http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 43(3), 267-272 (2026)

Su Ürünleri Dergisi (2026)
DOI: 10.12714/egejfas.43.3.10

RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

A structural assessment of fishery products processing facilities: The case of Isparta Province (Türkiye)

Su ürünleri işleme tesislerinin yapısal analizi: Isparta İli (Türkiye) örneği

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Received date: 23.01.2026 *Accepted date: 15.06.2026*

How to cite this paper:
Sürengil, G., Bilgin, Ş., İzci, L. (2026). A structural assessment of fishery products processing facilities: The case of Isparta Province (Türkiye). *Ege Journal of Fisheries and Aquatic Sciences, 43*(3), 267-272. https://doi.org/10.12714/egejfas.43.3.10

Abstract: This study examines the structural characteristics of four export-oriented fishery processing facilities in Isparta Province using a complete enumeration method. All facilities employ permanent workers, with no seasonal labor observed, and all personnel receive hygiene and occupational safety training. Women constitute 83% of the workforce, mainly in sorting, grading, and packaging, while men account for 17%. The majority of employees are aged 36–45 (42%) and have primary (74%) or secondary (15%) education. Technical personnel remain limited, with staff consisting of 90% production workers, 4% engineers (3 fisheries engineering, 1 food engineering), and 6% administrative personnel. All facilities implement HACCP-based food safety systems, and exports target both EU and non-EU markets. Isparta's location in the Lakes Region, strong production–processing linkages, and widespread female employment provide notable advantages. Enhancing R&D, diversifying products and export channels, expanding automation and traceability, and increasing qualified technical employment are essential for sectoral sustainability. The study offers an up-to-date, region-specific contribution to the literature on inland fishery processing.

Keywords: Fishery products processing facilities, socio-economic analysis, sustainability, Lakes Region

Öz: Bu çalışmada, Isparta ilinde faaliyet gösteren ve ihracat yapan dört su ürünleri işleme tesisinin yapısal özellikleri tam sayım yöntemiyle incelenmiştir. Tüm tesislerde daimi işçi istihdamı bulunduğu, sezonluk çalışanın olmadığı ve personelin hijyen ile iş sağlığı güvenliği eğitimlerini aldığı belirlenmiştir. Çalışanların %83'ü kadın, %17'si erkek olup kadınlar özellikle ayıklama, sınıflandırma ve paketleme aşamalarında yoğunlaşmaktadır. Personelin %42'si 36–45 yaş aralığındadır; eğitim düzeyi açısından %74'ü ilkokul, %15'i ortaokul mezunudur. Teknik personel sayısı sınırlı olup çalışanların %90'ı işçi, %4'ü mühendis (3 su ürünleri, 1 gıda), %6'sı idari personeldir. Tüm tesislerde HACCP temelli gıda güvenliği sistemleri uygulanmakta, ihracat ise AB ve AB dışı pazarlara yönelmektedir. Isparta'nın Göller Bölgesi'nde yer alması, iç su ürünlerine erişimin kolaylığı, üretim–işleme ilişkilerinin güçlü olması ve kadın istihdamının yaygınlığı sektöre önemli avantajlar sağlamaktadır. Ürün ve pazar çeşitliliğinin artırılması, Ar-Ge ve üniversite-sanayi iş birliklerinin desteklenmesi, otomasyon ve izlenebilirlik uygulamalarının yaygınlaştırılması ile nitelikli teknik personel istihdamının güçlendirilmesi sektörün sürdürülebilirliği açısından önem taşımaktadır. Bu bağlamda, Isparta'ya özgü güncel veriler kullanılarak gerçekleştirilen bu çalışma, su ürünleri işleme sektörünün yapısal özellikleri ve genel durumuna ilişkin literatüre özgün bir katkı sunmaktadır.

Anahtar kelimeler: Su ürünleri işleme tesisi, sosyo-ekonomik analiz, sürdürülebilirlik, Göller Bölgesi

INTRODUCTION

The fishery sector plays a strategic role in meeting the animal protein needs of the rapidly growing world population and in ensuring global food security (Şahinöz et al., 2017; Arısoy et al., 2021). The most critical component that increases the economic return of the sector and adds value to its products is processing and evaluation technologies. Processed fishery products beyond fresh consumption in forms such as frozen, smoked, or canned products both extend their shelf life and increase their competitiveness in international markets (Köse et al., 2010).

The sustainability and development of a sector depend not only on physical and technical capabilities but also on improving the socio-economic conditions of the businesses and personnel operating in that sector (Gümüş et al., 2013). However, studies focusing specifically on the structural profiles of processing facilities remain limited.

Isparta Province, located in the center of the Lakes Region, has strong potential in inland fisheries and plays a significant role in the export of freshwater fishery products to the Russian, EU, and US markets (Erkeç and Bilgin, 2020). Despite this potential, up-to-date and detailed information on the structural and socio-economic characteristics of processing facilities is lacking. Recent challenges—including fluctuations in raw material supply, rising energy and input costs, climate-related pressures on water resources, and shortages of qualified technical personnel—have further increased the need for current field-based assessments (Yıldırım et al., 2022). In this context, it is important to reveal the current status of fishery products processing enterprises using up-to-date field data and to evaluate the sector from a structural perspective.

This study aims to evaluate the structural characteristics and workforce composition of fishery products processing facilities in Isparta Province in 2025.

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MATERIALS AND METHODS

The study included all four export-oriented fishery products processing facilities registered with the Isparta Provincial Directorate of Fisheries and Aquaculture under the Ministry of Agriculture and Forestry. A complete enumeration approach was applied (n = 4). The survey form was adapted from Erkeç and Bilgin (2020) and updated for current sectoral conditions. Data were collected through on-site visits and face-to-face interviews with facility owners and administrative personnel. Observations regarding production processes, workforce structure, and operational conditions were also recorded.

The primary data used in the study covered a one-year period and were obtained for the year 2025. The first part of the assessment examined structural characteristics such as establishment year, business type, installed capacity, production volume, and capacity utilization rate. The second part evaluated workforce characteristics, including personnel numbers, gender, age, education level, and training status. The third part focused on production and processing structure, including raw material sources, processed species, processing methods, and quality certifications. The final part included open-ended questions on challenges, recent developments, and future plans. Detailed information regarding the survey questionnaire used in the study is presented in Table 1. The collected data were evaluated using descriptive statistical methods such as percentage values. Data organization and evaluation were performed using MS Excel.

Table 1. Fishery products processing facilities survey form

A. General Information

1. Establishment:
2. Owner/Authorized Representative of the Facility (Name–Surname, optional):
3. Type of Facility:

☐ Private sector ☐ Cooperative ☐ Public institution ☐ Other (please specify):

4. Installed Processing Capacity (tons/year):
5. Current Production Volume (last 1 year, tons/year):
6. Percentage of Capacity Utilization: % _____

B. Workforce Profile

7. Total number of personnel:
8. Distribution by type of personnel (number of personnel):

☐ Seasonal: ____ ☐ Permanent: ____ ☐ Daily: ____ ☐ Engineers/Technical personnel (total): ____

Fisheries Engineer: ____ Biologist: ____ Food Engineer: ____

Agricultural Engineer: ____ Veterinarian: ____

9. Number of personnel by gender: Male: ____ Female: ____
10. Number of personnel by age group: ☐ 18–25 ____ ☐ 26–35 ____ ☐ 36–45 ____ ☐ 46 and above ____
11. Number of personnel by education level:

☐ Primary school: ____ ☐ Secondary school: ____ ☐ High school: ____

☐ Associate degree: ____ ☐ Bachelor's degree: ____ ☐ Master's/PhD: ____

12. Number or percentage of personnel who consume fish: _____
13. Have personnel received hygiene training? ☐ Yes ☐ No
14. Have personnel received occupational health and safety training? ☐ Yes ☐ No
15. Is an occupational health and safety specialist employed? ☐ Yes ☐ No

C. Production and Processing Information

16. Method of raw material supply: ☐ Capture fisheries ☐ Aquaculture ☐ Both
17. Origin of raw material: ☐ Domestic ☐ Imported ☐ Both
18. Applied processing methods (multiple responses allowed):

☐ Fresh / Chilled ☐ Marinated

☐ Frozen products (whole/fillet, etc.) ☐ Canned

☐ Smoked ☐ Salted

19. Is HACCP implemented? ☐ Yes ☐ No
20. Quality and food safety certifications held:☐ ISO 22000 ☐ ISO 9001 ☐ BRC ☐ IFS ☐ Other: _____
21. Markets where processed fishery products are sold:

☐ Domestic market _____ ☐ EU countries _____

☐ Both domestic and international markets _____ ☐ Non-EU countries _____

22. Annual export volume: ☐ 0–500 tons ☐ 501–1000 tons ☐ 1001–5000 tons ☐ 5001 tons and above
23. Distance of the facility from the nearest settlement area: ☐ 0–5 km ☐ 6–10 km ☐ 11–50 km ☐ Over 51 km

D. Findings and Problems

25. What are the main problems most frequently encountered? _____
26. What positive developments have been observed recently? _____
27. Does the facility have any development or investment plans? ☐ Yes _____ ☐ No _____

RESULTS

In Isparta Province, there are four fishery products processing facilities registered with the Ministry of Agriculture and Forestry and approved for international export, as well as one trout processing facility producing fresh and frozen products solely for the domestic market. Within the scope of this study, the four export-oriented fishery products processing facilities were included in the analysis. Basic structural characteristics of the facilities, such as installed capacity, capacity utilization rate, and number of personnel, were evaluated.

The installed processing capacities of the examined facilities ranged between 975 and 2,500 tons/year, serving both the domestic market and international exports. The total installed processing capacity was determined to be 5,825 tons/year (Figure 1). Nevertheless, the sector also reports significant problems in finding personnel. This situation indicates that the sector has a stable employment structure. The capacity utilization rates of the facilities ranged between 36% and 50%. According to information obtained during interviews, fluctuations in raw material supply, seasonal production variations, and increasing operational costs were among the main factors limiting full utilization of installed capacity.

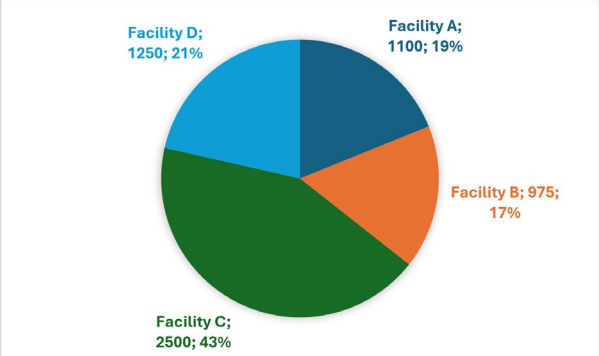

Figure 1. Processing capacity of fishery processing facilities in Isparta Province (tons/year)

Workforce profile of fishery products processing facilities

The general workforce profile of personnel working in fishery products processing facilities in Isparta Province was evaluated based on the total number of personnel, the distribution by personnel type, gender, age group, education level, fish consumption rates, and the training received, as shown in Table 2. All personnel working in the examined facilities were employed on a permanent status. Each facility employed at least one actively working engineer and administrative personnel. No seasonal or daily-paid personnel were employed in any of the facilities. This workforce structure suggests that production processes are largely dependent on manual labor, which may limit productivity improvements and technological transformation within the sector.

The survey revealed that 176 people are employed across the 4 fishery processing facilities in Isparta. The highest number of personnel was in two facilities, each with 50 people, while the lowest was in one facility with 36 people. This indicates a parallel distribution between the production capacities and the number of personnel in the facilities in the region. The personnel distribution in the facilities, based on the data obtained, is shown in Figure 2.

Table 2. Workforce characteristics of fishery products processing facilities in Isparta Province

Variable	Category	Value
Total personnel	Total number	176
Employment type	Permanent	100%
	Seasonal/Daily	0%
Gender	Female	83%
	Male	17%
Age groups	18–25	17%
	26–35	37%
	36–45	42%
	46+	4%
Education level	Primary school	74%
	Secondary school	15%
	High school and above	11%
Position	Production personnel	90%
	Technical personnel	4%
	Administrative personnel	6%
Training status	Hygiene & OHS training	100%
Fish consumption	Average	70–90%

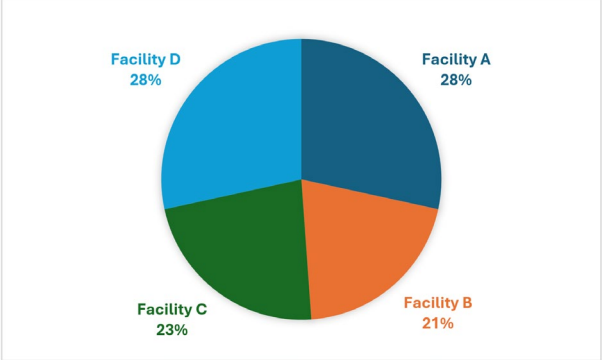

Figure 2. Personnel distribution by company

In processing facilities, 83% of the total workforce is female, and 17% is male (Figure 3). The high number of female personnel indicates that women are predominantly employed in manual processes such as sorting, cleaning, and packaging in the fishery products processing sector, while men work in positions such as logistics, warehousing, and sales marketing.

The age distribution of personnel in fishery products processing facilities showed that 74 personnel (42%) were in the 36–45 age group, 65 personnel (37%) were in the 26–35 age group, 30 personnel (17%) were in the 18–25 age group, and only 7 personnel (4%) were aged 46 years and above (Table 2). This distribution indicates that the majority of the

workforce is concentrated in the active working-age population, while the younger age group is relatively underrepresented. This situation may indicate a potential risk of workforce aging in the future.

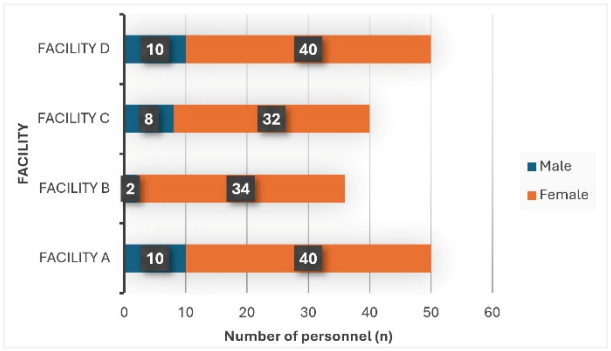

Figure 3. Gender distribution of personnel by company

In fishery processing facilities, the vast majority of the workforce is in production personnel positions. The proportion of production personnel exceeds 90% of the total workforce. Technical personnel are limited, accounting for less than 5% of the workforce, with only fisheries engineers and one food engineer (Table 2). There are no positions for biologists, agricultural engineers, or veterinarians. These results indicate that technical personnel is limited in these facilities and largely rely on manual labor. The low level of formal education, combined with the limited number of technical personnel, suggests potential constraints in adopting advanced processing technologies and improving production efficiency.

Fish consumption habits of personnel were also assessed in the study. The average fish consumption rate among personnel was approximately 75%. The highest rate was recorded as 90% in one facility, while the lowest rate was determined as 70%. These findings indicate a generally positive tendency toward fish consumption among personnel. All personnel in the examined facilities (100%) had received hygiene and occupational health and safety (OHS) training. In addition, each facility employed a contracted occupational safety specialist and a hygiene officer. Overall, fishery products processing facilities in Isparta Province were found to comply with food safety and hygiene standards.

All facilities implemented the HACCP system. In terms of quality certifications, three facilities held ISO 22000 certification, two facilities held ISO 9001, BRC, and IFS certifications, and one facility possessed GLOBAL G.A.P certification. These findings demonstrate that processing facilities in the region operate in accordance with international quality and food safety standards.

When examining the profiles and workforce qualifications of personnel in fishery processing facilities in Isparta, the high proportion of women in the workforce, the concentration of middle-aged individuals, low education levels, limited technical personnel, and high fish consumption habits indicate both the strengths and areas for improvement in the sector.

Furthermore, the fact that all personnel in the facilities receive occupational safety and hygiene training represents a significant opportunity for providing permanent employment for middle-aged women in that region.

DISCUSSION

The present study provides an updated structural assessment of four export-oriented fishery processing facilities in Isparta Province, focusing on production capacity, workforce characteristics, and operational conditions. The findings show that the facilities share several similarities with the general structure of Türkiye's processing sector, while also reflecting regional characteristics shaped by inland aquaculture dynamics. Nationwide, 278 fishery processing facilities operate, 138 of which are approved for European Union exports (GKGM, 2025). A significant proportion of these facilities are located along the Eastern and Central Black Sea coasts and include fishmeal and oil facilities, bivalve mollusk processing units, frog leg and snail processing facilities, and fish feed factories. In contrast, fishery processing facilities in Isparta benefit from relatively easy access to raw materials, advantageous geographical conditions such as logistical convenience and proximity to water resources, and suitable continental climatic conditions, all of which contribute positively to seafood export potential (TAGEM, 2025). Unlike coastal regions where marine species dominate processing activities, facilities in Isparta benefit from proximity to inland aquaculture farms, logistical convenience, and stable access to freshwater raw materials, which collectively support export-oriented production. Compared with earlier reports (Erkeç and Bilgin, 2020), installed capacities have increased, yet capacity utilization remains low (36–50%). Similar to national and international findings (Tezcan, 2005; Mol and Ulusoy, 2010; FAO, 2022; OECD, 2022), irregular raw material supply and rising operational costs continue to limit full-capacity operation.

A distinctive feature of the facilities in Isparta is their complete reliance on permanent personnel. This differs from many coastal regions where seasonal employment is common (Doğan and Yıldız, 2008; Karakaya et al., 2024). The high proportion of women in labor-intensive stages aligns with global patterns in fish processing (FAO, 2020; Weeratunge et al., 2010). While this supports local employment and contributes to social sustainability, the limited number of technical personnel may hinder technological modernization and efficiency improvements (Çapkın et al., 2008; Anderson et al., 2017; Kubilay et al., 2022).

The age structure and educational profile observed in the facilities are broadly consistent with previous studies conducted in Türkiye (Çağlak et al., 2012; Gümüş et al., 2013). Similar findings have been reported internationally, where limited technical training and low educational attainment may reduce innovation capacity and slow the adoption of advanced processing technologies (Dewali et al., 2023). When personnel education levels and job positions are evaluated together, it is seen that the workforce in fishery processing facilities

operating in Isparta Province is predominantly concentrated in personnel positions, while the number of technical and management personnel is limited.

Fish consumption rates among personnel were higher than those reported in many regional consumption studies in Türkiye (Şen and Canpolat, 2011; Bolat and Telli, 2019), suggesting that continuous exposure to fish products may positively influence consumption habits. The universal provision of hygiene and occupational safety training across facilities indicates compliance with food safety standards, supported by the widespread implementation of HACCP and international certification systems.

A limitation of this study is that the analysis includes the four export-oriented processing facilities in Isparta Province; the findings represent a regional assessment. However, these facilities represent the entire population of export-approved processing enterprises in the province. Therefore, while the findings provide a comprehensive picture of the regional processing sector, caution should be exercised when generalizing the results to other regions of Türkiye. Overall, the results suggest that while the sector has development potential, improvements in workforce structure, technological capacity, and operational efficiency are necessary to enhance its sustainability and competitiveness.

CONCLUSION

This study examined the structural characteristics and workforce composition of fishery products processing facilities operating in Isparta Province based on field data collected in 2025. The findings indicate that processing facilities in the province operate with moderate installed capacity, a predominantly personnel-based employment structure, and limited technical personnel. Based on these findings, improving raw material supply continuity, increasing the number of technically qualified personnel, and supporting technological modernization in processing facilities may contribute to improving operational efficiency and sectoral development. Strengthening collaboration between fishery production and processing facilities may also help increase capacity utilization levels. These findings suggest that workforce structure is directly linked to production efficiency and sectoral competitiveness.

Overall, the most critical development need identified in this study is the transition from a predominantly labor-intensive production structure toward a semi-automated processing model supported by qualified technical personnel. Therefore, integrating automation technologies with trained technical personnel is essential for improving operational efficiency, ensuring sustainability, and enhancing the sector's long-term competitiveness. Future studies involving a larger number of processing facilities from different inland aquaculture regions would allow broader comparisons and provide comprehensive results.

ACKNOWLEDGEMENTS AND FUNDING

This study was orally presented at the symposium entitled "Isparta's Past, Present, and Future III" held between October 30 and November 1, 2025. Subsequently, the study was revised and converted into an article format using updated data.

The authors would like to thank the owners of the fishery processing facilities operating in Isparta Province and the personnel who participated in the survey. In addition, sincere thanks are extended to the Fisheries and Aquaculture Branch Directorate of the Isparta Provincial Directorate of Agriculture and Forestry.

AUTHORSHIP CONTRIBUTIONS

Göknur Sürengil: designed the study, collected and analyzed the data, interpreted the results and wrote. Şengül Bilgin: contributed to the study design, supervision, wrote and revised the manuscript. Levent İzci: contributed to supervision, evaluation of the results, wrote and revised the manuscript. All authors read and approved the final version of the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest among them regarding this study.

ETHICAL APPROVAL

This study was conducted with the approval of the Scientific Research and Publication Ethics Committee of Isparta University of Applied Sciences, dated 04/09/2025 and numbered 04.

DECLARATION OF AI USE

Generative artificial intelligence tools were not utilized in the preparation of this study. All text, analysis, and content were produced exclusively by the authors through human input.

DATA AVAILABILITY

Questions regarding the datasets should be directed to the corresponding author.

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