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RESEARCH ARTICLE

Balancing Trade and Sustainability: Türkiye's Squid and Cuttlefish Market Dynamics

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ABSTRACT

Türkiye's squid and cuttlefish production struggles to meet domestic demand due to limited local supply. This study examines production levels, trade balances, and economic impacts using data from the Turkish Statistical Institute (TÜİK) and international sources. Production relies on natural stocks, providing stability but remaining insufficient. Between 2005 and 2024, export volumes fluctuated between 523.8 and 1,026.8 tons, while imports rose from 1,558.8 tons in 2005 to 5,204.4 tons in 2022. Import expenditures increased from $2.6 million to $31.5 million, emphasizing Türkiye's reliance on external sources. The zero-tariff agreement with Malaysia supports imports, yet Malaysia's production capacity is insufficient to meet Türkiye's needs. China's large-scale harvesting and processing, particularly of *Dosidicus gigas* and *Todarodes pacificus*, likely contribute to these products reaching Türkiye via Malaysia. The COVID-19 pandemic caused imports to drop to 2,397.1 tons in 2020, recovering to 3,656.9 tons by 2023. Export revenues peaked at $4.8 million in 2021 but did not offset trade deficits. The study provides insights into market dependencies and trade imbalances. To achieve a sustainable balance, Türkiye must improve fisheries management, diversify supply sources, and reduce import dependency through strategic trade policies.

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1. Introduction

Squid and cuttlefish are economically valuable cephalopod species worldwide. Their production is generally based on harvesting from natural stocks, as aquaculture efforts remain limited (Ospina-Alvarez et al., 2022). Countries like China and Peru lead in production, while production has declined in countries such as Japan. The conservation of stocks, such as the Patagonian shortfin squid, is emphasized (Villasante et al., 2014). Fishing is conducted using advanced techniques. In Europe, these species are often caught as bycatch. Illegal, unreported, and unregulated (IUU) fishing poses a significant threat to stocks (FAO, 2020).

Globally, squid fishing involves approximately 30-40 commercially important species, with an increasing share in total marine product catches (Arkhipkin et al., 2015). *Dosidicus gigas* and *Todarodes pacificus* hold substantial commercial value in countries such as Peru, Japan, and Korea (FAO, 2012). In terms of fishing techniques, common methods include light-assisted jigging, bottom trawling, and netting. Nevertheless, the environmental impacts and pressure on stocks require ecosystem-based management approaches (Caddy & Rodhouse, 1998). Squid species adapt quickly to environmental changes due to their short life cycles, rapid growth, and high reproductive rates (Rodhouse et al., 2014). According to FAO

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(2012), data on cephalopod fisheries highlight significant biomass movements and cyclical effects on ecosystems.

In the Mediterranean, squid fishing is prominent, with species like *Loligo vulgaris* and *Sepioteuthis lessoniana* commonly found (Arkhipkin et al., 2015). In Türkiye, species such as *Loligo vulgaris* hold significant commercial importance. In Türkiye, commercially important species such as *L. vulgaris* are commonly caught using traditional fishing methods, including set nets, jigging, and bottom trawling. However, effective stock conservation and strict enforcement of fishing regulations are essential to ensure sustainability. As highlighted by Rodhouse et al. (2014), the short lifespan and annual fluctuations of squid populations require careful and adaptive management strategies.

Cuttlefish (*Sepia officinalis*) is widely caught for commercial purposes globally. It is found in the eastern Atlantic and Mediterranean Sea. Fishing is done using methods like trawling. Stocks are influenced by environmental factors such as temperature and food availability (Boletzky, 1983; Forsythe et al., 1994). In Türkiye, *S. officinalis* is an important species in the Mediterranean, Aegean, and Marmara Seas (Duysak et al., 2014)

The trade of these species involves the circulation of fresh, processed, and frozen products within a broad trade network. China and South Korea are leaders in fresh product markets. Spain and Italy are key trade hubs in Europe, while processed products are extensively exported from North Africa to Europe and Japan (Arkhipkin et al., 2015). Cold chain infrastructure plays a critical role in these processes. Consumption typically occurs in fresh or processed forms. Consumer habits drive the global demand for these species. However, increased demand raises the risk of stock depletion (Ospina-Alvarez et al., 2022).

To ensure sustainability, traceability systems should be improved, and transparency in trade processes should be increased. The origin and fishing methods of cephalopod products should be accurately documented and made accessible to consumers. Illegal, unreported, and unregulated (IUU) fishing must be addressed. Fishing quotas should be established through regional and international cooperation, and strategies to protect natural stocks should be implemented. Supporting aquaculture initiatives can increase sustainable production capacity for these species. Additionally, strengthening cold chain infrastructure can help maintain product quality and reduce waste (Gleadall et al., 2024).

This study aims to analyze the economic value and sectoral importance of squid and cuttlefish species in Türkiye by examining their production, export, and import parameters over the past 20 years. Within the scope of the research, the production volumes, export and import trends, annual changes, and trade balances of these species were thoroughly evaluated. Based on the findings, the contribution of these species to the national economy was assessed, and recommendations were proposed for the development of sustainable production and trade strategies.

2. Materials and Methods

This study utilized two primary datasets provided by the Turkish Statistical Institute (TÜİK):

1. Catch Production Figures: This dataset, obtained from fisheries statistics, covers the period from 2003 to 2023. It includes the annual production quantities of squid and cuttlefish recorded in Türkiye.

2. Foreign Trade Data: This dataset, sourced from the TÜİK Foreign Trade Platform, covers the years 2004 to 2024. It includes the total export and import quantities and values specifically for squid and cuttlefish.

The information derived from these datasets was analyzed using the following methods and formulas:

The annual averages of production and trade figures over the given period were calculated using the formula:

$$\text{Annual Average} = \Sigma X_i / n \quad (1)$$

Where, X_i represents the production or trade figure for the i-th year, and n is the total number of years.

Annual trends were analyzed using a simple linear regression model via Excel's LINEST or TREND functions:

$$Y_t = \beta_0 + \beta_1 t \quad (2)$$

Where, Y_t: Production or trade value for year t; t: Time (year); β_0: Intercept; β_1: Annual change coefficient.

The foreign trade balance was calculated to determine the trade deficit or surplus for the relevant products:

Trade Balance = Total Export Value - Total Import Value

This calculation was performed annually to evaluate Türkiye's trade performance in this product category.

Data were categorized based on the form of the products (fresh, frozen, processed and canned). The classification of squid and cuttlefish into fresh, processed, canned, and frozen categories is determined based on the customs codes used in foreign trade regulations, ensuring standardization in trade documentation and reporting. The impacts of different product forms on trade figures were compared by calculating the annual averages of imports and exports for each category.

All data were analyzed using Microsoft Excel. Visualizations such as charts and graphs were created to illustrate trends over time. Statistical analyses, including linear regression, were conducted using Excel's built-in tools to evaluate production and trade patterns.

3. Results

Türkiye's squid and cuttlefish import-export data from 2005 to 2024 reveals fluctuations in export volumes, while unit prices have generally followed an increasing trend. In 2005, Türkiye exported 701.6 tons, generating $2 million in revenue, with an average unit price of $5.36/kg. By 2024, exports had risen to 848.4 tons, with revenue reaching $4.1 million and an average unit price of $5.90/kg. On the import side, there was a significant increase over the years, peaking in 2022 at 5,204.4 tons, costing $31.5 million. However, by 2024, import volumes had declined to 2,559.3 tons, while the unit price stood at $6.63/kg. These trends indicate shifting dynamics in Türkiye's seafood trade, highlighting both export market developments and increasing import dependency over certain periods (Table 1).

Table 1. Türkiye's squid and cuttlefish import-export volumes and average unit prices (2005-2024) (Data compiled from TÜİK foreign trade statistics).

Years	Export			Import		
	Tons	Million USD	Unit Price (Kg)	Tons	Million USD	Unit Price (Kg)
2005	701.6	2.0	5.36 ± 0.75	1.558.8	2.6	1.63 ± 0.18
2006	682.3	2.2	5.32 ± 0.71	1.364.9	1.9	1.94 ± 0.35
2007	650.9	2.9	6.23 ± 0.88	1.146.0	1.8	2.05 ± 0.36
2008	681.9	2.8	5.18 ± 0.71	1.660.0	2.5	2.35 ± 0.50
2009	791.6	2.7	4.74 ± 0.74	1.709.1	2.3	2.01 ± 0.40
2010	669.8	2.4	5.53 ± 0.71	2.713.0	3.2	1.40 ± 0.13
2011	752.4	3.5	6.25 ± 0.74	2.604.1	9.4	3.87 ± 0.14
2012	572.0	3.0	7.24 ± 0.66	3.624.7	14.3	3.64 ± 0.28
2013	675.0	2.5	7.66 ± 0.86	2.982.6	11.4	4.11 ± 0.15
2014	785.8	3.3	5.80 ± 1.07	2.436.1	9.1	4.03 ± 0.20
2015	523.8	2.0	5.99 ± 0.88	2.890.6	10.9	4.16 ± 0.21
2016	756.1	3.1	6.28 ± 0.98	2.397.2	9.3	4.36 ± 0.17
2017	785.6	3.4	5.07 ± 0.70	3.497.9	13.7	4.27 ± 0.18
2018	845.9	4.3	7.48 ± 0.81	3.350.6	11.6	4.79 ± 1.20
2019	758.4	2.9	5.91 ± 0.73	3.349.4	11.6	5.47 ± 1.47
2020	933.1	4.4	5.37 ± 0.51	1.842.6	8.1	4.12 ± 0.31
2021	1.026.8	4.8	6.70 ± 0.80	2.860.3	18.1	6.61 ± 0.59
2022	638.1	3.6	5.58 ± 0.69	5.204.4	31.5	6.59 ± 0.55
2023	784.3	3.9	6.16 ± 0.02	3.656.9	20.3	7.62 ± 1.65
2024	848.4	4.1	5.90 ± 0.68	2.559.3	12.0	6.63 ± 0.99

Import volumes increased throughout the years, starting from 1,558.8 tons in 2005 and reaching 5,204.4 tons in 2022. A steady rise in import expenditure was recorded, growing from $2.6 million in 2005 to $31.5 million in 2022. Annual data indicate that import volumes consistently exceeded export volumes. In 2005, imports amounted to 1,558.8 tons, while exports were recorded at 701.6 tons. By 2022, import volumes rose to 5,204.4 tons, whereas export volumes declined to 638.1 tons. The financial value of imports followed a similar pattern, increasing from $2.6 million in 2005 to $31.5 million in 2022. In contrast, export revenues grew at a much slower pace, rising from $2.0 million in 2005 to $4.1 million in 2024. Significant variations in unit prices per kilogram were identified. Export prices fluctuated over the years, ranging from $4.74 ± 0.74 in 2009 to $11.68 ± 3.02 in 2023. Import prices showed notable peaks, reaching $13.36 ± 9.01 in 2016 and remaining consistently above $6.59 ± 0.55 from 2022 onwards.

Table 2 provides Türkiye's foreign trade data for squid and cuttlefish, categorized by product type and analyzed over 5-year periods. For fresh products, export volumes ranged from 50.3±8.0 tons in 2005-2009 to 47.9±9.6 tons in 2020-2024, with a peak of 64.8±10.9 tons in 2010-2014. Imports decreased significantly, reaching 0.1±0.0 tons in 2020-2024. Export values reached their highest at 0.256 million USD in 2010-2014, while import values remained consistently low, with 0.001 million USD recorded in 2020-2024.

Table 2. Türkiye's squid and cuttlefish foreign trade data by product types: 5-Year periods and annual averages (Data compiled from TÜİK foreign trade statistics).

Product	Period	Export		Import	
		Tons	Million USD	Tons	Million USD
Fresh	2005-2009	50.3±8.0	0.183	5.4±1.0	0.009
	2010-2014	64.8±10.9	0.256	0.6±0.1	0.003
	2015-2019	51.1±8.1	0.171	2.6±0.4	0.011
	2020-2024	47.9±9.6	0.227	0.1±0.0	0.001
Processed	2005-2009	39.6±6.2	0.142	111.9±15.1	0.166
	2010-2014	30.6±5.7	0.134	290.0±43.4	0.950
	2015-2019	54.2±7.9	0.253	222.0±33.9	0.845
	2020-2024	16.8±2.6	0.093	70.9±12.8	0.246
Canned	2010-2014	6.1±0.8	0.073	36.6±0.9	0.185
	2015-2019	0.2±0.1	0.002	23.7±2.0	0.123
	2020-2024	0.2±0.1	0.002	4.9±0.6	0.025
Frozen	2015-2019	34.6±5.7	0.167	264.3±52.7	0.949
	2020-2024	35.3±8.2	0.176	327.9±89.8	1.845

As shown in Table 2, processed products had fluctuating export volumes, starting at 39.6±6.2 tons in 2005-2009, peaking at 54.2±7.9 tons in 2015-2019, and decreasing sharply to 16.8±2.6 tons in 2020-2024. Imports were highest in 2010-2014 at 290.0±43.4 tons but fell to 70.9±12.8 tons by 2020-2024. Export values were highest in 2015-2019 at 0.253 million USD, while import values saw a steady decline, dropping to 0.246 million USD in 2020-2024.

Table 2 also indicates that canned products recorded exports starting from 6.1±0.8 tons in 2010-2014, which decreased to 0.2±0.1 tons in both subsequent periods. Import volumes followed a similar declining trend, from 36.6±0.9 tons in 2010-2014 to 4.9±0.6 tons in 2020-2024. Export values dropped from 0.073 million USD in 2010-2014 to 0.002 million USD in later periods, while import values decreased from 0.185 million USD to 0.025 million USD during the same time frame.

Frozen products, as detailed in Table 2, were first recorded in 2015-2019, with export volumes increasing slightly from 34.6±5.7 tons to 35.3±8.2 tons in 2020-2024. Import volumes rose from 264.3±52.7 tons to 327.9±89.8 tons over the same periods. Export values showed a marginal increase from 0.167 million USD to 0.176 million USD, while import values saw a substantial rise from 0.949 million USD to 1.845 million USD in 2020-2024.

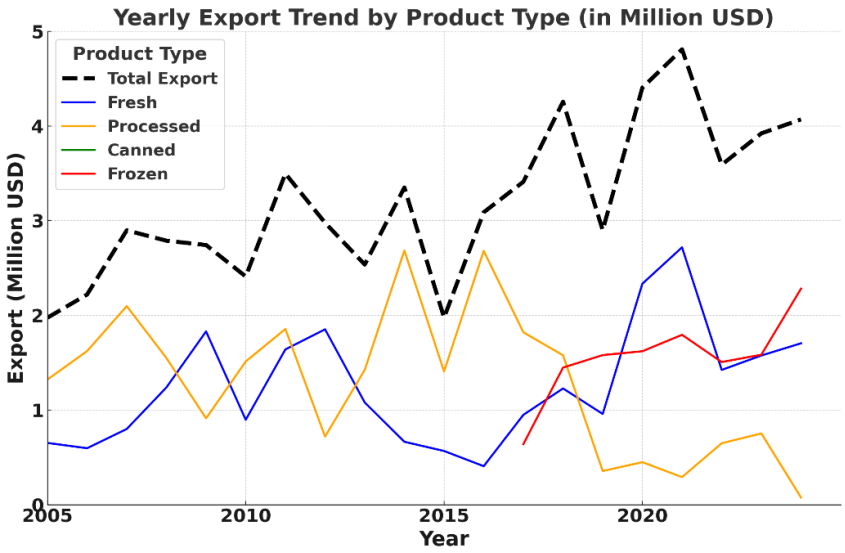

Figure 1. Export values of different products for Türkiye's squid and cuttlefish.

Figure 1 presents Türkiye's export performance for squid and cuttlefish across different product categories. Total export values increased over the years, reaching approximately 4.5 million USD in 2019. After this peak, exports declined slightly

and stabilized around 4 million USD in the following years. Fresh squid and cuttlefish exports fluctuated between 2005 and 2020, ranging from 1 million USD to 2 million USD. After 2015, fresh exports increased, exceeding 1.5 million USD in 2022. Processed product exports varied significantly, reaching 2 million USD in 2015 and decreasing in the following years. By 2022, processed exports remained below 1 million USD. Canned exports remained consistently low, staying below 0.5 million USD throughout the observed period. Frozen squid and cuttlefish exports increased steadily, especially after 2018, surpassing 1.5 million USD in 2022.

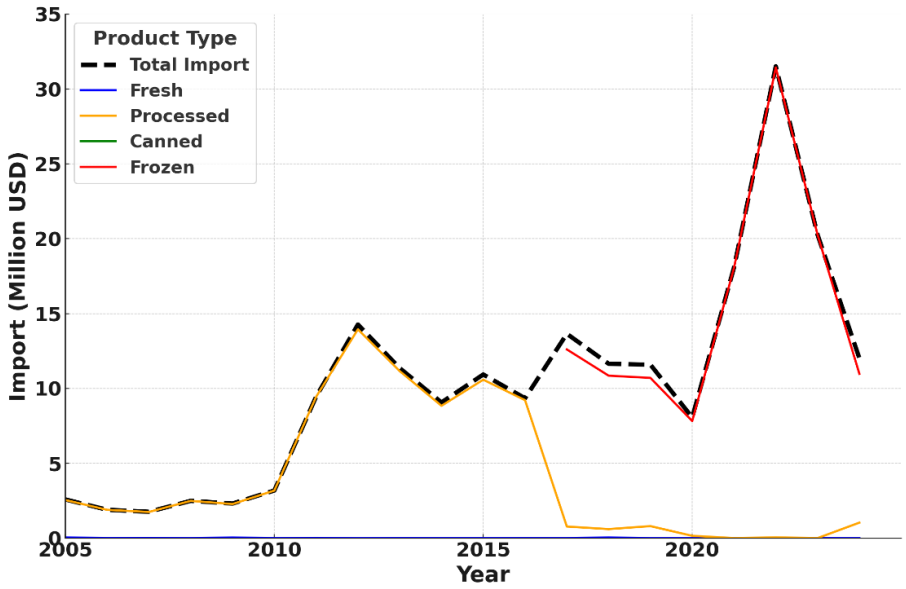

Figure 2. Import values of different products for Türkiye's squid and cuttlefish.

Türkiye's squid and cuttlefish production, export, and import data provide critical insights into the trade balance of these products. The chart indicates that while approximately half of the domestic production is directed toward exports, imports and the resulting trade deficit remain significant.

During the pandemic, particularly in 2020, a noticeable decline in imports was observed. This situation could be attributed to disruptions in global supply chains and logistical challenges. However, imports increased again in the following years, peaking in 2023. This increase likely reflects the easing of pandemic-related restrictions and a recovery in demand. In 2024, a reduction in imports was observed, possibly due to fluctuations in domestic demand or the availability of alternative supply sources.

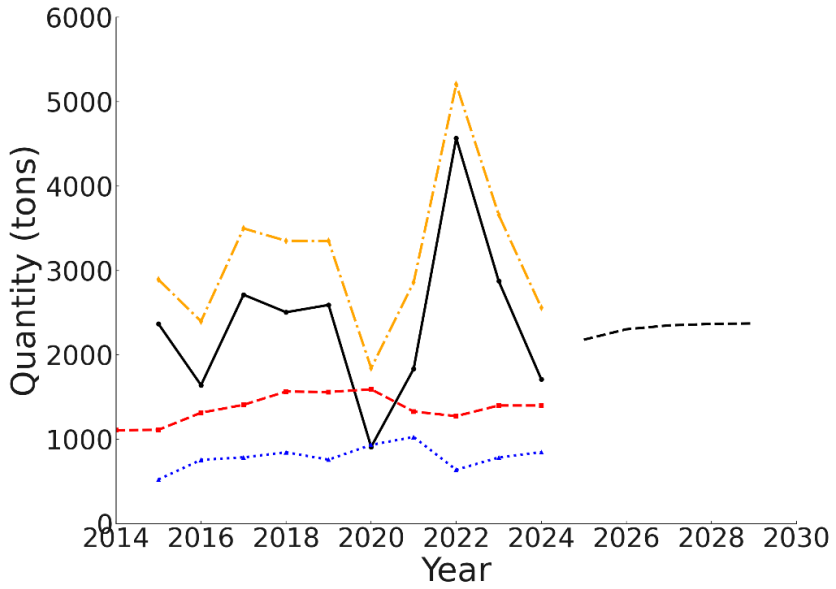

Figure 3. Türkiye's squid and cuttlefish production (red), export (blue), import (orange), trade deficit (black), and 5-year forecast.

In 2023, Türkiye's imports reached a peak of 4,566.3 tons, while exports remained at 845.9 tons. Domestic production was limited to 1,565.5 tons, resulting in a trade deficit of 3,720.4 tons. Although imports decreased to 2,890.6 tons in 2024, the trade deficit remained at a significant level of 2,366.8 tons. During the pandemic in 2020, imports dropped to 2,397.1 tons, while production and export levels remained stable, likely reflecting the impact of global supply chain disruptions on Türkiye's trade.

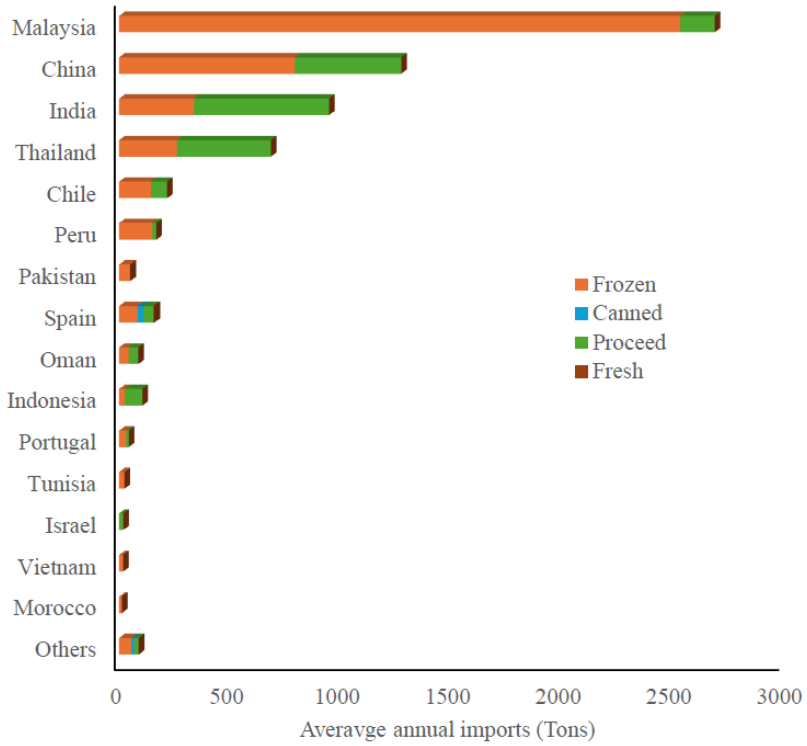

Figure 4. Annual import quantities of squid and cuttlefish by country in Türkiye over the last decades (Data compiled from TÜİK foreign trade statistics).

Türkiye's squid and cuttlefish imports mainly come from Asian countries. The largest supplier is Malaysia, with an annual import volume of approximately 2,900 tons, mostly consisting of frozen products. China and India follow, with 1,700 tons and 1,200 tons, respectively, with the majority of their exports to Türkiye being frozen and processed products.

Thailand is also a significant supplier, contributing around 900 tons annually. Other Asian countries, including Pakistan, Indonesia, Vietnam, and Oman, also export squid and cuttlefish to Türkiye, but in smaller quantities (Figure 4).

4. Discussion

Türkiye's production of squid and cuttlefish remains insufficient to meet domestic consumption demands. Addressing this gap by increasing production is considered a crucial step to reduce import dependency (Gazihan, 2017; Gökoğlu, 2021). However, since Türkiye's production heavily relies on natural stocks, achieving a significant increase in production is constrained by the limited availability of these resources (Pierce et al., 2010). The country's dependence on wild-catch methods, combined with the natural restrictions of its marine environment, makes large-scale production expansion challenging (Vidal et al., 2014). In this context, the cultivation of squid and cuttlefish locally emerges as a significant strategy to fulfill domestic demand sustainably. Such initiatives could reduce reliance on imports and simultaneously bolster both domestic consumption and potential export opportunities.

In the short term, however, imports remain a necessary solution to meet consumption demands. For years, Türkiye's production and trade dynamics have shown a relatively stable pattern. Approximately half of the local production is allocated for export, demonstrating the necessity of imports to satisfy internal market needs. Nonetheless, the COVID-19 pandemic significantly disrupted these dynamics. During the initial stages of the pandemic, import volumes dropped substantially due to disruptions in global supply chains and challenges in sourcing products from Asian countries, which are key suppliers. Türkiye responded to these constraints by utilizing existing local stocks to meet domestic demand and fulfill export obligations, often relying on frozen products due to logistical limitations (Can et al., 2020; Demirci et al., 2020).

Following the pandemic, particularly in 2022 and 2023, imports experienced a notable surge, nearly doubling compared to previous years. This sharp increase was largely driven by accumulated demand that could not be met during the pandemic period. By 2024, import levels stabilized and returned to pre-pandemic levels, reflecting a balance between demand and supply. This stabilization was likely supported by the resumption of normal trade flows and the realignment of domestic and export needs.

Türkiye's trade dynamics highlight the dependence on imports due to the limited capacity of local production. While local stocks were effectively managed during the pandemic, the heightened post-pandemic demand underscored the critical role of imports in sustaining market balance. This situation reinforces the need to develop local aquaculture initiatives to enhance production capacity and reduce reliance on external sources. Instead of reducing import dependency, the strategic management of imports and optimization of the trade balance are necessary. Examples of such strategies include:

High-Quality Imports: Increasing imports from countries like Malaysia, where production costs are low and zero-tariff agreements exist, can optimize quality and cost-effectiveness.

Strengthening Supply Chains: Improving logistics efficiency in import processes can reduce costs, especially by ensuring fresh and fast delivery to consumers in tourist areas.

Tourism-Integrated Models: Imported products can be marketed as part of the "Turkish cuisine" concept in tourist facilities, turning imports into an economic advantage.

International Partnerships: Establishing long-term agreements with suppliers like Malaysia can ensure consistent product availability and minimize price fluctuations.

When evaluating global squid and cuttlefish production volumes on a country basis, China and Peru lead the industry as the largest producers (Ospina-Alvarez et al., 2022). In contrast, Malaysia stands out as a key player in Türkiye's squid and cuttlefish imports, likely due to the zero-tariff agreement between the two nations. However, Malaysia's production capacity alone may not suffice to meet Türkiye's demands, as a significant portion of squid and cuttlefish supplied through Malaysia likely originates from China and other Asian countries (Pierce & Portela, 2014).

China, as the world's largest squid producer, predominantly harvests species such as *Dosidicus gigas* (Humboldt squid) and *Todarodes pacificus* (Pacific flying squid) (Chen et al., 2008; Liu et al., 2013). These species are caught in large volumes, with *Dosidicus gigas* being particularly abundant in the eastern Pacific (Pierce & Portela, 2014). China's advanced fishing fleets and processing facilities allow it to dominate global trade in squid products. It is highly plausible that a portion of China's production is exported indirectly to Türkiye, transiting through Malaysia to take advantage of the favorable trade agreement between Türkiye and Malaysia (Vieites et al., 2019). This arrangement underscores the interconnected nature of global squid and cuttlefish trade and highlights the strategic importance of trade policies in shaping market dynamics (Gleadall et al., 2024).

5. Conclusion

Türkiye's squid and cuttlefish trade over the years has shown an increasing dependence on imports, leading to a widening trade deficit. Limited local production, reliant on natural stocks, has restricted growth, making imports essential to meet domestic demand. While import volumes have fluctuated, Türkiye continues to rely heavily on external suppliers. As the world's leading squid producer, China plays a central role in this trade, with a significant portion of its products reaching Türkiye through intermediary countries such as Malaysia. This highlights the importance of establishing direct trade agreements with China to minimize intermediary costs and enhance supply chain efficiency.

To reduce import dependency and improve trade balance, the following strategies are recommended:

- Enhancing Direct Trade with China: Shifting from indirect imports via intermediary countries to direct trade agreements with China could reduce extra costs and stabilize supply, improving Türkiye's trade balance.
- Diversifying Alternative Suppliers: To decrease reliance on China, Türkiye should strengthen direct trade relations with other Asian countries, such as Indonesia, Thailand, and India, which also play a role in the global squid trade.
- Increasing the Value of Exports: While Türkiye's production capacity is limited, investing in processed and value-added squid and cuttlefish products could increase export revenues and improve market competitiveness.
- Strengthening Logistics and Cold Chain Infrastructure: Improving efficiency in import logistics and enhancing cold chain facilities can reduce costs and ensure fresher, higher-quality products, especially for the tourism sector.
- Tourism-Integrated Consumption Strategies: Incorporating imported squid and cuttlefish into Türkiye's gastronomic and tourism industries can transform imports into an economic advantage, particularly by promoting Turkish seafood cuisine to international visitors.
- Expanding International Trade Agreements: Securing long-term agreements with key supplier countries, such as Malaysia, could ensure stable supply and minimize price fluctuations, making Türkiye less vulnerable to market volatility.

Conflict of Interest

The author has no conflict of interest to declare.

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