stalls, and food hubs, often tailored to suit the specific needs of their communities.

Food cooperatives play a pivotal role in promoting environmental sustainability by reducing packaging waste and minimizing the carbon footprint associated with food transportation. By prioritizing local and organic produce, co-ops contribute to the preservation of ecosystems and support sustainable agricultural practices. Additionally, food cooperatives serve as economic engines for local development by channeling resources back into the community. By supporting local producers and ethical suppliers, co-ops bolster the regional economy and promote sustainable livelihoods. The circulation of money within the local economy fosters economic resilience and fosters a sense of ownership and empowerment among community members (Row, 2022).

Co-ops prioritize social responsibility, offering a wide range of fair trade products such as coffee and chocolate. By adhering to fair trade principles, co-ops ensure fair prices for growers and uphold high standards of worker treatment. In contrast, large supermarket chains may overlook ethical considerations, potentially supporting practices detrimental to workers' rights and well-being (Hernández-Perlines et al., 2020; Tang et al., 2020).

Cooperatives span across all countries and sectors, encompassing agriculture, food, finance, health care, marketing, insurance, and credit. With an estimated one billion individuals as members globally, they generate over 100 million jobs. In sectors like agriculture, forestry, fishing, and livestock, members engage in various activities such as production, profit-sharing, cost-saving, risk-sharing, and income generation, enhancing their bargaining power as buyers and sellers. The International Year of Cooperatives in 2012 celebrated their unique role as a "business model with a social conscience." World Food Day 2012 highlighted agricultural cooperatives' significant contribution to poverty and hunger reduction, given that 70 percent of the estimated 925 million hungry people reside in rural areas where agriculture serves as the primary economic activity. While agricultural and food cooperatives already serve as vital tools against poverty and hunger, there exists untapped potential for further impact. Thus, it's imperative to fortify these organizations, fostering their expansion within a conducive business, legal, policy, and social environment that promotes their growth (FAO, 2012).

3. THE ROLES AND IMPORTANCE OF FOOD COOPS IN THE SUSTAINABILITY OF FOOD SUPPLY

3.1 What is a Sustainable Food Supply?

A sustainable food supply goes beyond just getting food on your plate. It's about ensuring we can feed ourselves today without compromising the ability of future generations to meet their own food needs (Internet Geography, 2024). This complex system considers the entire journey of food, from farm to fork, with a focus on three key pillars: environmental, economic, and social sustainability (UNEP, 2024).

"Environmental Sustainability" focuses on minimizing the negative impact on our planet. This includes practices that conserve water, reduce greenhouse gas emissions, and protect biodiversity. Examples include organic farming, which avoids synthetic pesticides and fertilizers, and water-saving irrigation techniques (UN, 2023).

"Economic Sustainability" aims for a food system that is profitable for everyone involved. This means fair prices for farmers, good wages for food workers, and affordable food for consumers (UN, 2023). Local food systems, where food travels shorter distances, can contribute to economic sustainability by supporting local businesses and communities (Demirbaş, 2023; Rahimi and Demirbaş, 2023).

"Social Sustainability" ensures that everyone has access to safe, nutritious food. It also considers the working conditions of those who produce and distribute our food. Sustainable food systems promote fair labor practices and social justice throughout the supply chain (UNEP, 2024).

3.2 Why Cooperative Food Systems?

Cooperative food systems present an alternative paradigm to the conventional, profit-centric food industry. Emphasizing collaboration and collective ownership, these systems strive to forge a more just and sustainable food network (CDI, 2024).

Owned and governed democratically by their members, food co-ops cultivate a vibrant community ethos and a deep-rooted commitment to local food systems (Co+op, 2024c). Members actively participate in decision-making processes concerning product selection, sourcing strategies, and operational frameworks, thereby ensuring that the co-op mirrors their ethical principles.

Moreover, co-ops offer competitive pricing structures and avenues for profit-sharing among members. By championing local producers, they bolster the local economy and keep financial resources circulating within the community (ICA, 2024a).

A core tenet of food co-ops is the promotion of healthful, organic, and locally-sourced goods. This focus addresses issues of food insecurity and the dearth of fresh produce in underserved areas (Sustain, 2024).

Environmental stewardship is another hallmark of cooperative food systems. Practices such as minimizing food waste, advocating for sustainable agricultural methods, and prioritizing shorter transportation routes for products underscore their commitment to ecological sustainability.

3.3 Relations Between Sustainability and The Food Coops

Food cooperatives and sustainability are intrinsically linked. Food co-ops act as community hubs, fostering social connections and promoting local food education. They often provide educational workshops and events, raising awareness about healthy eating and sustainable agriculture practices (Dardak, 2015).

By their very nature, food co-ops prioritize social and environmental well-being alongside economic viability, making them a unique player in the food system. This section explores how food co-ops contribute to a more sustainable food system across various dimensions.

Environmental Sustainability: Food cooperatives frequently prioritize the sourcing of local and organic produce, aiming to reduce the environmental impact associated with long-distance transportation and conventional farming practices. Many of these cooperatives provide bulk buying options, which not only encourage the use of reusable containers but also minimize packaging waste. Additionally, some co-ops invest in energy-efficient appliances and technologies, such as $CO2$-based refrigeration systems, as part of their efforts to lessen their environmental footprint. Moreover, co-ops may implement food donation programs or collaborate with local organizations to manage food waste effectively and prevent it from ending up in landfills, which are significant sources of methane emissions (Co+op, 2024b). Food co-ops prioritize sourcing locally produced food, offering consumers a wider variety of fresh, seasonal options. This focus on local produce often translates to higher quality and better taste, while also reducing the environmental impact associated with long-distance transportation (Michahelles, 2008). Food co-ops frequently partner with producers who employ sustainable practices, such as organic farming methods. This fosters a more environmentally responsible food system and promotes healthy soil and biodiversity (Enlow et al., 2011).

Social Sustainability: Food cooperatives, commonly characterized by democratic ownership and operation among members, cultivate a profound sense of community ownership and responsibility. Emphasizing fair wages and conducive working conditions, these cooperatives actively contribute to advancing social justice within the food industry. Moreover, many cooperatives extend affordable food alternatives and initiatives tailored to aid low-income families and individuals, thereby championing equitable access to nutritious sustenance (ICA, 2024a; ICA, 2024b). By supporting local farms and promoting access to healthy food options, food co-ops contribute to a more resilient and secure local food system. This is particularly important in areas facing food insecurity or limited access to fresh produce. Food cooperatives serve as hubs for community engagement and education on food-related issues. Through workshops, cooking classes, and outreach programs, cooperatives empower consumers to make informed choices about their food purchases (Moragues-Faus & Marsden, 2021).

Economic Sustainability: By placing emphasis on local producers, food co-ops foster economic circulation within the community while bolstering support for local farmers and businesses (Co+op, 2024c). Operating with a long-term vision, co-ops prioritize responsible financial management and channel profits back into the cooperative for sustained growth. Food cooperatives prioritize fairness throughout the supply chain, from production to consumption. By sourcing products directly from local farmers and producers whenever possible, cooperatives support fair prices and transparent trading relationships (Dragicevich, 2020). Additionally, many food cooperatives prioritize organic, ethically sourced, and culturally relevant products, promoting fair labor practices and environmental stewardship. Contrary to traditional corporate grocery chains, food cooperatives foster competition and diversity in the marketplace. By offering a platform for small-scale producers and local artisans, cooperatives contribute to a more dynamic and inclusive food economy (McDonnell & Faherty, 2019). Moreover, cooperatives often collaborate with other cooperatives and independent retailers, strengthening solidarity within the sector.

4.CONCLUSION AND RECOMMENDATIONS

Food cooperatives play multifaceted roles in fostering a fair and competitive food supply chain. By adhering to principles of fairness, promoting diversity, and prioritizing community engagement, cooperatives contribute to a more equitable and sustainable food system. As consumers increasingly seek alternatives to conventional grocery shopping, the importance of food cooperatives in shaping the future of food cannot be overstated.

Food cooperatives play also a vital role in building a more robust, equitable, and sustainable local food system. They provide fair prices to producers, offer consumers access to high-quality local food, and promote environmentally friendly practices. As consumer interest in local food continues to grow, food co-ops are poised to play an even more significant role in shaping the future of our food supply chain.

A sustainable food supply is a complex but crucial concept. By adopting practices that are environmentally sound, economically viable, and socially just, we can ensure a secure and healthy food system for generations to come. Food cooperatives, with their emphasis on fairness, diversity, and community engagement, are integral to achieving this goal.

In conclusion, food cooperatives play a pivotal role in fostering sustainability within the food supply. By prioritizing principles such as community engagement, environmental stewardship, and economic viability, food cooperatives demonstrate a sustainable alternative to conventional food systems. Through their emphasis on local sourcing, reduced food miles, and equitable distribution, they contribute to environmental conservation, promote food security, and support local economies. Moreover, by empowering consumers with knowledge and agency, food cooperatives foster a deeper connection between individuals and their food, promoting healthier lifestyles and fostering a sense of community resilience.

Given the critical role of food cooperatives in fostering sustainability in our food supply, it is recommended that policymakers, consumers, and stakeholders alike support and promote the growth of these cooperatives. This support can come in various forms, such as providing financial incentives, creating supportive policies, and encouraging community involvement. Additionally, consumers can actively participate by choosing to support local food cooperatives and advocating for sustainable practices within their communities. By collectively embracing and championing the values of food cooperatives, we can work towards a more resilient, equitable, and sustainable food system for the benefit of both present and future generations.

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Chapter 2

THE IMPACT OF CLIMATE CHANGE ON LAKES AND CURRENT RESEARCH IN TURKISH LAKES

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Introduction

Lakes, covering 3% of the Earth's terrestrial surface, provide vital ecosystem services including freshwater and food supply, water bird habitats, and contribute to climate regulation through the carbon cycle as key components of biogeochemical processes. In these days of experiencing climate change with comprehensive social and ecological implications, the impacts of changing climate on freshwater resources, water quality, and biological diversity also hold significant importance.

Lakes exposed to the potential impacts of climate change caused by human activities are dynamic ecosystems that reflect unique basin characteristics and changes in climate and biological components. The effects of climate change on water quality typically differ depending on the geographic positioning of a water body within a basin (Pulatsü and Topçu 2023). The main consequences for water resources caused by climate change are increases in water temperature, changes in precipitation patterns and ice cover, and possible increases in the frequency of floods and droughts (Anonymous 2020; Woolway et al. 2020). In addition, sewer overflows during heavy rains, combined with higher water temperatures and a longer ice-free season, can lead to an increase in the number of pathogens in the water (Anonymous 2010). One of the main concerns about climate change in temperate latitudes is the possibility of a shift towards the dominance of cyanobacteria species, which form harmful blooms within phytoplanktonic organisms. The impacts of climate change on lakes can be direct, through changes in CO2, temperature and precipitation patterns, or indirect, through invasive species and nutrient dynamics. Moreover, alterations in climate can impact the ecosystems and environmental systems crucial for sustaining freshwater habitats that support fisheries. Impacts on fish species and aquatic life also have the potential to significantly affect traditional subsistence fishing communities (Anonymous 2022a).

It has been underlined that in the context of climate change in Turkey, the most significant changes will occur in the Mediterranean climate region (western and southern Turkey) with increasing temperatures and decreasing precipitation, while consistently observed long-term changes in Turkey will involve rising annual minimum temperatures and summer temperatures along with decreasing winter precipitation (Yılmaz and Yazıcıgil, 2011). In recent years in Turkey, due to changing climate conditions, the Mediterranean climate region has experienced extreme drought, while the Black Sea climate region has faced drought accompanied by sudden and intense rainfall leading to flood disasters (Topaldemir and Taş, 2022). It is also reported that wetland surfaces in the Central Aegean and Central Anatolia will shrink to a great extent, and to a lesser extent in Marmara and Eastern Anatolia. It has been noted that while surface areas may shrink due to increased evaporation caused by rising temperatures, coastal deltas and lagoons may not experience significant changes in their conditions due to the expected rise in sea levels. However, there could be a certain degree of change and loss in the fauna and bird species reliant on these areas due to increased salinity and changes in floral elements (Anonymous 2018).

For over twenty years, global research has been conducted on the potential impacts of future climate change on lake and freshwater ecosystems, with numerous comprehensive reports published by the Intergovernmental Panel on Climate Change (IPCC) at the country level. The mentioned reports highlighted three main topics: future climate projections, potential changes in lakes and freshwater systems, and recommended actions for lake and water resource managers (Anonymous 2022b).

This review study focused on: a) Summarizing the potential effects of climate change on lakes, b) Highlighting the main findings of research conducted in Turkish lakes after 2010, and c) Proposing solutions related to the topic.

Potential Effects of Climate Change on Lakes

In this context, the potential effects of climate change on lake ecosystems are summarized as follows:

a) Impacts on the physical and chemical characteristics of lakes

Anonymous (2010) reported that increases in surface water temperatures are expected to continue, and over the past century, water temperature values in some large rivers and lakes in Europe have increased by 1-3°C, primarily due to the warming effects of air temperature rise and point-source pollution sources such as heated cooling water from power plants. It has been noted that parallel to the predicted increase in air temperatures, lake surface water temperatures could be approximately 2°C higher by the year 2070 compared to present levels.

Increases in air temperature are associated with increases in surface water temperature (Edlund et al. 2017) and increasing average temperatures and extreme temperature changes will increase surface water temperature and affect thermal stratification in lakes. Warmer winters can affect mixing and nutrient recycling rates in temperate lakes, resulting in reduced seasonal cooling, distorting the contrast of thermal intensity. Increasing temperatures and thermal stability result in less mixing of the water column. Moreover, further increases in dissolved organic nitrogen (DOC) concentrations can reduce light penetration, partially preventing the warming of deeper water layers (Anonymous, 2010). As a result, higher air and water temperatures will increase open water evaporation rates and lead to declines in lake levels unless balanced by increases in precipitation or changes in other factors affecting evaporation rates (Hulme et al., 2003; Anonymous, 2022b).

Elevated temperatures will likewise impact the duration of ice cover, freezing and thawing timings, and the thickness of ice layers. It has been reported that due to climate change, lakes experience less ice cover, and with a 4°C increase in air temperature, there is a risk that over 100,000 lakes could spend their winters ice-free. Additionally, it has been noted that the freezing duration of lakes in the Northern Hemisphere has shortened by 28 days over the last 150 years. It has been indicated that with the removal of ice cover, evaporation rates in lakes could significantly increase, leading to adverse consequences for water availability (Woolway et al., 2020; 2022).

Vincent (2009) proposed that a heightened and enduring layering of lake waters might result in amplified alterations in chemical parameters across the water column. Such circumstances could initiate a shift from oxygen-rich to oxygen-depleted conditions in the lower depths of nutrient-rich lakes. Additionally, anoxic environments can stimulate greater nitrogen depletion within the ecosystem, facilitated by bacterial activities like denitrification, wherein nitrate is transformed into nitrogen gas. Research on the effects of climate change on the thermal structure of lakes has been conducted in different countries (Winder and Schindler 2004; Hadley et al. 2014; Edlund et al. 2017). Noges et al. (2009) reported that at higher temperatures in cold regions, cold monomictic lakes can become dimictic by stratification in summer, while in temperate ecoregions many dimictic lakes will resemble Mediterranean lakes by becoming warm monomictic lakes uninterrupted by ice cover with a long stratification period in summer and a single circulation period in winter. According to the results of the empirical evaluation of 41 years of vertical sampling profiles of three Austrian lakes, climate change has resulted in higher surface water temperatures, stronger thermal stability and longer thermal stratification times in the lakes. Ongoing climate change and changes in thermal characteristics suggest that in temperate lakes initially covered by ice will inevitably lead to a transition of mixing regimes from dimictic to monomictic mixing, and that this transition will occur earlier in larger and deeper lakes (Ficker et al. 2017).

Changes in radiation or other climate variables, including cloud cover, relative humidity and wind speed, can also cause marked changes in lake ecosystems. Changes in wind speed and prevailing wind direction will also affect mixing processes and thermal stratification in lakes (Hulme et al. 2003). It is crucial to comprehend the impacts of rising air temperature and shifts in wind speed on lakes of varying depths and surface areas to effectively manage these ecosystems amidst climate variability (Magee and Wu 2017). Global annual average lake evaporation rates are projected to increase by 16% by 2100, depending on factors such as regional variations, ice cover, stratification, wind speed and solar radiation (Woolway et al. 2020).

Changes in the temporal and spatial patterns of precipitation significantly influence both endorheic (closed) and exorheic (open) lakes, as their dynamics are closely tied to the equilibrium between inflows and evaporation. These lakes prove highly susceptible to alterations in both aspects. Elevated precipitation levels and their frequency contribute to more frequent riparian flooding events, whereas arid conditions exacerbated by heightened evaporation rates diminish inflows to the lake, consequently lowering lake levels (Hulme et al. 2003).

According to simulation results by Murdoch et al. (2000), climate change has a significant impact on surface water quality (precipitation and temperature), and factors such as storms, snowmelt, high air temperature or drought periods can cause conditions that exceed ecosystem tolerance thresholds, leading to water quality degradation. Climate change will lead to greater variability in rainfall patterns, higher air temperature and increased sedimentation and erosion. These changes are also factors that will threaten water quality. In addition, the color of the water will increase due to the increase in humic matter inputs as DOC from the basin (Anonymous 2010). All these changes in the water quality of rivers, lakes or streams will also degrade the water quality of existing source waters needed for drinking water.

Another effect of climate change on lakes is changes in residence time (Anonymous 2022b). Mooij et al. (2005) reported that water residence time in shallow lakes is expected to decrease in winter and increase in summer. Changes in precipitation/evaporation rate can cause changes in the water budget and hydraulic residence time of lakes as well as in their depth and area. Ponds and wetlands are particularly sensitive to rainfall/evaporation variations due to their shallow depths and large surface/volume ratios. It has been reported that the hydraulic residence time of the lake will affect the chemical composition of the lake waters, and in lakes subjected to anoxic bottom water conditions and nutrient release from the sediment, reduced precipitation and input water will result in increased phosphorus accumulation and eutrophication (Vincent 2009).

It has been reported that nitrogen and phosphorus loads to lakes in Northern Europe are likely to increase, especially in winter, due to projected climate change (Jeppesen et al. 2011). Reports suggest that the ramifications of climate change on phosphorus (P) transportation in streams and eutrophication in lakes could be significant. Forecasts indicate a rise in phosphorus loading from land to streams in north temperate coastal areas due to heightened winter precipitation, while warm temperate and arid climates are anticipated to experience a decrease (Jeppesen et al. 2009). The researchers emphasized that in lakes, higher eutrophication can be expected with higher P release from sediment with increasing temperature. Furthermore, it has been indicated that there will be a shift towards smaller and more abundant planktivorous fish in fish community structure, along with increased control of predatory organisms on zooplankton, resulting in higher phytoplankton biomass. Within this framework, data sourced from Danish lakes reveal heightened levels of chlorophyll-a and phytoplankton biomass, marked by a notable predominance of dinophytes and cyanobacteria, particularly those capable of nitrogen fixation. However, there is a diminished presence of diatoms and chrysophytes.

Whitehead et al. (2009) reported that decreases in inflows and dilution rates will result in longer residence times in rivers and lakes, increased potential for toxic algal blooms and decreased dissolved oxygen levels. Increases in algae growth due to shorter duration of ice cover during winter in lakes could lead to turbidity, reducing the growth of aquatic plants and associated habitat benefits (Anonymous 2022c).

While responses to lake chemistry and thermal structure vary depending on the lake, overarching patterns can be discerned among similar lake types. For instance, the capacity of a lake to absorb or emit heat is contingent upon its depth, implying that shallower lakes (like numerous small Mediterranean lakes) will experience more pronounced impacts from warming (Lind et al. 2022). Lakes are also significant emitters of CO_2, CH_4 and N_2O into the atmosphere, and if productivity increases, so will the release of these gases (DelSontro et al. 2018).

Ice cover on lakes will isolate the water body from the atmosphere, creating an imbalance characterized by an increase in CO_2 as a result of biological oxidation of organic matter and a decrease in the concentration of dissolved oxygen (DO) in the water. In times of prolonged ice cover, aerobic processes deplete all existing dissolved oxygen (DO), leading to the development of anoxic conditions, particularly in eutrophic waters characterized by substantial organic matter production during the growing season. The anoxic zone first forms at the lake bottom, where decomposition is most intense, and extends further towards the surface (Noges et al. 2009). In addition, an increase in phosphorus release from sediment is expected in stratified lakes due to decreased oxygen concentration in the bottom water (Anonymous 2010).

While little is known so far about the impacts of climate change on hazardous substances, higher temperatures could lead to increased evaporation and degradation of some substances. Increased frequency of heavy rainfall could lead to increased soil and sediment erosion, exposing surface waters to higher pollutant loads. While drier conditions may result in less loading, higher concentrations could be observed due to the lack of dilution. Although an increase in pesticide use is possible, it will naturally decrease in areas where agriculture is abandoned due to high frequency of droughts (Anonymous 2010).

It has been stated that salinization, another consequence of climate change, may lead to undesirable consequences such as biological invasions or harmful algal blooms in both inland freshwaters and estuaries and that saline lakes are among the most threatened ecosystems in the world due to climate change (Jeppesen et al. 2023).

b) Effects on algae and aquatic plants

Algal blooms, even if not toxic, can still harm aquatic life by blocking sunlight and clogging fish gills, affecting aquatic ecosystems. In addition to higher surface water temperatures and increased nutrient loading from agricultural runoff, lower lake levels can also lead to an increase in the incidence of harmful algal blooms in lakes (Anonymous 2022a; 2022b). Anonymous (2010) also supported the view that climate change-oriented changes in temperature, changing water flows and wind-induced changes may affect cyanobacterial harmful algal blooms by altering population dynamics.

Noges et al. (2009) discussed changes in dominance within phytoplankton communities in certain lakes in Northern Europe, attributed to the increasing frequency of blooms and rising nutrient loading from diffuse sources. In this context, attention was drawn to the impacts on zooplankton and benthic fauna due to the possibility of cyanobacteria proliferation and oxygen depletion in the hypolimnion. This effect may be stronger in shallow and/or eutrophic lakes in cold regions with anoxic hypolimnia. Vincent (2009) noted that overgrowth of blue-green algae or cyanobacteria can cause many water quality problems in lakes and reservoirs, including the release of taste and odor compounds, the production of toxins that can kill fish and other organisms, and the formation of excess biomass that leads to clogging. Harmful algal blooms can also create "dead zones", areas with little or no oxygen that threaten aquatic life. In this context, increased harmful algal blooms can also negatively affect the effectiveness of ecosystem conservation efforts (Anonymous 2022b). Harmful algal blooms can also reach dimensions that threaten public health by reducing spring water quality.

It has been reported that most diatoms in deep lakes follow changes in thermal structure, shifting towards the cyclotelloid genera Cyclotella and Discostella (Edlund et al. 2017), but the ecology of deep lake species is not completely resolved (Rühland et al. 2015).

The duration and intensity of vertical mixing in winter and early spring strongly influence the internal recycling of nutrients and subsequent phytoplankton development in the deep perialpin lakes of Central Europe. Reports suggest that the diminishing water volume in shallow Mediterranean lakes and lakes within warm ecological zones, exacerbated by climate change, will render them increasingly vulnerable to eutrophication and various types of pollution (Noges et al. 2009). The research results of climate change on freshwater ecosystems in the Baltic Sea region are that the annual ice-free period is longer and the ice cover breaks earlier, there are shifts in dominance among phytoplankton taxa, altered successions, reduced species diversity, and a transition from a clear water state (dominated by macrophytes) to a turbid water state (dominated by phytoplankton). One of the studies on reducing external nutrient loading against climate change was conducted in the shallow eutrophic Søbygaard Lake in Denmark. Ecological model simulations using the PCLake model, based on 22 years of data for the lake, have reflected that nitrogen is the primary limiting nutrient for primary production and that there is a high release of phosphorus from the sediment. Nutrient load reduction scenarios predicted increased diatom dominance and increased zooplankton: phytoplankton biomass ratios. Simulations generally indicate that phytoplankton benefit from a warmer climate and the cyanobacteria fraction increases. In this context, it has been reported that under a 6 °C warming scenario, up to a 60% reduction in nutrient loading would be required to achieve summer chlorophyll-a levels similar to the baseline scenario with today's temperatures (Rolighed et al. 2016). Gutierrez et al. (2016) studied whether large-bodied zooplankton structure in shallow hypertrophic Lake Søbygaard (Denmark) was again inhibited by Climate Warming following a reduction in nutrient loading. In this context, despite the overall improvement observed in the lake following Nutrient Loading Reduction, larger-bodied zooplankton organisms did not show similar recovery; there was a shift from the initial dominance of *Daphnia spp.* to *Bosmina spp.* in macrozooplankton, along with a decrease in copepod body size and an increase in nauplii abundance.

Macrophytes play a crucial role in freshwater ecosystems, contributing directly and indirectly to water purification and serving as habitat for various aquatic organisms. Nevertheless, the potential consequences of a shortened ice-free period resulting from climate change may pose numerous challenges, such as prolonging the growth period for both native and non-native species, which could in turn hinder aquatic recreational activities (Anonymous 2022b). Lind et al. (2022) also reported that climate change today poses a major threat to macrophyte communities by altering many factors that determine macrophyte abundance and composition.

The synergistic impacts of climate change are expected to result in heightened prevalence and wider dispersal of emerging and floating species, alongside diminished prevalence and distribution of submerged macrophytes. These dynamics are anticipated to occur more rapidly in smaller shallow lakes compared to deeper temperate lakes. Reduced light penetration, fluctuations in water levels, and rising temperatures are likely to promote the dominance of algae within the ecosystem.

It has been reported that increases in water temperature will affect the community composition, phenology, abundance and distribution of aquatic plants, which will have a strong ecological impact on the structure and function of aquatic ecosystems globally (Dhir 2015). However, such effects are expected to be species-specific and the increase in temperature is expected to stimulate the growth of some species to a greater extent. For example, it has been reported that *Lagarosiphon major* and *Elodea canadensis* exhibit different growth responses when subjected to different temperature treatments mimicking different seasons (with temperatures exceeding ambient temperature by +3°C) in a cultivation chamber (Silveria and Thiebaut 2017).

c) Impacts on fish species

Climate change-driven increases in water temperature (and corresponding decreases in oxygen levels) as well as worsening of other stressors (e.g. nutrients, increases in pollutant inputs) may affect ecosystem health (Anonymous 2005; Anonymous 2022a). Many freshwater fish species are sensitive to the thermal regime of water and often have a limited temperature tolerance range. The thermal regime is also critical for the life cycle of a wide variety of aquatic organisms.

Extended ice cover on lakes regulates lake productivity by managing light penetration and concentrations of dissolved oxygen. Consequently, dissolved oxygen levels may diminish gradually during the ice-covered season, reaching lethal thresholds for fish. Changes in the duration of winter ice cover on lakes can yield both advantageous and disadvantageous outcomes for these ecosystems. Shorter ice cover in winter has been reported as a positive effect in that it may reduce the likelihood of cold-water fish kills in shallow lakes, while a negative effect is that the growing season of rooted plants (including non-native species) may be prolonged, causing various recreational problems (Nõges et al. 2009; Anonymous 2022c).

Increased water temperatures, an earlier start, and prolonged thermal stratification, along with reduced dissolved oxygen levels, may collectively pose substantial and potentially detrimental impacts on aquatic organisms, especially. Shallow waters are particularly sensitive to increases in water temperatures in parallel with increases in air temperatures, reducing the availability of freshwater habitats for cold-water fish species. Dead zones resulting from higher water temperatures in deep lakes can lead to large-scale fish mortality and proliferation of harmful algal blooms (Anonymous 2022c; Woolway et al. 2022). Higher temperatures and lower oxygen concentrations can cause stress and reduce habitat suitability for cold-water species like salmon in lakes and rivers (Anonymous 2010). DeStasio et al. (1996) reported an expected increase in habitat areas for both cold-water and warm-water fish species in North-temperate lakes (Wisconsin, USA) due to anticipated changes in physical conditions caused by climate change. This habitat expansion is due both to an increase in water temperature and an increase in the duration of periods with favorable temperatures. Nevertheless, it has been highlighted that in southern lakes, where freezing occurrences are less frequent, maximum temperatures tend to rise, and the anoxic zone expands, potentially leading to a reduction in the habitat of cold-water fish.

Rising temperatures will lead to earlier snowmelt, which, combined with heavy rainfall, more severe weather conditions and flooding, is likely to negatively affect the ability of aquatic species to reproduce. However, in the Arctic, the productivity of lake trout is anticipated to rise as a consequence of forthcoming warming (Campana et al. 2020).

As many fish species are sensitive to even low temperature changes in their environment, climate change-driven temperature increases could cause a shift in the geographical distribution of most taxa. It has been expressed that these changes in the distribution of many fish species may occur especially in cold water fish species (Anonymous 2022a). In addition, climate change may affect the migratory behavior of some fish species. It has been reported that if Arctic lakes become more productive as a result of climate change, Arctic char migrations may decrease and are expected to be smaller in size (Vincent 2009).

It has been pointed out that higher air and water temperatures can also expand the habitat of existing invasive species or allow new ones to establish. In colder regions, where water temperatures may be more of a limiting factor, invasions of non-native species are also more likely (Anonymous 2022c). According to Whitehead et al. (2009), species capable of adapting to changing temperatures and flow regimes are likely to invade new areas, such as migrating within the United Kingdom, which could lead to the invasion of non-native species. It has been emphasized that invasive species could pose challenges to the success of ecosystem conservation efforts, ranging from large-scale ecosystem management like the Great Lakes to restoration of coastal estuaries (Anonymous 2020).

One of the greatest concerns related to climate change is the potential for increased contamination and biological uptake in freshwater systems in the Arctic and Alpine regions, depending on the extent to which toxic substances are mobilized as water temperatures rise. It has been noted that rapid melting of snowpack due to intense rainfall and wetter winter conditions can facilitate acidification in aquatic ecosystems, leading to fish mortality and loss of invertebrate species (Whitehead et al. 2009).

Studies Conducted on the Subject in Turkey

Dursun (2010) stated that the water levels of Beyşehir Lake are affected by hydro-meteorological conditions and anthropogenic activities and suggested solutions to the possible problems of the lake related to global warming. Bucak et al. (2018) linked catchment model outputs to two different process-based lake models: PCLake and GLM-AED. They tested scenarios using five General Circulation Models, two Representative Concentration Pathways, and three different land use scenarios, allowing consideration of various sources of uncertainty. The research anticipates notable reductions in total hydraulic and nutrient loads, along with slight alterations in chlorophyll-a (Chl-a) concentrations, stemming from various climate change and land use scenarios. Additionally, it was projected that cyanobacteria abundance would rise in both lake models, with total phosphorus, temperature, and hydraulic loading identified as the primary factors influencing cyanobacteria biomass.

Ekercin and Örmeci (2010) analyzed multitemporal SPOT imagery data of Tuz Lake and found that between 1987 and 2005, the lake's salt reserve decreased due to drought and unregulated water consumption. They suggested that to manage water and salt resources effectively in the area, the utilization of water resources, particularly groundwater, around the lake should be regulated, and regular monitoring of the lake using remote sensing data is essential. Aktaş (2014), on the other hand, pointed out that the average runoff in Turkey is expected to decrease by 15-20% after 2040 and that the water and salt reserves in Tuz Lake decreased by approximately 30% between 1987 and 2005 due to drought and uncontrolled water use. Aydın et al. (2020) utilized the Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), and Erinç Aridity Index (EAI) to determine the relationship between changes observed over the past 32 years on the surface of Tuz Lake and climate factors. Within the scope of the research, the positive trend of the North Atlantic Oscillation NAO and AO indices over the past 20 years partially explains the observed decrease in the water-covered area of the lake.

Bahadır and Özdemir (2011) conducted correlation and regression analysis to establish the relationship between basin climate elements and changes in the water level of Lake İznik. They identified a significant positive relationship among the parameters. According to both trend analyses conducted to determine the level changes in the lake, it is estimated that the lake level will decrease by approximately 30 cm by the year 2025.

A research examining records concerning diminishing water depths in Lake Tuz, İznik, Eğirdir, Manyas, Van, Ladik, and Sapanca Lakes in light of climate change revealed a 35% shrinkage in Lake Tuz's surface area from 1987 to 2005, along with an approximate 23% decline in Beyşehir Lake's water potential, and noted that certain areas along the shores of İznik Lake experienced approximately a 10-meter water recession. It was also pointed out that the water level of Lake Eğirdir decreased by 56 cm and the water depth of Lake Manyas decreased by approximately 0.4 m. In Lake Van, it was reported that a 2 m drop in level resulted in an increase in the salinity and soda ratio of the lake water (Yüksel et al. 2011).

Between 1975 and 2010, Lake Kovada and its basin experienced a notable rise in temperature and evaporation, coupled with a decline in precipitation. Consequently, the lake's level and volume diminished, with reports indicating a 0.7°C temperature rise, a 120 mm increase in evaporation, and a 20 mm decrease in precipitation during this period. Analyses suggest that the fluctuations in Lake Kovada's level and volume primarily stem from shifts in precipitation rather than alterations in temperature and evaporation (Bahadır 2012).

In the study by Yağbasan and Yazıcıgil (2012), an analysis of IPCC A2 and B1 scenarios using a lake-aquifer simulation model revealed that climate change could lead to temporary drying of Mogan and Eymir Lakes in Central Anatolia by the end of the century. Coppens et al. (2020) employed a combined modeling approach using the catchment model Soil and Water Assessment Tool (SWAT) and the lake model PCLake to investigate the potential effects of various climate scenarios on shallow Mogan Lake. The findings indicate that reduced precipitation and higher temperatures could lead to a significant decrease in inflow rates and water levels. When water levels were low and nutrient concentrations were also low, submerged macrophytes benefitted. However, during dry periods characterized by low inflow rates and high evaporation, in-lake nutrient concentrations and chlorophyll-a levels increased. Cyanobacteria biomass was greater under conditions that were both drier and warmer.

Davraz et al. (2019) reported in their study, where they analyzed changes along the shoreline of Lake Burdur using nine satellite images, rainfall, evaporation, discharge, and lake level records, that from 1975 to 2016, the lake area decreased by 37% from 210 km2 to 131 km2, but the change in lake levels may be due to human impacts rather than climatic factors. Çolak et al. (2022) highlighted that the lake's surface area decreased by nearly half, raising concerns as shallower regions usually harbor greater biodiversity. Climate models (CNRM-ESM2-1GCM for temperature and GFDL-ESM4-GCM for precipitation) project that from 2070 onwards, the Brazilian Cerrado Biome (BCB) will encounter extended periods of moderate to severe drought. This, coupled with the increased demand for water for irrigation and the impacts of climate change, could hasten the drying of these lakes in the near future, leading to devastating effects on lake ecosystems and their biodiversity. It was also reported that the lake water level was in a downward trend in the 1975-2020 period and this situation will continue in the 2021-2050 period (Pınarlık et al. 2023).

Mogan and Eymir Lakes (Ankara) are shallow wetlands sensitive to global warming, and according to meteorological and lake budget data, the main climate threat to these lakes is high-frequency (decadal) precipitation deficit and long-term (several decades) increase in sunlight, but the deterioration of climate parameters is slow and unstable (Apaydın and Kocaoğlu 2020).

Yılmaz et al. (2021) reported that the surface area of the lakes in the Konya Closed Basin, which includes Beyşehir and Tuz Lake, has decreased significantly and even some of them have dried up, while many lakes in the basin, such as Düden Lake, have become more saline. Additionally, it was discovered that three waterbird species facing extinction globally inhabit the basin, while 18 out of the 62 species that previously bred there have vanished. The basin is home to 38 fish species, with 74% being endemic and 61% categorized as threatened or near-threatened. The research anticipates further substantial decreases in water levels in the future attributable to climate change, resulting in the degradation or complete loss of lake ecosystems and the services they provide. Giannetto and Innal (2021) reported the presence of 62 endemic fish species in 37 lakes in Turkey, highlighting the existence of non-native species, agricultural activities, climate-related drought, and decreasing water levels as the most significant threats affecting fish communities.

In a study analyzing the Google Earth Pro application, four lakes—Düden Lake, Gölköy Dam Lake, Bademli Dam Lake, and Burdur Lake—were investigated for changes in surface area between 2011, 2015, and 2021. Results revealed that over the past eleven years, Düden Lake experienced a 3.4% reduction in water volume, while Gölköy Dam Lake saw a 24.6% decline over the last seven years. Additionally, Burdur Lake recorded a 10.3% decrease in the last seven years, and Bademli Dam Lake exhibited a significant 73.1% reduction in water volume over the past eleven years (Doğrul and Alkan 2022).

According to the Water Framework Directive, water management is based on the sustainable management of the quantity and quality of water for its intended use, using integrated basin management principles. Integrated basin management suggests that the biological, chemical, physical, hydromorphological, hydrological and hydrogeological characteristics of the basins should be considered as a whole and a management plan that includes all components should be developed to cover the whole basin or sub-basins. Preparation of Basin Protection Action Plans was initiated in 2009 and completed in 2013 for all basins (25 Basins). Basin Protection Action Plans, which are developed by setting short, medium and long-term targets on basin basis, aim to ensure controlled and sustainable use of water resources (Pulatsü et al. 2014; Birpinar and Tuğaç 2018).

The integration of climate change into European policies such as the Water Framework Directive (Directive 2000/60/EC) is in line with the river basin management planning process. In this context, studies have been carried out in river basins on the axis of climate change in recent years in our country. For example, the effects of climate change were investigated in 5 basins, namely Meriç-Ergene Basin - Asi Basin - Çoruh Basin - Aras Basin - Tigris-Euphrates Basin, and recommendations were made on what should be done in the basins by addressing the possible problems to be encountered in the future (Tokuşlu 2022). A study conducted by Topaldemir and Taş (2022) in certain wetland areas of the Yeşilırmak Delta in the Central Black Sea Region (Terme, Samsun) observed the impact of climate change over four years, focusing on rainy (November-March) and dry (June-September) seasons. The study found that shallow wetland areas holding sufficient water during the rainy season experienced loss of water during dry periods, affecting free-floating leafy aquatic plants (particularly Azolla filiculoides, occasionally Salvinia natans, and Wolffia arrhiza), while dense growth of emerald herbaceous plants (especially Ranunculus sphaerospermus and R. tricophyllus) was observed during the spring season.

Conclusion and Recommendations

Global surface temperatures are projected to increase by as much as 6.1°C by 2100 compared to pre-industrial levels in the worst-case scenario, posing challenges for freshwater lake managers in meeting water quality requirements under the EU Water Framework Directive (WFD) and other international standards (Rolighed et al., 2016). While it's inevitable for lake managers to face challenges when multiple stressors and climate change interact, it has been reported that complex lake ecosystem models can assist in developing preventive management plans against eutrophication symptoms. Increased nutrient inputs and rising temperatures tend to exacerbate eutrophication symptoms synergistically.

Mooij et al. (2005) highlighted the need for lake managers to mitigate the observed and predicted climate change impacts on most man-made shallow lakes in the Netherlands through regulations such as nutrient load reduction, coastal zone development, lake subdivision and fisheries management. Jeppesen et al. (2009) suggested that reducing critical loads is essential for maintaining good ecological status in lakes with a warmer future climate, while Jeppesen et al. (2017) emphasized that a prerequisite for successful restoration in all climate regions in the long term is sufficient reduction of external nutrient loading. In the temperate northern region, measures such as improved phosphorus cycling in agriculture, reduction of loading from point sources, and (re)creation of wetlands and riparian forests are initiatives aimed at addressing these issues. In the dry Southern Europe, particularly in irrigation, there is a need for restrictions on water use by humans. Jeppesen et al. (2020) emphasized the need for collaboration among hydrologists, ecologists, modelers, economists, engineers, social scientists, both locally and globally, to provide effective reduction solutions. They also highlighted the importance of strong engagement from policymakers, NGOs, and local citizens.

The impact of climate change on water resources is also tried to be controlled by a number of legal regulations. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by two United Nations organizations, the World Meteorological Organization and the United Nations Environment Programme, to assess the risks of climate change caused by human activities. One of the main activities of the Panel is to publish special reports on issues related to the implementation of the United Nations Environmental Convention on Climate Change. Turkey's 8th National Communication Report covering the years 2019-2022, prepared in accordance with the United Nations Framework Convention on Climate Change (Anonymous 2023), includes various sections such as national circumstances, mitigation and adaptation policies, current projections, climate change impacts and adaptation, finance, and education. The report indicates that the water resources sector in Turkey is highly sensitive to climate change impacts that could affect other sectors as well, emphasizing the need for comprehensive measures to adapt to these changes. Within the scope of the report, it was reported that the risk of drought in water resources in the Western Marmara Region, southern provinces of Central Anatolia, Eastern Mediterranean provinces, Southeastern Anatolia and most of Eastern Anatolia is high or very high, while the risk of drought in the coastal provinces of the Aegean is moderate.

Conservation and improvement of wetlands in Turkey serve as a potent strategy in combating climate change. The "Lakes and Wetlands Action Plan 2017-2023" was devised in Turkey under the guidance of the Directorate General of Water Management, aiming to achieve holistic preservation of lakes and wetlands while maintaining a delicate equilibrium between conservation and utilization. Directive 2017/1 pertaining to the "Lakes and Wetlands Action Plan" was enforced to guarantee conscientious and meticulous execution of the Action Plan by the pertinent ministries, institutions, and organizations (Anonymous 2017). A number of climate change-oriented projects are also considered in this context. For example; "Determination of Climate Change Mitigation Potentials of Lake Yeniçağa (Bolu) and Akgöl (Konya) Wetlands Project"and "Preparation of the Van Lake Drought Management Plan Project" (Anonymous 2018).

Yılmaz and Yazıcıgil (2011) emphasized the need for basin-scale impact assessment studies using combined land surface and regional climate model outputs to better assess the evolving impacts of global warming on both the quality and quantity of water resources. In the context of managing lakes in the face of climate change, it was emphasized that efforts should be made to minimize groundwater pumping for irrigation and reduce water consumption by humans and animals that depletes water from wetland ecosystems. There was particular emphasis on the importance of using climate scenarios to assess potential future hydrological changes (Anonymous 2022c). A simulation project was initiated in February 2020 at METU Ankara and Mersin campuses in Turkey to understand the responses of Anatolian lakes to climate change and increasing salinization events. Ertürk (2023) proposed an analytical simulation model that can specifically demonstrate the effects of climate change on wetland and freshwater ecosystems in the presence of other pressures.

Based on this study, it is possible to say that there are limited recent studies in the literature regarding the impact of climate change on lakes in Turkey, and generally, climate change has negatively affected the volume, size, and areas of lakes in Turkey. Additionally, researchers commonly agree that our lakes are under pressure from various sources of pollution, both point-source and non-point-source, attributed to climatic factors as well as anthropogenic activities. In this context, the phenomenon of climate change, being one of the significant risk factors threatening freshwater ecosystems, should not be overlooked, and long-term, rational lake management plans and practices need to be implemented. Additionally, projects focusing on the impact of climate change on lakes should be supported within national climate change action plans.

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Chapter 3

EFFECT OF HOT PRESS SPEED ON SOME MECHANICAL PROPERTIES OF PARTICLEBOARDS

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4 Yıldız Integrated Mudurnu Particleboard Factory

1. Introduction

Wood has been utilized for a different of purposes since the beginning of human history, and its applications have grown significantly as technology has advanced. Wood, which is used for building and fuel, plays a vital role in human existence due to its vast range of applications (Ergun, 2021). Solid wood and its products are widely employed in many applications (Aydın, 2016).

Wood is a commonly utilized industrial material owing to its numerous good qualities. Nowadays, when forests are quickly vanishing, it is necessary to use their derivatives instead of solid wood components as much as feasible (Ergün and Özlüsoylu, 2022). Therefore, particleboard, fiberboard, veneer, plywood, etc. are commonly demanded in the furniture sector. It has become a fundamental element of our life (Yiğittap, 2016). Particleboard is a material typically made from wood chips or small particles that are bonded together with a synthetic resin or suitable adhesive under heat and pressure to form large, flat boards . This material is commonly used in both building construction and furniture manufacturing (Akyüz, 2004; Gözalan, 2016; Ergün et al., 2023).

The usage of wood products has expanded globally in tandem with industrial progress, and wood raw resources, which were plentiful a century ago, started to become rare around the end of this century (Yildirim et al., 2020). However, today's raw materials cannot be used to their full potential. These include low-grade wood, invasive tree species, afforestation thinning, sawmill waste residues, plywood remnants, and processing residues such as sawdust, wood chips, and shavings (Ergün et al., 2024). However, because of the biological, physical, and chemical characteristics of the cell wall that creates them, these raw materials with a ligno-cellulosic structure have strong physical and mechanical capabilities independent of their shape. Furthermore, their significance as industrial raw materials is further increased by their plentiful and extensive presence on Earth and their renewable nature (Eroğlu and Usta, 2000).

The wood-based board industry has had a very quick growth in development and production volumes due to the emergence of new end-user needs and preferences brought about by today's growing population and economic advancements. Following this procedure, Turkey has emerged as the world's leading producer of boards (TOBB, 2011; Yıldırım et al., 2016). The acceptance of board products has aided in the growth of the board industry, especially in the furniture sector, which is pervasive in everyday life and is producing more goods (Serin et al., 2014; Serin and Şahin, 2016; Şahin and Serin, 2016).

The majority of wood-based board firms in Turkey are among the most significant in the world and Europe in terms of production quantity and product quality. Turkey ranks first in Europe and second in the world in MDF/HDF in terms of production quantities, second in Europe and third in the world in laminate flooring, third in Europe and fifth in the world in particleboard. In addition, it ranks fifth in the world and second in Europe in the wood-based panel production sector (OAIB, 2015; İstek et al. 2017).

In particleboard manufacture, there are essentially three production methods. These include the fabrication of molded particleboards, vertical particleboards, and flat particleboards. All manufacturing techniques include essentially the same procedures. The method of pressing, the manner of laying, or the binder used all account for the variations. The boards are referred to as either vertical or horizontal particleboard depending on how they are pressed. Despite the fact that the pressing technique is used horizontally in each case, variations in the laying procedure allow for the production of single-, multi-, and orientated boards. Special molds are used to press molded particleboards into the desired final form of the product. Cementations' or gypsum particleboard is the term for the boards made when cement and plaster are employed as adhesives. The steps of particleboard manufacture are essentially the same, except from certain variations. Normal particleboard chip dimensions are as follows: length is 10–25 mm, width is 2–6 mm, and thickness is 0.25–0.40 mm (Güller, 2001).

1.1 Pressing Process in Particleboard Production

One of many spreading techniques is used to distribute the chips, creating a thick, loose mat. The thickness of the mat is around twenty times that of the finished board. The tiny chip fragments in this loose mat tend to settle at the bottom if it is disturbed in any manner, giving the boards an uneven look and changing mechanical characteristics. There are two different pressing methods used: hot pressing and cold pressing. Heat loss and a longer pressing time occur when the board mat is put straight to the hot press because of the increased space between the press layers. Pre-press is another term for the cold press (Yiğittap, 2016).

Pre-pressing (Cold Press)

A cold press compresses the chip mat after it has been distributed into shape molds or edge frames. The cold press not only compacts the board but also enables the air to escape. There is no shipping or press boards required when transferring a cold-pressed mat to a hot press. The pre-press pressure should be 15-20 kp/cm^2 (Güller, 2001).

Figure 1: Pre-pressing (Aydın, 2016).

There are two categories of cold presses: continuous and intermittent. Pre-presses may be made up of pressure rollers or hydraulic presses with a single aperture. The aims of the cold pressing process are:

1. Maintaining clean edges throughout the chip mat-forming process

2. Cutting waste during edge trimming procedures

3. Improving the interlocking between the surface and core layers are the goals of the cold pressing process

4. To reduce the amount of time the hot press closes and to avoid chip displacement brought on by vibrations when the board mat is being transported to the hot presses (Güller, 2001; Karakuş, 2007).

Hot Pressing

In single-layer presses, just one board is pushed during each pressing cycle, but multi-layer presses include between four and twenty-two press layers. Hydraulic pressure is used to presses (single or multi-layer). The press plates may be heated with hot water, steam, oil, or high frequency. The press temperature ranges from 150 to 220 °C, depending on the kind of adhesive employed. The period varies from 3 to 7 minutes, depending on the adhesive's curing time and board thickness (Akbulut, 2000). The closing time of the press (the time it takes for the press plates to compress the mat to the board thickness) is critical to the board's resistance qualities. A shorter closure time causes the top layers to have a greater density than typical, whereas the core layer has a lower density. This improves surface smoothness and bending resistance, but reduces the surface's perpendicular tensile strength. Inadequate particular pressure, temperature, and time may cause the boards to explode. The press plates used for pressing serve two functions: thermal and mechanical.

The thermal function heats the board mat to cure the adhesive, while the mechanical function compresses it to the desired thickness (Karakuş, 2007).

In continuous presses (Figure 2), an operator in the control room enters data such as temperature, pressure, and pressing factor into the computer, letting the machine to function automatically while monitoring production via the monitor. Continuous presses differ from multi-layer presses in that they produce continuously. The continuous method uses a circular saw to trim the mat to conventional lengths after pressing, rather than sizing it before entering the press (Ayrılmış, 2000).

Figure 2: Continuous press (Aydın, 2016).

The mat's moisture content, board thickness, press temperature, and press closure speed all affect how long the pressing process takes. The adhesive hardens under the effect of press pressure and temperature, creating a stable substance, as pressing duration and moisture content change (Güller, 2001). The hot press's capacity affects a particleboard plant's capacity as well. There are four connected steps in hot pressing:

1. Compressing the particleboard mat from the cold press to the desired board thickness within tolerance limits,

2. Applying the pressure required to ensure adhesion between individual particles,

3. Heating to the desired bonding temperature and reducing the board moisture through evaporation,

4. Compressing and bonding the loose particles to the desired density.

The critical factors to consider in hot pressing are as follows (Aydın, 2016):

- The ratio of particle mixture in the board mat,
- Press temperature,
- Press pressure,
- Chemical reactions,
- Press time.

2. Material and Method

In this study, the effect of changing the hot press speed on some mechanical properties of particleboards, provided that other conditions were constant, was examined. For this purpose, particleboard with a density of 600kg/m^3, a thickness of 18 mm, dimensions of 2100x2800 mm and 2100x3660 mm was produced on the production line of a company that produces particleboard. The mechanical properties of the particleboards were determined in the quality control laboratory of the same enterprise. In the production of particleboards; Chips obtained from larch, poplar and fir wood were used in various proportions. To reduce the moisture-induced thickness increase of particleboards, 60% white colored paraffin emulsion was used as a hydrophobic substance. In addition, a 25% solution of ammonium sulfate was used as a curing agent in the outer layer and middle layer, at a rate of 1-2% by weight of completely dry adhesive. As an adhesive, E1 type urea formaldehyde adhesive (UF) with 1.12 moles of solids and 65% solids was used in the surface layers, and E2 type UF adhesive with 1.25 moles of solids and 65% solids was used in the middle layer.

2.1 Three-layer Board Production

Particleboard production was carried out on the production line of the enterprise according to traditional particleboard production principles. The chips were processed from the raw material area and delivered to the chipping unit. Wood and logs were taken for chipping according to the jaw opening capacity of the rough chipping machine. Coarse chips were transported by conveyors to silos that fed chips to Pallmann mills for fine chipping. Coarse chips were turned into fine chips in Palmmann mills to the desired thickness. The thinned chips were carried to the wet chip silo by conveyors, and from there they were transported again to the dryer entrance by conveyor.

The chips were dried to 1.8% moisture in a rotary drum dryer with a dryer inlet temperature of 350-400 ^{0}C and an exit chimney temperature of 130-133 ^{0}C. The chips coming out of the dryer were first passed through shaker sieves and sorted. Here, chips are divided into unwanted coarse chips (oversized), middle layer chips, outer layer chips and powder. Oversized chips were transported to the mill to be ground again. The middle layer chip was moved to its own silo, the outer layer chip was moved to its own silo and the powder was moved to the powder silo to be burned. The chips sent from the shaker screens to the silos were then transported to the laying line for the laying process. While the outer layer chips are laid by the pneumatic method, the middle layer chips were laid according to the mechanical method.

The mate formed in the laying line is passed through a pre-press (cold press) to reduce the thickness of the mate and the air in the mate is expelled. In hot pressing, the mate remained in the press at different speeds (340, 360, 380 and 400 mm/sec) in the endless press, passed through changing temperature groups and came out of the press endlessly. The endless particleboards coming out of the hot press was cut to the desired dimensions with cross saws, its sides were cut and transported to the star cooler. There were 2 star coolers and the boards took a turn in the 1st star, they moved to the 2nd star. Here, after a tour, they were moved to the stacking tables to be stacked on top of each other. Here, the stacked boards are transported by forklifts, first to the warehouses, and then to the sanding machine for sanding. The production conditions of the test boards are given in Table 1.

Table 1. Production conditions of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)
600	18*2100*2800	340
		400
	18*2100*3660	360
		380

2.3 Determination of Board Properties

The mechanical properties of the particleboards were determined according to the standards specified in Table 2, and the effect of hot press speed variation on the mechanical properties was investigated.

Table 2. Standards used to determine the mechanical properties of particleboards

TS EN No	TS EN Definition	Test Name
TS EN 310 (1999)	Wood- Based panels- Determination of modulus of elasticity in bending and of bending strength	Bending strength determining
TS EN 311 (1999)	Wood-based panels - Surface soundness - Test method	Surface soundness determining

TS EN 319 (1999)	Particleboards and fibreboards- Determination of tensile strength perpendicular to the plane of the board	Internal bond (IB) strength determining
TS EN 320 (2011)	Fibreboards; determination of resistance to axial withdrawal of screws	Withdrawal of screws determining

3. Result and Discussion

3.1. Internal Bond (IB) Strength

The average internal bonding strength (IB) strength values of the particleboards are given in Table 3.

Table 3. IB results of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)	Internal bond strength (N/mm^2)
600	18*2100*2800	340	0,45
		400	0,36
	18*2100*3660	360	0,44
		380	0,42

When Table 3 is examined, , the IB values drop as hot press speed increases for the dimensions of 18 * 2100 * 2800 mm. Likewise, a reduction in IB resistance was recognized in the boards manufactured with 18 * 2100 * 3660 mm dimensions, although a smaller decrease than in the preceding group. This situation might be because the adhesive is unable to create a strong enough internal connection and the amount of time the boards spends in the hot press decreases as hot press speed increases. Figure 3 shows how IB resistance changes in response to various press speed.

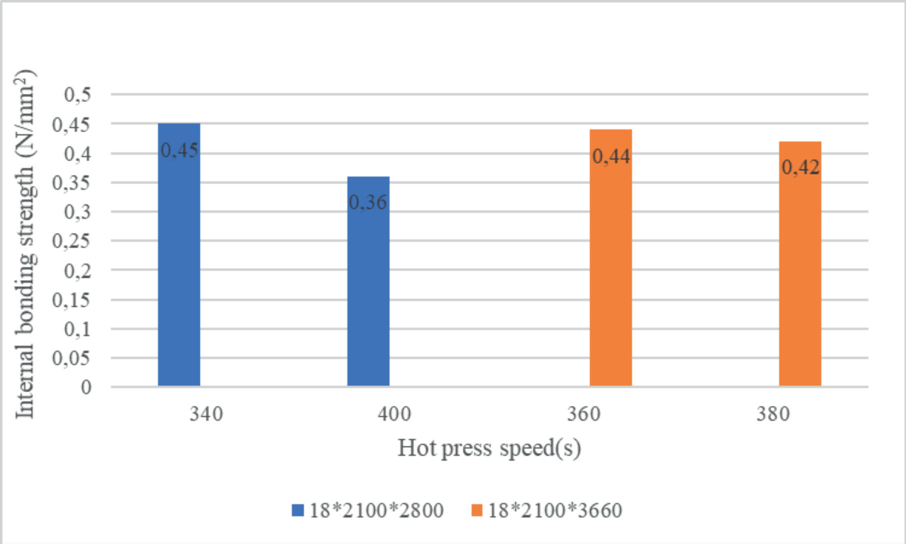

Figure 3. Effect of different hot press speed on IB value

3.2 Bending Strength

The average bending strength (BS) values of the particleboards are given in Table 4.

Table 4. BS results of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)	Bending strength (N/mm^2)
600	18*2100*2800	340	11,95
		400	12,18
	18*2100*3660	360	12,88
		380	12,59

Examining Table 4, it can be shown that given the dimensions of 18*2100*2800 mm, the BS strength rises as hot press speed increases. Conversely, it is known that as hot press speed increases, the BS for boards made with dimensions of 18*2100*3660 mm falls. Figure 4 shows how the BS varies with different hot press speed.

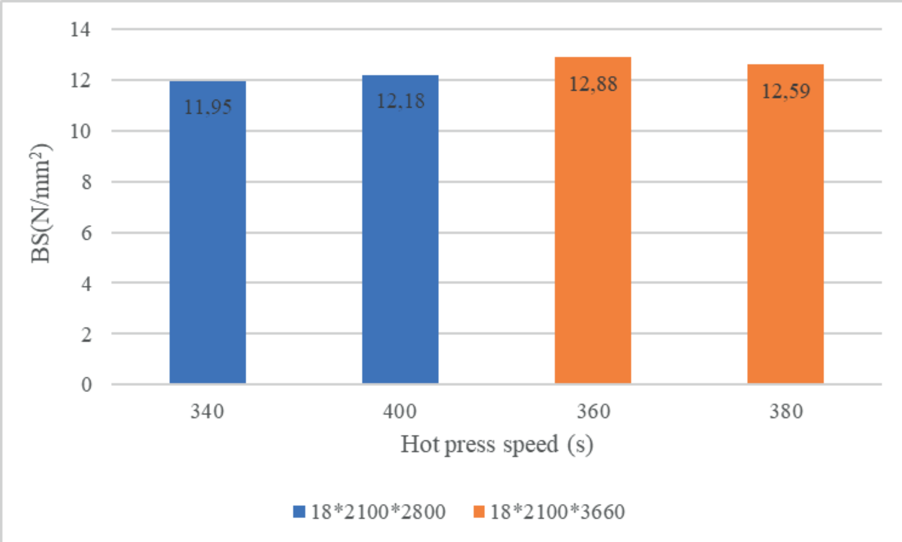

Figure 4. Effect of different hot press speed on BS value

3.3 Surface Soundness

The average surface soundness (SS) values of the obtained test samples are given in Table 5.

Table 5. SS results of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)	Surface soundness (N/mm^2)
600	18*2100*2800	340	1,03
		400	1,14
	18*2100*3660	360	1,14
		380	1,15

When Table 5 is examined, SS were increased with increasing hot press speed for dimensions of 18 * 2100 * 2800 mm. Similarly, SS of 18 * 2100 * 3660 mm dimensions boards were increased with increasing hot press speed. The change in SS according to different hot press speeds is given in Figure 5.

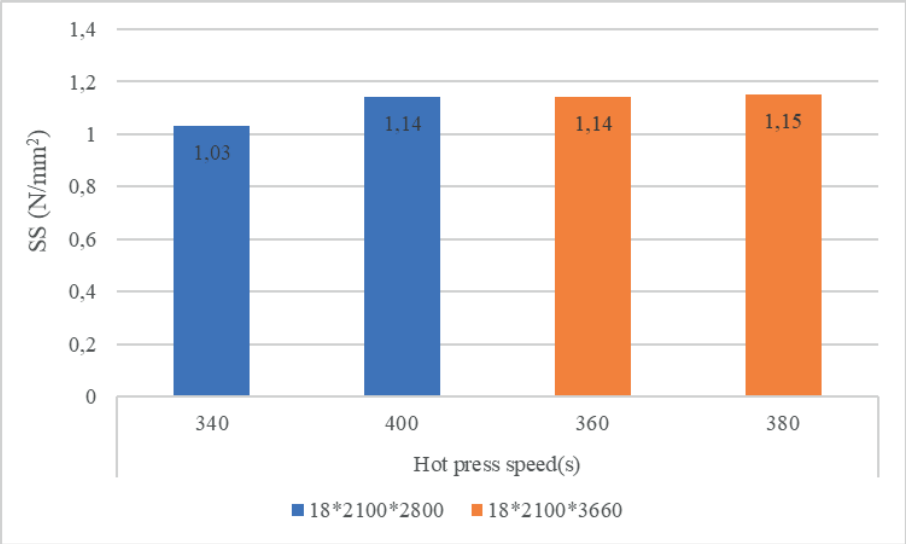

Figure 5. Effect of different hot press speed on SS value

3.4 Edge Screw Withdrawal Strength

The average edge screw withdrawal strength (E-SWS) values of the test samples are given in Table 6.

Table 6. E-SWS results of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)	Edge screw withdrawal strength (N/mm^2)
600	18*2100*2800	340	1113
		400	904
	18*2100*3660	360	945
		380	994

It is observed that an increase in hot press speed results in a decrease in E-SWS resistance for boards with dimensions of 18*2100*2800 mm in Table 6. On the other hand, E-SWS resistance of 18 * 2100 * 3660 mm dimensions boards was increased with increasing hot press speed. The variation in E-SWS resistance with different hot press speeds is given in Figure 6.

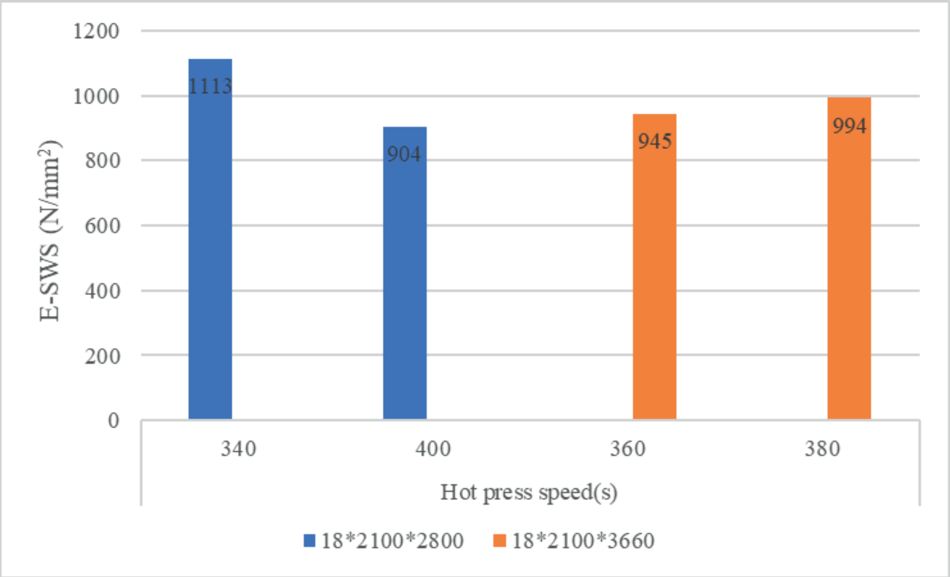

Figure 6. Effect of different hot press speed on E-SWS value

3.5 Surface Screw Withdrawal Strength

The average surface screw withdrawal strength (S-SWS) values of the test samples are given in Table 7.

Table 7. S-SWS results of test samples

Board density (kg/m^3)	Board dimensions (mm)	Hot press speed (sec)	Surface screw withdrawal strength (N/mm^2)
600	18*2100*2800	340	745
		400	630
	18*2100*3660	360	709
		380	711

Table 7 shows that for boards of 18*2100*2800 mm, a higher hot press speed caused the S-SWS resistance to decrease. On the other hand, an increase in hot press speed causes an increase in S-SWS resistance for boards that are manufactured with dimensions of 18*2100*3660 mm. Figure 7 shows how S-SWS resistance varies with hot press speed.

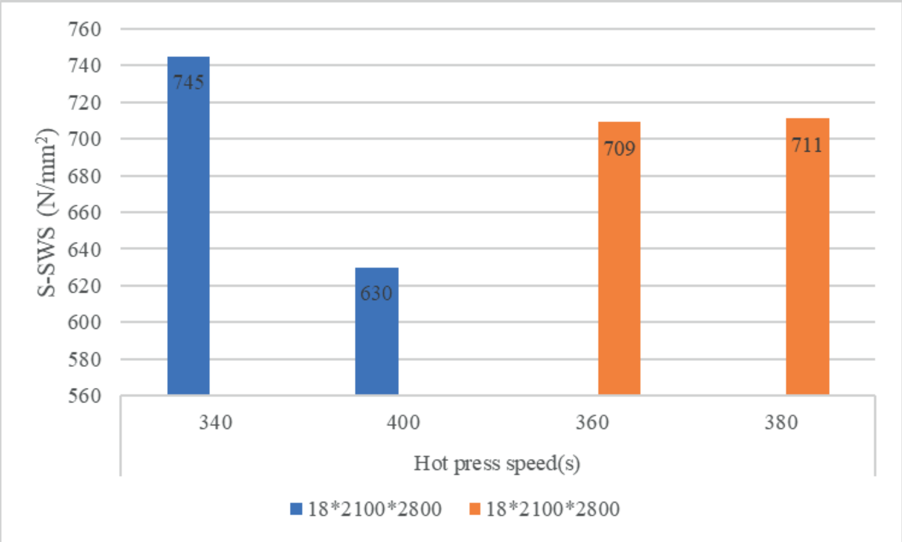

Figure 7. Effect of different hot press speed on S-SWS value

Conclusion

In this study, the effect of different hot press speed on the mechanical properties of particleboards, specifically internal bond (IB) strength, bending strength (BS), surface soundness (SS), and edge and surface screw withdrawal strengths (E-SWS and S-SWS), was investigated under constant conditions.

For boards with dimensions of 18*2100*2800 mm, an increase in hot press speed resulted in a decrease in IB values. Similarly, for boards with dimensions of 18*2100*3660 mm, although the reduction was less pronounced, a decrease in IB strength was observed. An increase in hot press speed led to an increase in BS strength for 18*2100*2800 mm boards, while a decrease in BS strength was observed for 18*2100*3660 mm boards. For both sets of dimensions, an increase in hot press speed resulted in an increase in SS strength. Regarding E-SWS resistance, an increase in hot press speed caused a decrease for 18*2100*2800 mm boards, whereas an increase was observed for 18*2100*3660 mm boards. Similarly, an increase in hot press speed resulted in a decrease in S-SWS resistance for 18*2100*2800 mm boards, while an increase was observed for 18*2100*3660 mm boards. Selecting the hot press speed according to the desired properties for the intended use of the particleboards will provide benefits in terms of both quality and cost.

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Chapter 4

PARASITE DIVERSITY OF FISHES IN TÜRKİYE – VII. ARTHROPODA

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1. INTRODUCTION

Arthropod parasites, including copepods, branchiurans, and isopods, pose significant challenges to the aquaculture industry, leading to substantial economic losses. These parasites directly cause issues such as skin ulceration, osmotic imbalance, physiological stress, and immunosuppression (Walker et al., 2004, Lester and Hayward, 2006). These ectoparasites attach to the gills, body, and fins of fish hosts. Large crustacean ectoparasites such as *Argulus* (fish lice), *Caligus* (sea lice), *Lernanthropus* species, and isopods have well-developed attachment organs and mouthparts, causing significant damage at the sites where they attach and feed (Sethi, 2016). *Ergasilus, Lernaea*, and *Argulus* are three main genera of economic importance (Klinger and Floyd, 2002). Caligids in marine environments are also known to cause several conditions from mild skin damage to stress-induced mortality in fish (Costello, 2006). Significant primary damages caused by these ectoparasites in the form of skin lesions also predispose secondary systemic bacterial and fungal pathogens into host fishes (Sethi, 2016).

Copepoda parasites are widely represented by the members of the family Ergasilidae, Lernaeidae, Caligidae, Pennellidae, and Lernaeopodidae, with some species such as *Ergasilus sieboldi, Lernaea cyprinacea, Lepeophtheirus salmonis, Caligus elongatus, Lernaeocera branchialis*, being distributed worldwide. A branchiuran *Argulus foliaceus* is also one of the best-known freshwater fish parasites infesting mainly cyprinids. Among isopod parasites of fish, members of the family Cymothoidae are widely distributed in marine environments with a few occurring in freshwater environments. Members of the family Gnathiidae, the blood-feeding isopods, infest many species of marine and estuarine teleosts and elasmobranchs (Lester and Hayward, 2006). The life cycle of copepods includes different developmental stages of nauplius, copepodid, chalimus, preadult, and adult. The host range of the parasites differs at the species level, some have strict host preferences such as *Lepeophtherius salmonis* which is largely restricted to the Salmonidae, and *Argulus foliaceus* which has a broad host range belonging to many host families (Lester and Hayward, 2006).

Research on arthropod parasites of fish in both freshwater and marine environments in Türkiye has produced numerous papers and several comprehensive checklists (Öktener, 2003, 2005, 2014; Özer, 2019, 2020, 2022; Özer et al., 2015; Özer and Öztürk, 2017). Özer (2021) published the first comprehensive host-parasite and parasite-host checklist book in Türkiye, compiling all previous reports. This chapter on arthropod parasites of fish in Türkiye is based on the data presented in this recent book, which includes all individual publications on each arthropod parasite species.

2. ARTHROPODA DIVERSITY OF FISHES IN TÜRKİYE

Özer (2021) reported a total of 126 arthropod species from marine, freshwater, and brackish water fish species in Türkiye, accounting for 16% of all fish parasites reported in the country (Figure 1). Arthropod parasites were the third most prevalent parasitic group. Among the 126 species, the highest number was found in wild marine fish (88 species), followed by cultured marine fish and wild freshwater fish (Figure 2).

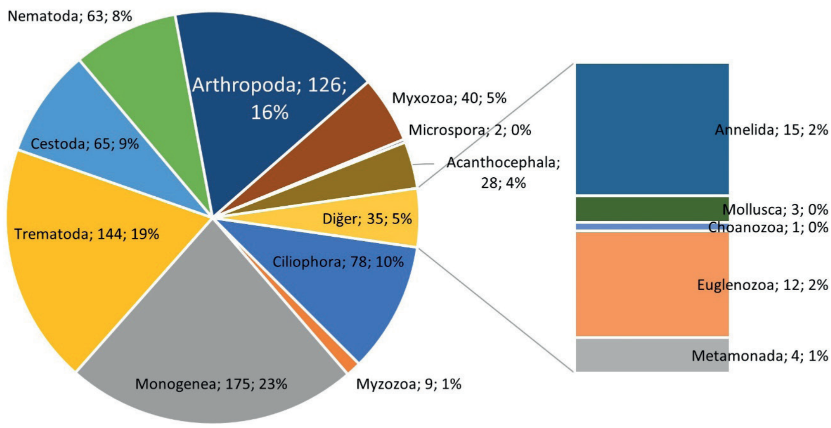

Figure 1. *Total number and percentage of arthropod parasites reported from fishes in Türkiye*

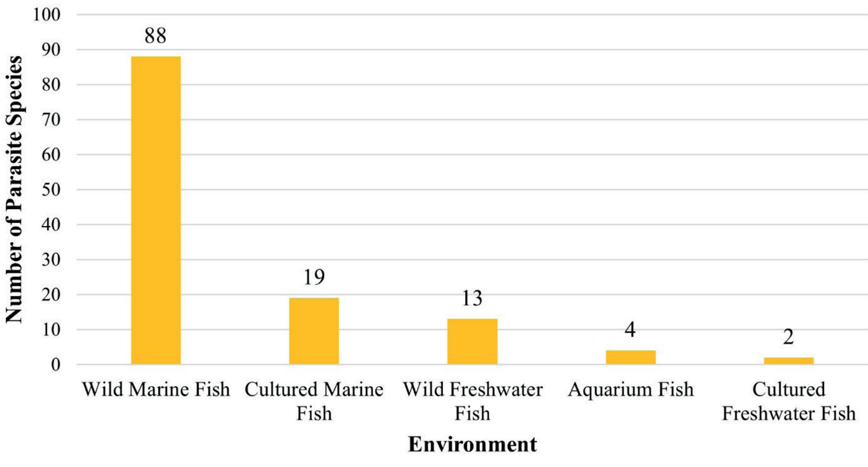

Figure 2. *The total number of arthropod species reported from marine, freshwater, and aquarium fishes in Türkiye*

3. ARTHROPODA DIVERSITY OF MARINE FISHES

3.1. Wild marine fishes

As illustrated in Figure 2, arthropod species diversity was highest in wild marine fish from the surrounding seas of Türkiye. The Aegean Sea had the greatest diversity with 17 species, followed by the Mediterranean Sea, the Sea of Marmara, and the Black Sea (Figure 3).

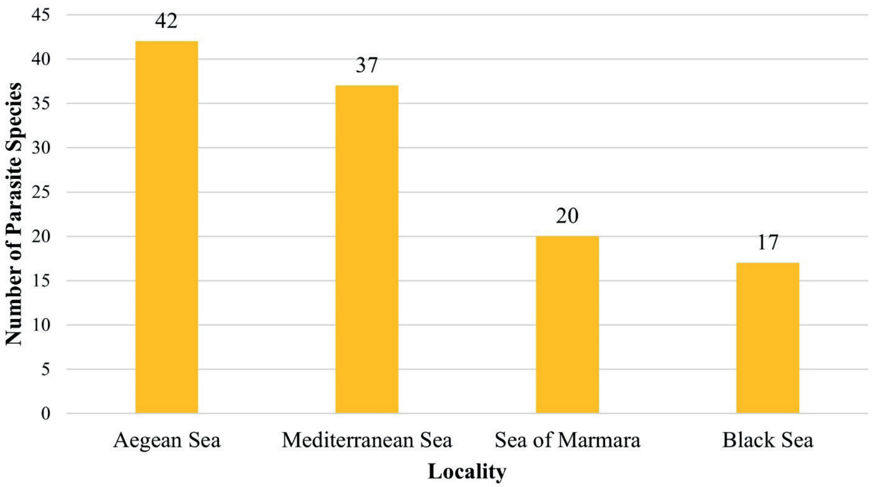

Figure 3. *The number of arthropod species reported from wild marine fish species inhabited the surrounding seas of Türkiye*

As can be seen in Figure 4, annular seabream *Diplodus annularis* and common pandora *Pagellus erythrinus* were hosts for a maximum of 9 different arthropod parasite species from the surrounding seas of Türkiye. Other fish species of flathead grey mullet *Mugil cephalus* (8), the bogue *Boops boops* (7), the blotched picarel *Spicara maena*, picarel *Spicara smaris*, seabass *Dicentrarachus labrax*, the common two-banded sea bream *Diplodus vulgaris* and striped seabream *Lithognathus mormyrus* were reported to be the host for 6 different arthropod species and the rest of fish species with lesser number of arthropods (Figure 4).

Among the arthropod species infecting marine host fish, the cymothoid isopod *Anilocra physodes* was the most frequently reported, infecting 24 different marine fish hosts. This was followed by the crustacean *Gnathia* sp, which infected 23 fish species, and the isopods *Ceratothoa oestroides* and *Nerocila bivittata*, each infecting 22 fish species. Other species had lower numbers of host species (Figure 5). Özer (2021) can be consulted for arthropod species reported from less than 3 host fish species.

3.2. Cultured marine fishes

The number of cultured fish species in Türkiye's marine environments is increasing, with seabass (*D. labrax*) being the most intensively farmed species. According to Özer (2021), seabass hosts a total of 13 different arthropod species, the highest number among cultured fish species (Figure 6). Another commonly cultured species of sea bream *Sparus aurata* hosted only two arthropod species namely copepod *Caligus minimus* and isopod *Ceratothoa aestroides*. Conversely, when examining the number of host fish species infested by arthropod parasites, *Ceratothoa oestroides* was the most commonly reported, affecting 10 different host species. This was followed by *Gnathia* sp, which was reported from 8 different host species (Figure 7). Lower numbers of host fishes infested by other arthropods can also be seen in Figure 7.

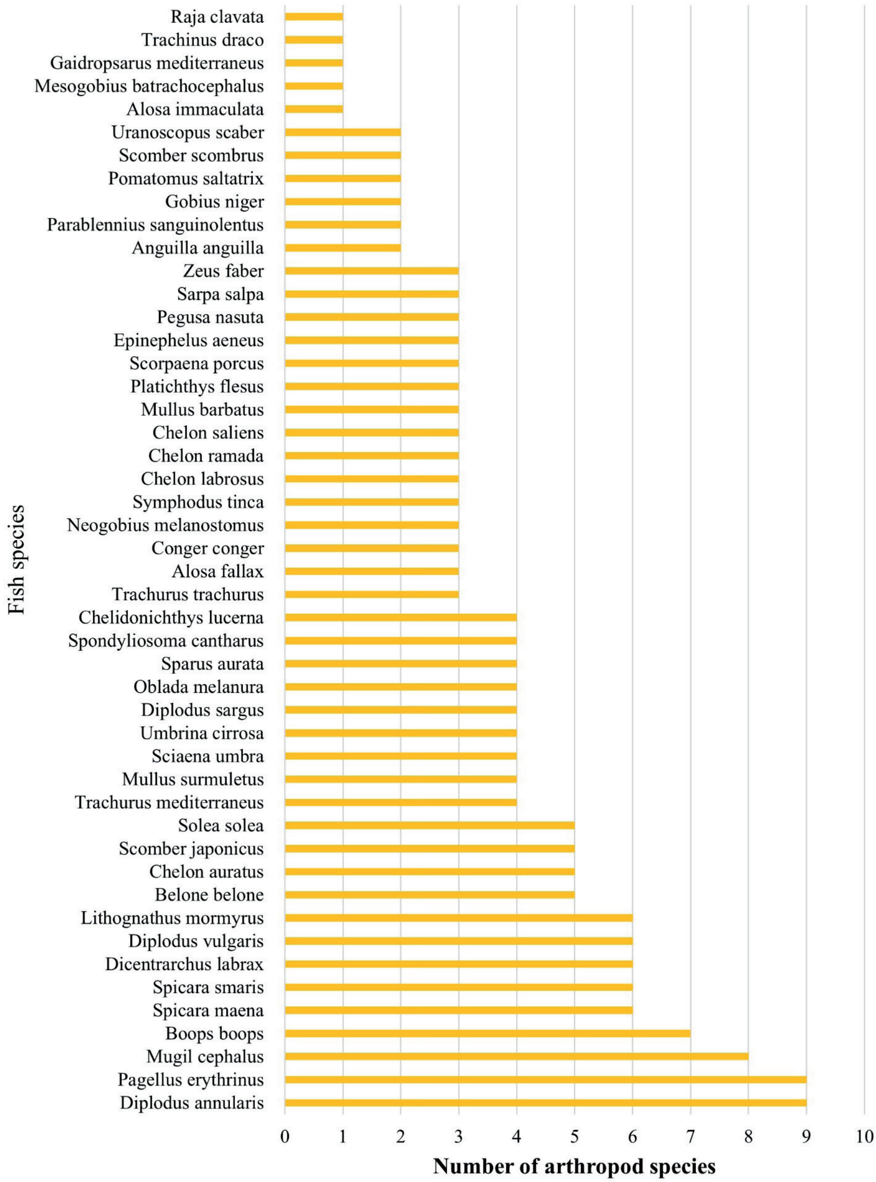

Figure 4. *The number of arthropod species infecting the wild marine host fishes in Türkiye*

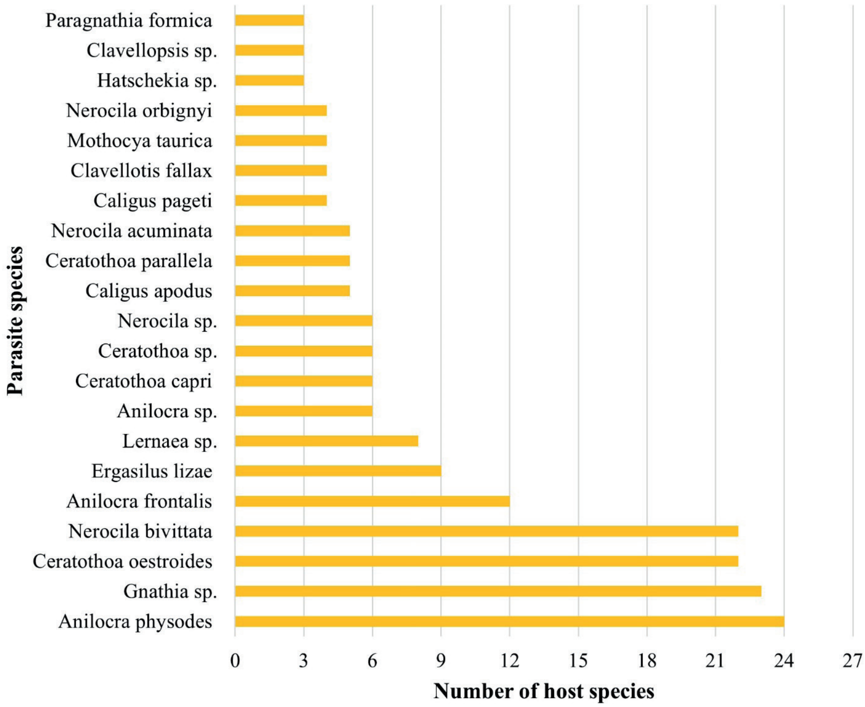

Figure 5. *The number of wild marine host fish species infested by arthropods species in Türkiye*

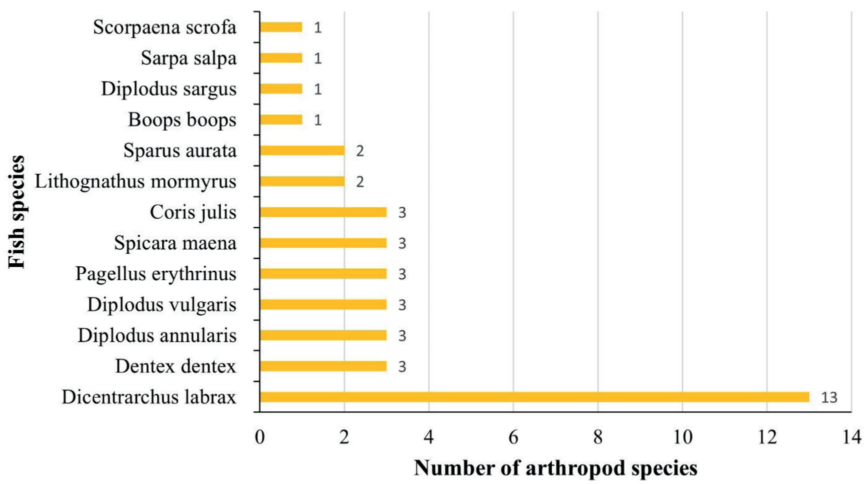

Figure 6. *The number of arthropod species infecting cultured marine fish species in Türkiye*

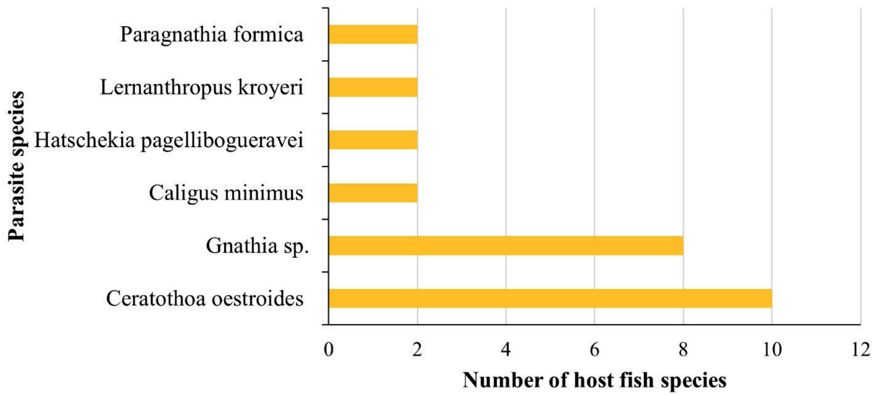

Figure 7. *The number of cultured marine host fish species infested by arthropods parasites in Türkiye*

4. ARTHROPODA DIVERSITY OF FRESHWATER FISHES

4.1. Wild freshwater fish

According to Özer (2021), 13 arthropod species have been reported from wild freshwater fish in Türkiye. Common carp (*Cyprinus carpio*) hosted the highest number with 5 species, followed by tench (*Tinca tinca*) and Wels catfish (*Silurus glanis*), each with 4 species. Other fish species had fewer arthropod species (Figure 8).

Conversely, when examining the number of wild freshwater fish species infested by arthropod parasites reported in Türkiye according to Özer (2021), *Argulus foliaceus* infested the highest number of host fish species, affecting 22, followed by *Lernaea cyprinacea cyprinacea*, which infested 18 host species (Figure 9). Arthropods infesting fewer than 5 host species can be seen in Figure 9 and as well as in Özer (2021).

4.2. Cultured freshwater fish

Rainbow trout (*Oncorhynchus mykiss*) is the predominant commercially cultured freshwater species in Türkiye, cultivated in various freshwater environments including rivers, streams, lakes, concrete pools, and cages. Following closely is the common carp (*Cyprinus carpio*), which is the second most cultured species in semi-intensive and extensive aquaculture systems across Türkiye. Despite their high production amounts over the years, parasite species are limited to only one parasite species for both fish hosts, namely *Lernaea* sp on *O. mykiss* and *Argulus foliaceus* on *C. carpio* (Özer, 2021).

5. ARTHROPOD diversity of aquarium fishes

Out of the 32 ornamental fish species in Türkiye, only 8 have been reported to harbor arthropod parasites (Figure 10). According to Özer (2021), goldfish (*Carassius auratus*) and guppy (*Poecilia reticulata*) were found to host 4 and 3 different arthropod species, respectively, in Türkiye. The remaining ornamental fish species were reported to host only one species each (Figure 10). When considering the parasitic arthropod species infesting different host species, it is evident that *Argulus* spp. and *Lernaea cyprinacea cyprinacea* infest varying numbers of host species (Figure 11).

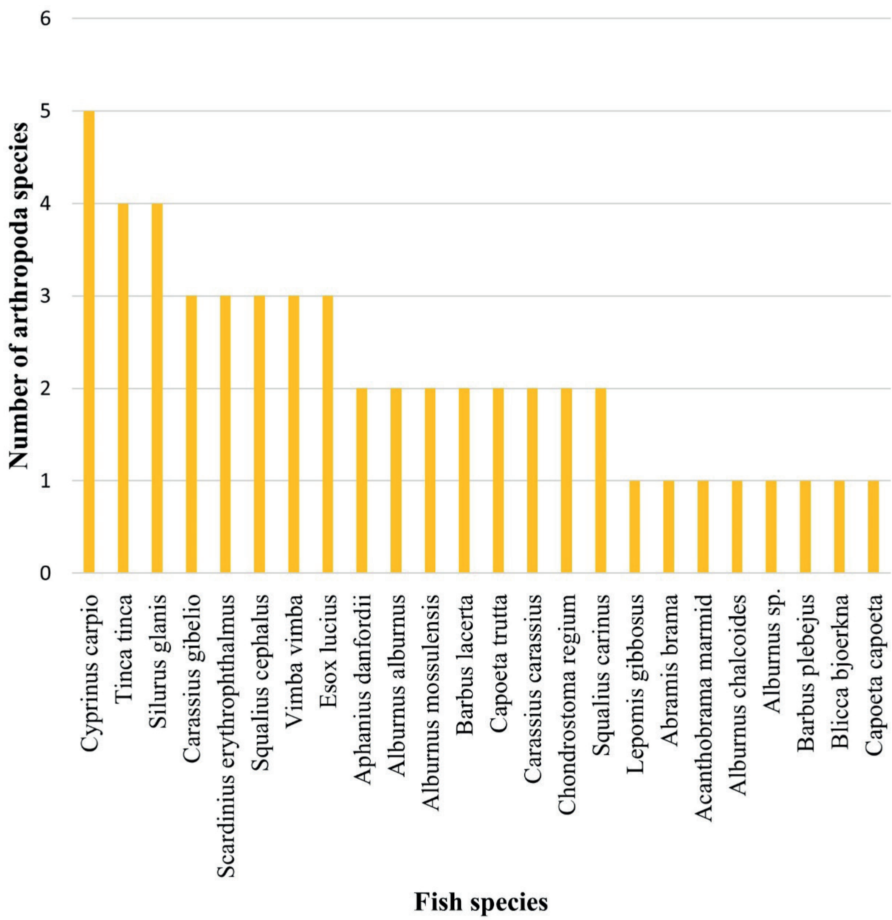

Figure 8. *The number of arthropod species infesting the wild freshwater host fishes in Türkiye*

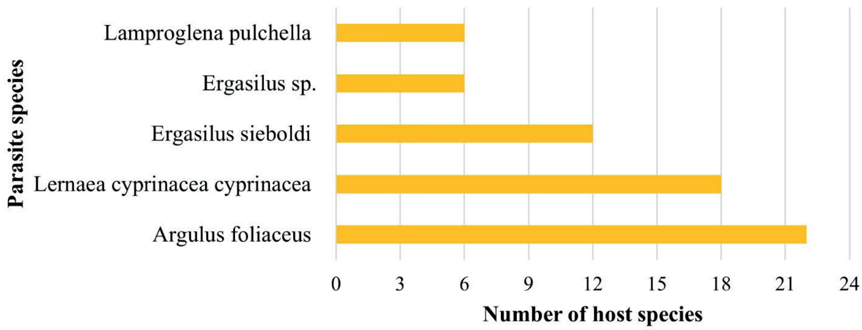

Figure 9. *The number of ≥5 wild freshwater fish species infested by arthropods in Türkiye*

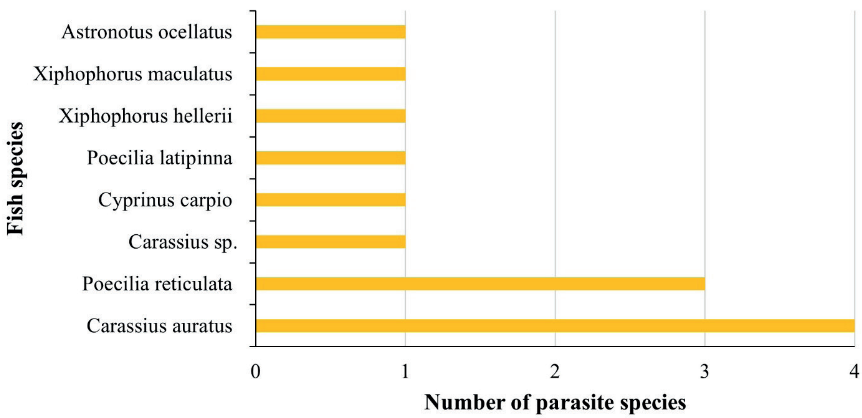

Figure 10. *The number of arthropod species infesting aquarium fishes in Türkiye*

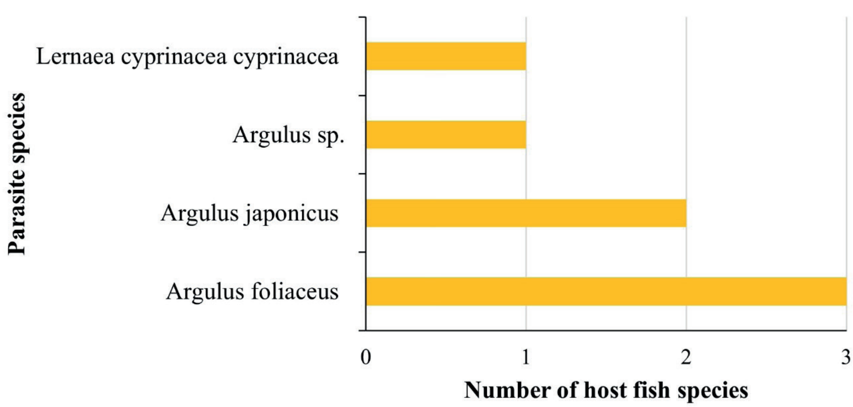

Figure 11. *The number of aquarium host fish species infested by arthropod parasites in Türkiye*

6. CONCLUSION

This chapter presents current insights into the arthropod parasites of wild and cultured fishes in marine, freshwater, and aquarium environments in Türkiye, drawing on Özer's comprehensive research (2021). The data reveal that wild marine and freshwater fishes host a diverse array of arthropod parasites, whereas cultured environments do not exhibit a corresponding increase, contrary to expectations driven by higher population densities in aquaculture facilities and other factors. Özer (2021) reports that 101 marine fish species and 42 freshwater fish species in Türkiye host arthropods, figures that appear low compared to the reported 561 marine and 401 freshwater fish species in Türkiye by Froese & Pauly (2022). The actual number of arthropod species infesting host fishes in Türkiye's marine and inland waters remains unknown, but future studies are expected to uncover more species or expand the range of host species documented.

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Chapter 5

PARASITE DIVERSITY OF FISHES IN TÜRKİYE

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VIII. NEMATODA

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1. INTRODUCTION

Nematodes are roundworms found in any body part of host fishes. They parasitize fish as either definitive or intermediate hosts depending on the species. Nematode infections can be contracted either by directly ingesting larvae or consuming an intermediate host that harbors larvae. Nematodes rely on hosts to progress through their life cycles. When fish harbor adult reproductive nematodes, they serve as the definitive host for that particular nematode species. They use intermediate hosts to undergo essential life stages before transitioning to their definitive host. Fish hosts can be used in two distinct life cycles, direct and indirect, the latter means that the nematodes use an intermediate host, whereas the direct method does not. Fish can also act as paratenic hosts not included in the life cycle completion but contain infective life stages causing diseases (url1).

Members of the genera *Anisakis*, *Contracaecum*, *Hysterothylacium,* and *Pseudoterranova* are common in the teleost fish in the Antarctic, Subantarctic, and Arctic areas (Morsy et al.2012) including Turkish marine waters (Özer, 2021; Kuran et al. 2021). Some species belonging to some genera are known to be generalist species such as *Hysterothylacium aduncum* which has been registered from many marine fish species (Andersen, 1993) and occurs in around 30 fish species some of which are from Turkish marine environments (Özer et al. 2016; Özer, 2020, 2021, 2022). *Anisakis simplex* (s.s.) is also another commonly known nematode species that has been reported from 50 pelagic, benthopelagic, and demersal teleost fishes as third-stage larvae (L3) (Mattuicci et al. 2018).

The impact of nematode-induced diseases can vary based on the nematode species, its life stage, the site of infection, and the species of the infected host fish. Nematodes commonly infect musculature, visceral organs, and tissues within the body cavity, such as the gut, pyloric caeca, liver, and mesenteries (Noguera et al., 2015; Özer et al., 2016). Certain members of the genera Anisakis, Pseudoterranova, and Contracaecum, belonging to the family Anisakidae, are responsible for anisakiasis, a fish-borne zoonotic disease that poses significant medical and socioeconomic concerns globally (Bao et al., 2019; Buchmann & Mehrdana, 2016). Anisakiasis is a potentially life-threatening disease caused by ingesting larval nematodes (L3 stage), specifically *Anisakis simplex* (As), *A. pegreffii*, and *Pseudoterranova decipiens*, typically found in fish or squid (Morsy et al., 2012; Paravettoni et al., 2012). The incidence of anisakiasis is on the rise due to the consumption of raw or undercooked seafood (Rosales et al., 1999). Globally, approximately 20,000 cases of anisakiasis are reported each year, with over 90% occurring in Japan, and significant numbers in Spain, the Netherlands, and Germany, reflecting regional fish consumption habits (Paravettoni et al., 2012).

Research on nematode parasites of fishes in both freshwater and marine environments in Türkiye has generated a substantial body of literature and multiple checklists (Öktener, 2003, 2005, 2014; Özer, 2019, 2020, 2022; Özer et al., 2015, 2016; Özer and Öztürk, 2017). Özer (2021) published the first comprehensive host-parasite and parasite-host checklist book in Türkiye, consolidating all previous reports. This chapter on nematode parasites of fishes in Türkiye is based on data from Özer's recent book, which includes detailed publications on each nematode parasite species.

2. NEMATODA DIVERSITY OF FISHES IN TÜRKİYE

According to Özer (2021), a total of 63 nematode species have been documented across marine, freshwater, and brackish water fish species in Türkiye, representing 8% of all reported parasite species in Türkiye (Figure 1). Nematode parasites rank as the sixth most prevalent parasitic group among all others. Among these 63 species, the highest number was found in wild marine fishes (36 species), followed by wild freshwater fishes and other species (Figure 2).

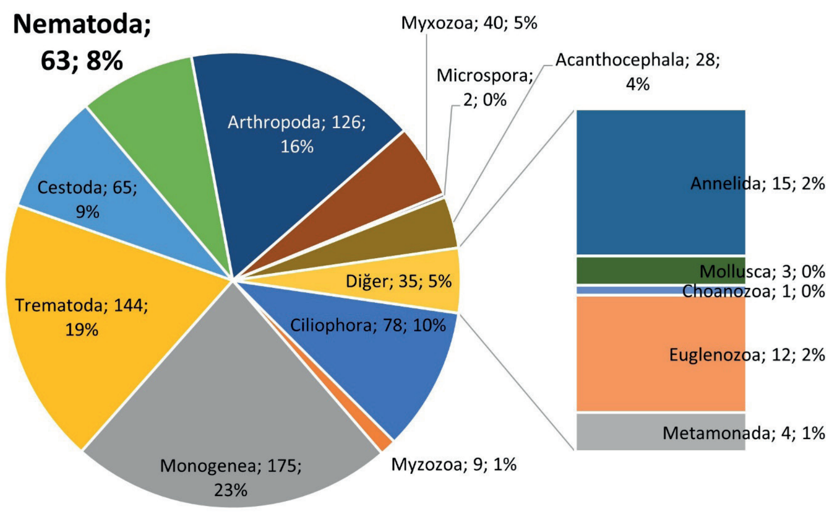

Figure 1. *Total number and percentage of nematode parasites reported from fishes in Türkiye*

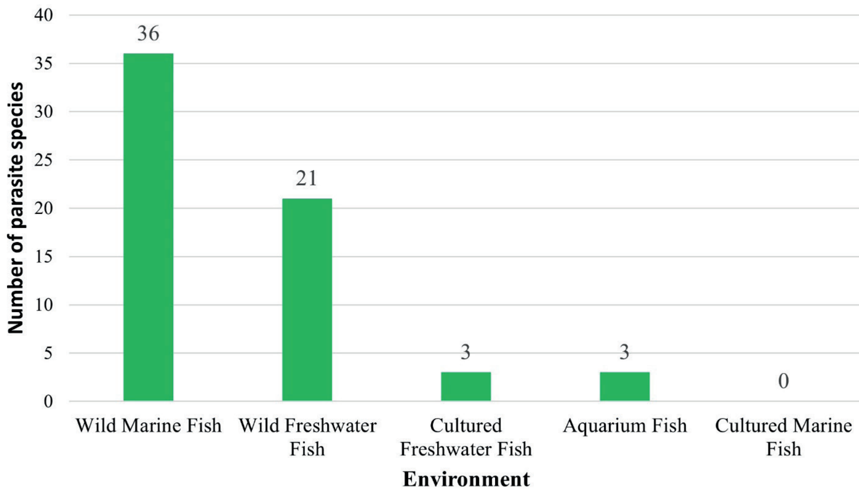

Figure 2. *The total number of nematode species reported from marine, freshwater, and aquarium fishes in Türkiye*

3. NEMATODA DIVERSITY OF MARINE FISHES

3.1. Wild marine fishes

The diversity of Nematoda species was most pronounced in wild marine fishes inhabiting the seas surrounding Türkiye, as depicted in Figure 2. The greatest diversity of nematode species was observed in the Black Sea (19 species), followed by the Aegean Sea, the Mediterranean Sea, and the Sea of Marmara (Figure 3).

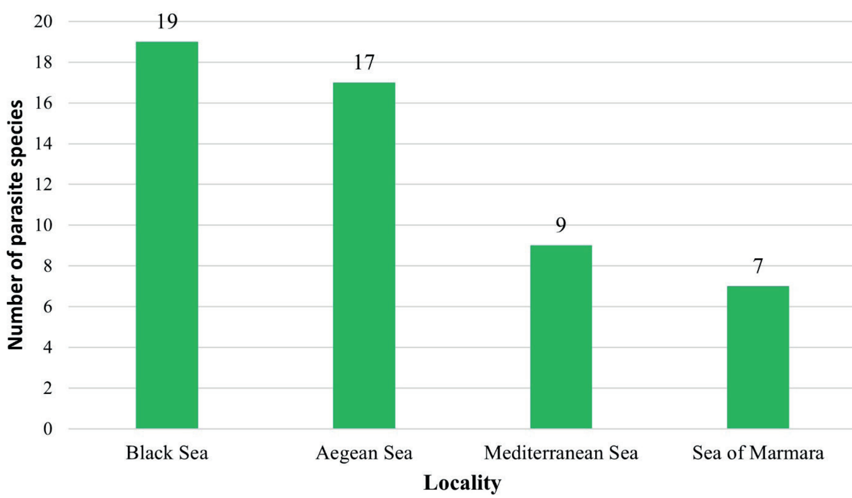

Figure 3. *The number of nematode species reported from wild marine fish species inhabited the surrounding seas of Türkiye*

As depicted in Figure 4, red mullet (*Mullus barbatus*) and Mediterranean horse mackerel (*Trachurus mediterraneus*) were hosts to a maximum of 7 and 6 parasitic nematode species, respectively, from the seas surrounding Türkiye. Other fish species of whiting *Merlangius merlangus*, shore rockling *Gaidropsarus mediterraneus*, European flounder *Platichthyes flesus* and common pandora *Pagellus erythrinus* were reported to be the host for 5 different nematode species and the rest of fish species with lesser numbers of nematodes (Figure 4).

Regarding nematode species infecting marine host fishes, Hysterothylacium aduncum was the most frequently reported species, infecting 38 different marine host species. It was followed by *Anisakis simplex, Hysterothylacium fabri*, and *Hysterothylacium* sp, reported from 22, 18, and 16 host species respectively. Other species were reported from fewer host species (Figure 5). Özer (2021) can be consulted for nematode species reported from less than 3 host fish species.

3.2. Cultured marine fishes

Despite the increasing diversity of cultured fish species in Türkiye's marine environments, no nematode species have been reported from any of these cultured fish species.

4. NEMATODA DIVERSITY OF FRESHWATER FISHES

4.1. Wild freshwater fish

According to Özer (2021), a total of 21 nematode species has been reported from wild freshwater fishes in Türkiye. Among them, rudd *Scardinius erythrophthalmus* had the highest number of nematode diversity of 6 species, followed by common carp *Cyprinus carpio* and chub *Squalius cephalus* (5), and the rest of the fish species had lesser numbers of nematode species (Figure 6).

Figure 4. *The number of nematode species infecting the wild marine host fishes in Türkiye*

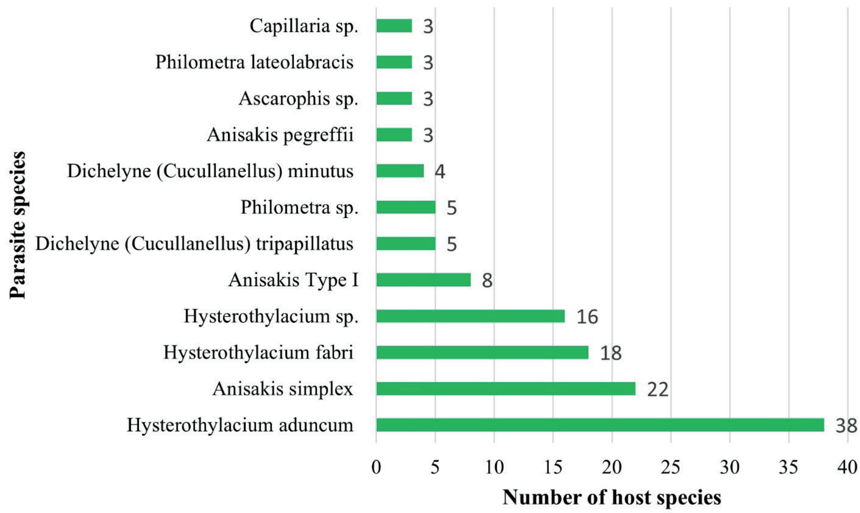

Figure 5. *The number of ≥3 wild marine host fish species infested by nematode species in Türkiye*

When the number of wild freshwater fish host species infected by nematode parasites reported in Türkiye is considered in Özer (2021), *Eustrongylides excisus* was reported from the highest number of host fish species 18, followed by *Rhabdochona denudate, Contracaecum sp.* and *Eustrongylides* sp. from 14, 11, 9 host species, respectively (Figure 7). The other nematode species infecting fish hosts were reported from 3 and lesser numbers of host species as can be seen in Özer (2021).

4.2. Cultured freshwater fish

Rainbow trout (*Oncorhynchus mykiss*) is extensively cultivated as the primary commercial freshwater species in various freshwater environments across Türkiye, including rivers, streams, lakes, and both concrete pools and cages. Despite its high production amounts over the years, only *Hysterothylacium aduncum, Hysterothylacium gadi aduncum* and *Schulmanela petruschewskii* were reported from this host species by now (Özer, 2021). However, it must be noted that *Hysterothylacium gadi aduncum* is the synonym of *H. aduncum* and the total number of valid nematode species number should be considered as only two.

5. NEMATODA DIVERSITY OF AQUARIUM FISHES

Out of the 32 ornamental fish species documented in Türkiye, only 4 have been reported to be affected by nematode parasites, as indicated by Özer (2021) (Figure 8). Among them, *Symphosodon* sp was reported to host only 2 and the other 3 fish species had only one nematode parasite species (Figure 8). Similarly, the number of ornamental host fish species is also low and Capillaria sp was reported from 3 host species while the other two nematode species was reported from only one host species (Figure 9).

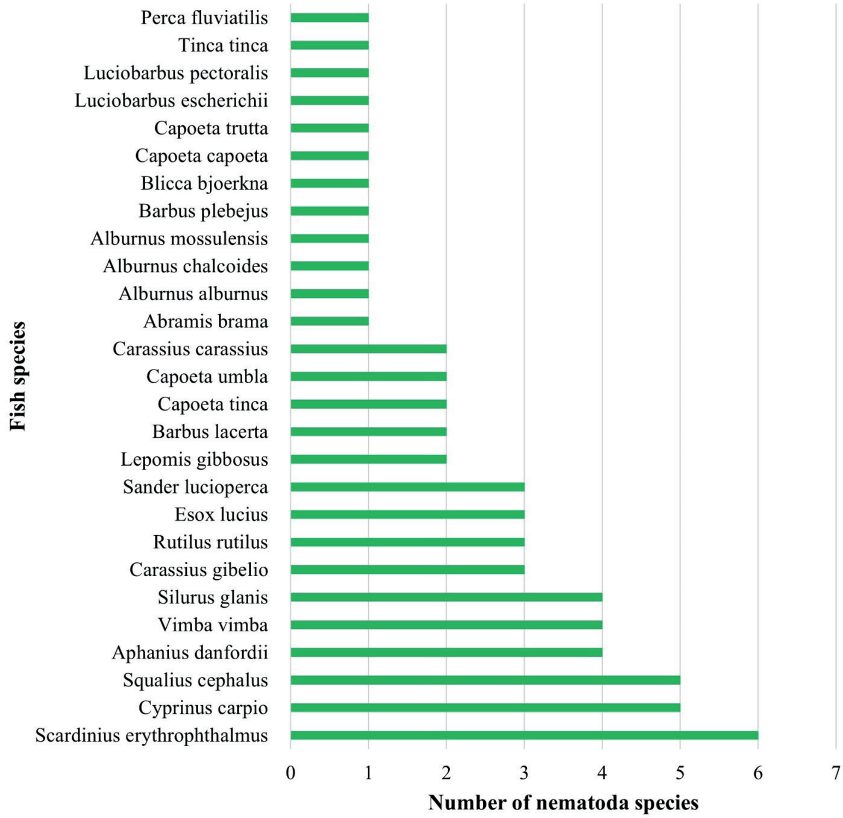

Figure 6. *The number of nematode species infecting wild freshwater host fishes in Türkiye*

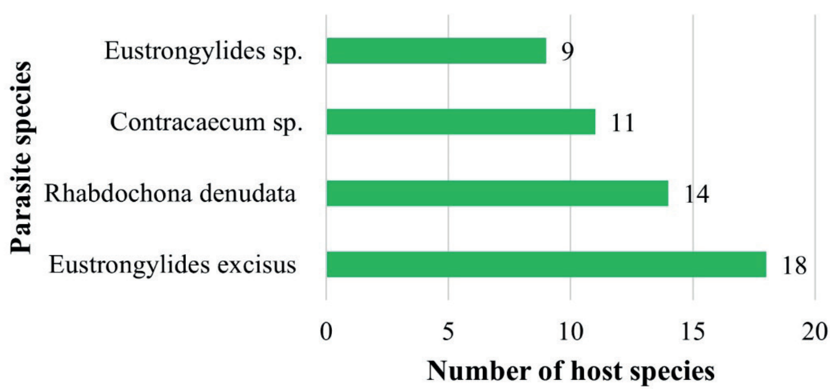

Figure 7. *The number of wild freshwater host fish species infected by nematode species in Türkiye*

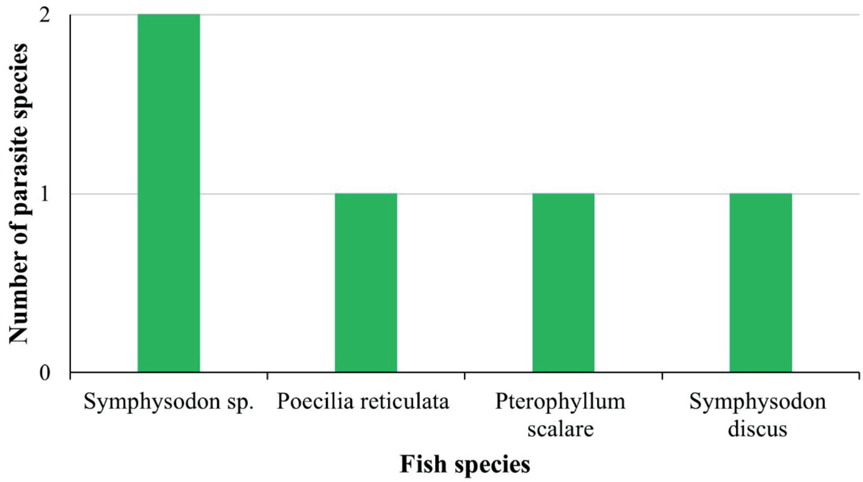

Figure 8. *The number of nematode species infecting ornamental host fishes in Türkiye*

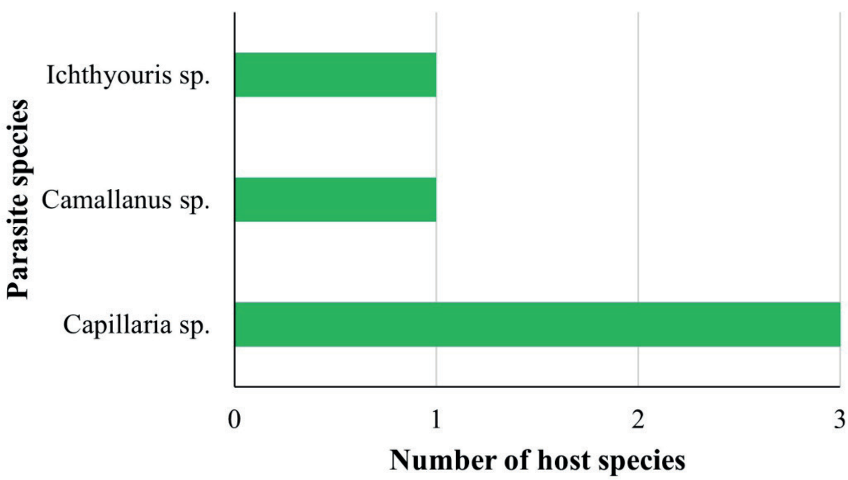

Figure 9. *The number of ornamental host species infected by nematodes in Türkiye*

6. CONCLUSION

This chapter presents the current understanding of nematode parasites affecting wild, cultured, and ornamental fish hosts in Türkiye, drawing on Özer's comprehensive research (2021). Wild marine and freshwater fish hosts exhibit greater diversity in nematode species compared to cultured and ornamental hosts. Natural environments evidently provide conducive conditions for these parasites, which have complex life cycles involving necessary alternate hosts or developmental food sources, among other factors. According to Özer (2021), nematodes infect 71 host fish species in wild marine environments and 46 in wild freshwater environments, figures that appear low considering the 561 marine and 401 freshwater fish species reported in Türkiye by Froese & Pauly (2022). The actual number of nematode species infecting fish hosts in Türkiye's marine and inland waters remains uncertain. Future studies are expected to uncover more nematode species or expand the list of host species documented.

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Chapter 6

THE EFFECTS OF YEAST FERMENTED FEED SUPPLEMENTATION AS AN ALTERNATIVE PROBIOTIC SOURCE TO QUAIL DIETS ON PERFORMANCE, FECAL MICROBIOTA AND ILEAL HISTOLOGY

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Introductıon

With the increasing population, access to the nutrients necessary for people to survive is becoming more and more difficult. In addition, food supply is not sufficient. In order to provide food supply and protein needs, it is necessary to obtain higher yields from existing animals or to increase the animal wealth. Antibiotics have been given to animals for many years to obtain higher yields, to protect the health of animals, as a yield enhancer and health protector. The use of antibiotics was banned on January 1, 2006 due to cross-effect and resistance of pathogenic bacteria in humans and animals and the lack of antibiotic effect in diseases. Instead of antibiotics, scientists have focused on probiotics, defined as CEC (Competitive Exclusive Culture), which facilitate digestion with the same effect and suppress pathogens in the intestines. The interest in probiotics is increasing day by day due to their effects such as strengthening immunity, increasing the absorption of minerals such as magnesium, calcium, zinc and removing pathogens. Yeast cells, which are resistant to acid pH (6.5-6.7) in the digestive system of poultry, are also known to have positive health effects for many animals (Ergün 2004, Yalçınkaya and Leblebicier, 2012). Especially the positive effects of Saccharomyces cerevisiae, also known as bakery yeast, have been studied by many researchers and its positive effects have been revealed (Hassanein and Soliman 2010, Coşkun 2018, Kabir, 2009; Park et al., 2002; Kim et al., 2002).

In recent years, it has been reported that products fermented with probiotics have positive effects on poultry and can be used as an alternative probiotic source in fermented products (Zhu et al., 2023; Li et al., 2020; Yaşar and Yegen 2017). Yaşar and Yegen (2017) showed that the feed prepared by fermentation of feed made from cereal flour, curdled milk and tomato pulp with *Saccharomyces cerevisiae* significantly increased the growth rate and improved feed conversion ratio on the 21st and 42nd day. Zhu et al., (2023) reported that the addition of feed obtained by fermentation of broiler diets with a mixture of *Lactobacillus plantarum*, *Bacillus subtilis*, and *Saccharomyces cerevisiae* improved the growth performance and feed utilization of broiler chicks compared to the control group. Li et al. (2020) reported that probiotic fermented feed has potential on the growth of broiler chickens. When the studies were examined, it was determined that the studies were conducted on broiler chicks and the effects of fermented feed obtained by fermentation of feed with bread yeast in quail were not determined. Therefore, the aim of this study was to determine the probiotic effects of fermented feed obtained by fermenting the ration with bread yeast in quails.

Materials and Methods

Quail chicks were reared for 21 days and sex was determined from breast feathers. A total of 120 male quails with equal body weights were selected for the experiment. This study was approved by Kırşehir Ahi Evran University Animal Experiments Local Ethics Committee with 18/04/2018/7/3 ethics committee. The feeds used in the study were obtained from a commercial feed company active in Kırşehir province. The nutrient analysis of the feeds are given in Table 1.

Table 1. Composition of the experimental diet (air-dry basis).

Ingredients	
Maize %	44.00
Soybean meal (44% CP)%	41.15
Meat-bone meal%	4.00
Soybean oil%	6.50
Dicalciumphosphate%	2.50
L-lysine HCl %	0.70
DL-methionine %	0.35
Salt %	0.30
Vitamin premix*%	0.25
Mineral premix#%	0.25
ME [kcal/kg]	100
Crude protein%	22.39
Crude cellulose%	3080
Crude fat%	8.50
Total Calcium%	2.80
Available P*%	8.50

*vitamin D3, 2.400 IU; vitamin E, 30 mg; : vitamin A, 12.000 IU; vitamin B1, 3 mg; vitamin B2, 7 mg; vitamin B6, 5 mg; vitamin B12, 15 µg; vitamin K3, 4 mg; niacin, 25 mg.

Trace mineral concentrate supplied per calorie: fe, 80 mg; folic acid, 1 mg; pantothenic acid, 10 mg; biotin, 45 mg; colin, 125000 mg; cu, 5 mg; mn, 80 mg; zn, 60 mg; 150 µg se.

Fermentation

Commercial dry yeast containing 1010 Saccharomyces cerevisiae was purchased as fermentation source. A 50 liter capacity plastic container with a lid was used for fermentation. 10 kg of feed was poured into the fermentation container. 100 g of dry yeast was dissolved in 10 liters of water and the water containing yeast was poured over the feed and the mixture was provided. The mixture was subjected to fermentation at room temperature for 24 hours. After fermentation, the fermented feed was poured onto the bench cleaned with alcohol and dried for 3 days. The dried fermented feed was analyzed for yeast and an average of $6x10^6$ live yeast was detected in 1 gram of feed.

Animals, diets and management

The experiment was conducted in Ahi Evran University, Faculty of Agriculture, Department of Animal Science, Trial was conducted at poultry unit under fully environmentally controlled conditions and lasted for 21 days. 120 healthy male quails which were 21 days old and sexed from the feathers under the neck were taken into 50x100x50 cm floor cages. Wood shavings was spread as litter. While light support was provided for the animals to benefit from feed 24 hours a day, the ambient temperature was optimized with heaters to prevent heat and energy loss. Feed and drinking water were given to the animals ad-libitum. The factors that would cause bad odor formation in the poultry house were taken into consideration and the poultry house was ventilated at regular intervals. Groups M1 (5% yeast fermented feed), M2 (10% yeast fermented feed) and Control groups were formed according to the random plots experimental design and fermented feeds were given to the animals with specially provided feeders. Before the animals were placed in the cages, their live weights were weighed one by one on an electronic scale with a sensitivity of ±1 g and the average live weight in the cages was determined as 61.4 g. Ten animals were placed in each cage and the experiment was started with 4 replications. Feed consumption was calculated by subtracting the tare and weekly weighing from the total feed amount. Feed utilization ratios were obtained by dividing the feed consumption calculated until the weighing day by the live weight.

Slaughtering and Sampling

On the 21st day of the experiment, feeders and drinkers were collected from all treatment groups in the poultry house between 24.00 at night and 08.00 in the daytime. All treated animals were weighed individually and the average live weights of the groups were calculated. At the end of weighing, 2 animals were randomly selected from each replicate (8 animals from each groups, total 24 animals) and their weights were determined. The selected animals slaughtered from their throats and their insides were opened with the help of a scalpel and the part from the esophagus to the last part of the cloaca was carefully removed. Heart, liver, proventriculus, pancreas, gizzard weights were taken and digestive tract lengths and weights were determined. For histological analysis, 1 cm samples were taken from the ileum region of the digestive tract and placed in 10% formaldehyde.

Fecal Microbiota

Lactic acid bacteria (LAB), Yeast, Total Bacteria Count (TBC), *Enterobacteria*, *E. coli* and Coliforms were determined. For this purpose, 1 g of sample materials were mixed with peptone water to obtain a homogeneous distribution. Dilutions were prepared at certain ratios from the stock materials obtained and inoculations were made. MRS Agar was used as inoculation medium for LAB. Incubation temperature was 37°C and incubation period was 3 days. MEA Agar was used as inoculation medium for yeast. Incubation temperature was 25°C and incubation period was 3 days. 3M E. coli counting plates were used for *E. coli* counting. 3M Coliform counting plates were used for coliform counts. 3M TCB counting plates were used for total viable bacteria (TVB) counting. 3M *Enterobacteria* counting plates were used for the enumeration of *Enterobacteria*.

Ileum Histology

On the 21st day of the experiment, ileum samples taken from randomly selected and slaughtered animals from each treatment group were placed in 10% formaldehyde to show one-to-one similarity in each animal. The samples taken from the animals were dehydrated, polished in xylene and then embedded in paraffin blocks. The samples taken from the animals were dehydrated, polished in xylene and then embedded in paraffin blocks. The samples were cut at a thickness of 5 microns and kept in an oven at 50 degrees for 12 hours to allow the tissue to adhere to the slide, then the tissues were placed in xylene and the paraffin was removed from the tissues. The tissues were then stained with Hematoxylin X Eosin stain and photographed with a digital camera microscope (ZEISS Primo Star, Germany) for proper visualization. The photographs obtained for each treatment group and each sample were analyzed statistically by measuring villi length and villi length with ZEN 2012 SP2 image processing and analysis software.

Statistical Analysis

The data obtained from the study were analyzed by one way analysis of variance analysis. Differences between means were subjected to Duncan multiple comparison test and the results were recorded. Statistical analyses in the study were performed using SPSS 15.0 for Windows Evaluation version statistical package program.

Results

The performance parameters obtained from the broiler quails slaughtered on the 21st day of the experiment are shown in Table 2. While live weight gain was statistically significant in M1 group, feed conversion ratio showed an increasing trend in M1 group. At weeks 1, 2 and 3, body weight gain was not affected. M1 group gained more body weight than the control at the end of 21 days. In terms of feed conversion ratios, there was no difference as a result of the calculations obtained as a result of weekly weighings. However, it was observed that FCR of the M1 group was statistically developed than the control group at the end of study.

Table 2. Effects of yeast fermented diet supplementation on performance parameters in quails.

	Day	Control	M1	M2	SEM	P
BW		61.35	61.40	61.33	0.025	0.35
	(1-7)	58.71	59.20	60.06	1.18	0.92
	(7-14)	61.17	63.81	61.95	0.96	0.63
BWG	(14-21)	28.63	39.22	29.422	2.51	0.10
	(1-21)	148.50^{b}	162.24^{a}	151.42^{ab}	2.49	0.06
	(1-7)	158.75	155.983	158.67	3.57	0.96
	(7-14)	203.92	197.17	203.11	1.78	0.30
FI	(14-21)	127.92	107.30	109.56	5.54	0.34
	(1-21)	490.582	460.44	471.33	5.67	0.13
	(1-7)	2.70	2.64	2.66	0.05	0.88
	(7-14)	3.35	3.09	3.28	0.05	0.18
FCR	(14-21)	4.61	3.12	3.75	0.46	0.15
	(1-21)	3.32^{b}	2.85^{a}	3.12^{ab}	0.08	0.06

$^{a-b}$ Means within each column with no common superscript are significantly different ($P < 0.05$). BWG: Body weight gain, FI: Feed intake, FCR Feed conversion ratio, SEM: Standart error of means,

The effects of yeast fermented feed supplementation on bacteria in quails are given in Table 3 *Enterobacteria*, *E coli*, Coliform, TBC, LAB and yeast count was not different. Dietary supplementation of yeast-fermented feed numerically decreased the *Enterobacteria* population (7.02-6.66). Yeast colonization in the feed fermented with yeast increased numerically (5.97-6.38). Fecal microbiota did not change, but the number of yeasts in feces increased in the M1 group.

Table 3. Differention fecal microbiota parameters with yeast fermented diet supplementation in quails. (Log 10 CFU)

	Control	M1	M2	SEM	P
Enteroctericaea	7.02	6.82	6.66	0.16	0.73
E coli	7.13	7.10	6.97	0.13	0.89
Coliform	7.03	7.00	6.87	0.08	0.76
TBC	7.58	7.34	7.33	0.10	0.57
LAB	7.28	7.04	6.52	0.16	0.16
Yeast	5.97	6.49	6.38	0.11	0.13

SEM: Standart error of means, TBC: Total bacteria count, LAB: Lactic acid bacteria.

Effect of yeast fermented feed supplementation on internal organ development in broiler quails effects are given in table 4. Digestive tract weight, heart, liver, gizzard, proventriculus weights of each animal were weighed and calculated individually on a digital scale with a precision of ±1 g. Digestive tract length increased linearly in the treatment groups ($p < 0.05$). Digestive tract weight showed a statistically significant increase in the M1 group compared to the other treatment groups. Gizzard weight showed a significant increase in M2 group compared to M1 and control groups ($p < 0.05$).

Table 4. Effects of yeast fermented diet supplementation on inner organ development in quails. (g-cm/100 gr live weight)

	Control	M1	M2	SEM	P
GL	22.70^{b}	23.70^{b}	25.77^{a}	0.46	0.02
GW	2.39^{b}	2.73^{a}	2.35^{b}	0.07	0.02
Heart	1.33	1.24	1.51	0.06	0.16
Liver	1.72	1.98	1.74	0.10	0.53
Gizzard	2.14^{b}	2.14^{b}	2.43^{a}	0.05	0.04
Proventriculus	0.37	0.35	0.34	0.01	0.61

a-b Means within each column with no common superscript are significantly different ($P < 0.05$). SEM: Standart error of means, GL: Gut length, GW: Gut weight

The results of histomorphologic analysis of ileum in quails are shown in Table 5. As a result of the study, it was determined that the villi lengths obtained in the M1 and M2 groups with 5% and 10% yeast addition were statistically higher than the control group. The results obtained in M2 group were higher than both M1 and control group and the highest villi lengths were observed in M2 group. In terms of LMM, M1 group was found to be lower than the control and M2 groups. M1 group was lower than M2 group in terms of LMM and equal to the control group. In terms of crypt depth, the crypt depth obtained from the M1 group was higher than the control and M2 groups.

Table 5. Effects of yeast fermented diet supplementation on ileum histomorpholgy in quails.

	Control	M1	M2	SEM	P
Villi length (μ)	250.80^{a}	274.25^{b}	309.19^{c}	4.28	0.00
LMM (μ)	19.54^{a}	17.18^{a}	25.08^{b}	0.62	0.00
Crypt depth	14.60^{a}	18.67^{b}	16.36^{a}	0.40	0.00

a-c Means within each column with no common superscript are significantly different ($P < 0.01$). SEM: Standart error of means, LMM: Lamina muscularis mucosae.

Discussion

This study was conducted to determine SC fermented diet addition to growing quail diets on live weight, feed conversion, feed intake, some visceral organ weights, digestive system elements, intestinal histomorphology, and fecal microbiota. In the studies carried out so far, many materials have been used as probiotic sources to the ration in broiler or quail trials. As a result of the trials conducted by the researchers, it is known that there are many advantages of using probiotics to improve growth and performance in feed content.

It was observed that live weight was not statistically affected in the first week. However, at the end of 21 days, M1 (5% yeast fermented feed) group showed a statistically significant increase in terms of total body weight gain. The live *Saccharomyces cerevisiae* in the fermented feed content enhanced weight gain of quail chicks. The results of this study were similar the studies conducted in turkeys (Bradley and Savage, 1995) and broiler chicks (Karaoglu and Durdag, 2005; Kahraman et al. 1999). Onifade et al., (1999) reported that the addition of yeast (SC) at 0.15, 0.30 and 0.60% levels to broiler diets fed with high cellulose and low protein diets increased performance parameters than in the control. These data are in parallel with the present data. In addition, Kumar and Dingle (1996) found 2% better carcass weight in 5-week-old broiler chicks compared to the control group as a result of adding 1% yeast culture to cereal-containing diets. Panda et al. (2005) investigated the effects of yeast culture addition to broiler diets on performance. At the end of the 42-day experiment, they reported that 1% yeast culture reached 4.25% more live weight than the control group As a matter of fact, it is seen that the results obtained are in harmony. FCR statistically developed in M1 group from control. Yaşar et al. (2016) reported that fermented grains improved feed conversion and feed conversion rates in broiler chickens. In addition, the results of this study were similar with turkey pullets (Bradley and Savage, 1995), broiler chicks (Kahraman et al. 1999; Karaoğlu and Durdağ, 2005) studies. Ayanwale and Ayanwale (2006) reported that the addition of 0.75% SC to the ration was the best in feed conversion ratio. Similarly, Karademir et al. (2012) reported that the addition of probiotics to the ration improved intestinal health and accordingly improved performance. The length of the GL in the M2 group was found to increase compared to the Control and M1 groups. Again, according to the results obtained from the quails in the M1 experimental group in the weight of the digestive system, it was seen that there was a difference compared to the Control and M2 groups. While gizzard weight increased in M2 group, there was no difference between M1 and Control groups. Other internal organs such as heart, liver and proventriculus weights did not differ between the groups. Yaşar et al. (2016) reported that there was no change in heart weight on the 21st and 42nd days in their study in broiler chickens in which fermented wheat, barley and oats were compared with non-fermented wheat, barley and oats, while liver weight increased in oat fermentation. In the same study, while there was no significant change in the length of the digestive tract, it was observed that there was a tendency to decrease in the weight of the digestive tract on the 42nd day when oats were compared with unfermented oats.

At the end of the study, it was observed that 5% and 10% yeast fermented feed supplementation had positive effects on the length of villi in the intestine. Lamina muscularis mucosa thickness decreased in M1 group, while it remained at the same level with the control group in M2 group. It was determined that the M2 group with 10% yeast fermented feed supplementation showed the best development in villi length. Bacteria in the intestinal lumen remove pathogens thanks to probiotics and this supports the conclusion that villi in the intestine are positively affected by probiotics, prebiotics and symbiotics (Bayırbağ, 2007). At the end of the experiment, the crypt depth was found to be higher in the results obtained from the M1 group animals compared to the control and M2 groups. Zhang et al. (2005) reported that SC added to broiler diets at different levels increased the length of intestinal villi. Bradley et al. (1994) reported that probiotic substances added to broiler diets did not change the height of intestinal villi but bacteria played an active role in intestinal cells. Samli et al. 2007, they reported that probiotic added to broiler ration increased lactic acid colonization and villus lengths in the intestine. The results obtained in terms of intestinal histomorphology are in accordance with the studies in the literature. Coliforms, *Enteroctericaea*, *E coli*, TBC, LAB and yeast count was not differ in feces by adding yeast fermented feed to quail diets. The results of our study were similar to the results of previous studies. Biswas and Kim, (2023) reported that dietary yeast supplementation did not affet cecal *Lactobacillus* and *Escherichia coli* counts. Similarly, Rybarczyk et al., (2023) reported that dietary supllementation did not affet total bacteria count (TBC), anaerobic bacteria, *Enterobacteriaceae*, *E. coli*, *Enterococcus*, yeasts, *Lactobacillus*, *Lactococcus* in broilers.

In the light of this information obtained, it was concluded that the addition of live yeast to the feed keeps the microflora in the animal intestines in balance, suppresses the pathogen action mechanism, positively affects the immune system and can be used as a growth factor. Bakery yeast (*Saccharomyces cerevisiae*) has the potential to be used as probiotic in poultry. There are no studies in the literature on direct fermentation of feed with yeast (*Saccharomyces cerevisiae*) in quail. The potential of *Saccharomyces cerevisiae* as a probiotic source in different animals, at different doses, under different environmental and stress conditions should be demonstrated.

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