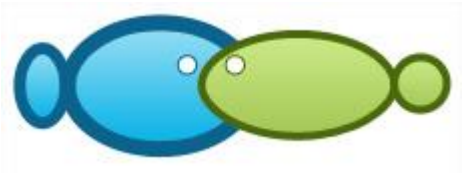

The blue swimming crab export: a trend analysis of Indonesia and other countries export contribution to the USA market, 2015-2023

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Abstract. This study examines the trends in blue swimming crab (BSC) exports by volume to the United States of America (USA) market from 2015 to 2023, aiming to analyze the trend export contribution and identify influencing factors. Utilizing descriptive statistics, the research investigates the impact of catching seasons, regulations, and international trade policies on the BSC industry. To infer the findings, a quantitative-explorative approach and time series analysis (ARIMA forecasting) were employed to project the export volume of BSC to the US market for the next three years (2024-2026). Results reveal significant shifts in the contribution of Indonesian BSC exports to the US over the study period, with projections extended to 2026 for deeper insights into trade dynamics. External factors, including catching seasons and trade regulations emphasizing environmental resilience, greatly influence export trends by volume. These findings enhance comprehension of BSC trade dynamics, facilitating informed policy formulation for sustainable marine resource management. The implications extend to industry stakeholders, governments, and environmental organizations, guiding actions to foster the longevity and prosperity of the BSC sector.

Key Words: ARIMA, BSC export, resource management, trade.

Introduction. Seafood is a significant commodity in international commerce with major economic contribution to both exporting and importing countries (Wiloso et al 2022). Crustaceans have long been favoured fishery items, especially in Asian countries, due to their significant market potential (Pathak et al 2021), where crabs rank third after shrimps and lobsters as the most favourite seafood (Varadharajan & Soundarapandian 2012). Blue swimming crab (BSC; *Portunus pelagicus*) is a species of high-value found in tropical areas, especially in Southeast and East Asia or the eastern Indian Ocean and western Pacific Ocean (Romano & Zeng 2008; FAO 2020). It significantly affects the fishery in the Palk Bay and the Gulf of Mannar along the southeast coast of India (Jose 2013). Indonesia is one of the largest BSC producers in the world (Kurniawan 2022) with 150 thousand tons production (live weight) in 2017. Of the total production, approximately 90% was exported, mainly in canned form, constituting almost half of all BSC on the global market. Several countries imported the products, including the United States, China, and the European Union. The USA's demand for crab meat products was expected to increase at the end of 2022 for the upcoming festive seasons. However, in October 2022, the USA buyers' market for pasteurized crab meat products only showed little increase (Kurniawan 2022).

Pasteurized crab meat is produced by packing pre-cooked crab meat in tin or plastic cans to be hermetically sealed and pasteurized at 86°C for two hours. After pasteurization, the cans are chilled in an ice bath for two hours (Pathak et al 2021). The pasteurized crab meat products offer several benefits, including (a) extended shelf life than fresh crab meat, (b) ready to eat, (c) cheaper than fresh crab meat, (d) available

year-round and easy to find even in big cities, (e) versatile and can be cooked or mixed with other ingredients to make healthy dishes, and (f) quick cooking procedure. There was a dynamic trading in this commodity from 2015 to 2023 due to various factors, including changes in demand, supply chain dynamics, trade policies, and environmental factors. During this period, Indonesia experienced fluctuations in its BSC export volumes and prices to the US market. Understanding these trends is crucial for policymakers, industry stakeholders, and researchers to formulate informed strategies for sustainable management of the BSC trade. Additionally, consumer preferences, regulatory standards, and competition from other seafood suppliers also influence the US market's receptiveness to Indonesian BSC exports. Furthermore, analyzing Indonesian export contributions to the US market offers valuable insights into broader trends in the global seafood trade, including market integration, supply chain dynamics, and international trade relations. This research was performed to examine the export trends over an extended period in order to comprehensively understand the factors influencing the BSC trade and its implications for Indonesia and the US. Moreover, with the increasing importance of sustainable seafood practices and the stronger concern on environmental and social impacts of seafood production, analyzing the trends in Indonesian BSC exports to the US market can provide valuable insights into the sustainability challenges and opportunities within the seafood industry (Foreign Trade 2023; Future Market Insights 2023). This research is expected to provide in-depth insights to stakeholders, policymakers, and industry in determining the most profitable crab export trends by volume, the contribution of the central exporting countries to the US market during the 2015-2023, and the projection (by BSC volume export) for three years afterwards (2024-2026). In addition, the results of this research can become a reference for developing sustainable policies, improved marketing strategies, and conserving marine BSC resources to ensure the industry's future ecological viability and long-term viability of the BSC trade.

Material and Method. The research focused on Indonesia, commencing with an overview from various countries that export crabs to the USA, highlighting those with a competitive advantages in crab production. These countries meet US quality and food safety standards, possess infrastructure and technology that efficiently support the crab fishing industry, and demonstrate economic stability and robust export growth rates. Year to date (YTD) and monthly data on BSC export volume (pasteurized and fresh crab meat) were collected through literature studies. Secondary data were also obtained from the Foreign Trade database and Crab report (Foreign Trade 2023). YTD secondary data referred to the data that were collected from January, 2015 until December, 2023.

Initially, this research was performed using the exploratory data analysis (EDA) to identify the trend of export contributions from each BSC exporter country to the USA. Trade variables, specifically the volume of each country's crab exports to the USA, were analyzed descriptively using tabulations and graphs. To infer the findings, a quantitative-explorative approach and time series analysis (ARIMA forecasting) were employed to project the export volume of BSC to the USA market for the next three years (2024-2026). A nine-year trend assessment and a three yearsafterward projection were carried out to illustrate the development conditions of crab exports to the USA (da Silva et al 2019; Voumik 2021; Siddique et al 2024).

Results and Discussion

Sources and type of crab exports to the USA. Several countries are the major crab suppliers to the United States. Over the last nine years (2015–2023), there have been 74 exporting countries that fulfil the demand for crab meat in the USA. This research analyzed the data from Indonesia and the other top 10 countries, which collectively accounted for 95.54 out of 99.7% of the total pasteurized crab exports to the USA, namely: (1) Indonesia, (2) China, (3) Philippines, (4) Vietnam, (5) India, (6) Sri Lanka, (7) Thailand, (8) Nicaragua, (9) Mexico, (10) Tunisia, and (11) Venezuela (Figure 1).

Indonesia significantly dominates with 44.43% of the total contribution from 74 exporting countries. Indonesia's expansive territorial waters offer ideal conditions for catching high-quality crabs, supporting both quality improvement and sustainable fishing practices. This positions Indonesia as the leading contributor to the USA's global crab market. China is the second largest exporter after Indonesia (19.66% of the total contribution of 74 exporting countries), which supplies crab to the USA with an estimated growth in the fish processing sector of more than 30% in 2030 (Green 2015). Abundant marine resources, sophisticated fishing technology, and the development of solid infrastructure in crab processing allow China to ensure adequate quality and quantity in crab supply to the USA. The central export destination countries for processed or frozen crab from China are the USA, Malaysia, Japan, Hong Kong, and Chinese Taipei (OEC 2021). Meanwhile, the Philippines contributed 13.18% of pasteurized crab exports. More than 90% of crabs from FAO (2014) artisanal fishermen (Suerte 2015) have become an essential commodity that support large industries and employ labors (Yap 2020). The types of crab products exported include pasteurized crab in the form of cans (pasteurized canned) and processed products (value added) (Yap et al 2017). Vietnam make up to 8.74% of pasteurized crab exports to the USA. Despite fluctuations in export values (Statista 2023), Vietnam is projected to play a significant role in the total export volume of fishery products consumed by 2030 (FAO 2022). With a 4.95% contribution of pasteurized exports, India is also one of the ten leading countries supplying fishery products by value globally, with the USA as the largest importer. Sri Lanka exports diverse fishery products, including marine invertebrates, aquatic plants, and other species, contributing to 2.32% of pasteurized exports (FAO 2022).

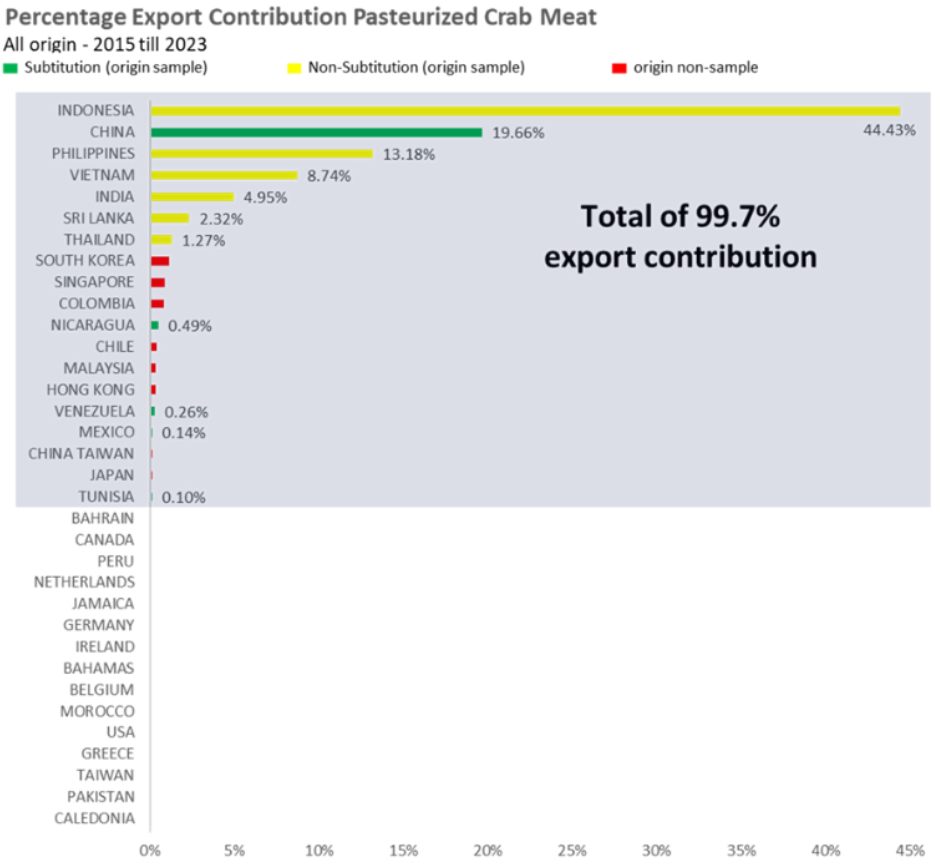

Figure 1. Export contribution of all origins (including Indonesia) to USA, 2015-2023.

Thailand as with the centre of the crab fishery in the Gulf of Thailand and the Andaman Sea (Surat Thani crab fishery) has a 1.27% contribution to pasteurized exports and has established a fishery improvement program (Fishery Improvement Project or FIP) to address the exploitation of crab populations in fishing activity areas and small-sized crab

fisheries, which has minimal management. These efforts successfully improved the quality of crab exports to USA and the sustainability of stocks in Thailand's Surat Thani crab fishery. Nicaragua, Mexico, Colombia, Venezuela, and Tunisia are also crab exporters to the USA. Nicaragua makes a 0.49% of contribution to the total world crab export volume to the USA (WWF 2020; Seafood Watch 2023a).

The USA classifies crab imports into two main groups: those belonging to the Portunidae and the *Callinectes* group. The Portunidae group encompassess all swimming crabs, including the Indo-Pacific *Portunus* crabs. However, the *Callinectes* group consists solely of the blue crab (*Callinectes sapidus*) and all other *Callinectes* swimming crab species, primarily found along the coasts of the USA's and Atlantic Ocean (Warner et al 2015). Nicaragua exports crabs from the genus *Callinectes*, while Mexico also contributes to this category, albeit minimally at 0.14%. Venezuela began exporting crab meat, including fresh and frozen varieties, to the USA in 2017 and 2018, respectively, with a 0.26% contribution to total USA crab imports. Tunisia, with a 0.10% share of USA crab imports, initiated its export of frozen raw/cooked crab meat to the USA and expanded its offerings to include frozen crab meat products in 2022.

Indonesia and the other top 10 crab exporting countries are capable of ensuring the stability of crab stocks or marine crab resources, the implementation of sustainable crab fishing and fisheries, and the quality of crab. The high demand for crab from the USA has created a trend that has attracted the attention of business people and fishing industry observers. There are at least seven types of crab products imported by the USA: (1) frozen raw or cooked with a shell; (2) frozen crab meat; (3) frozen crab value-added; (4) fresh crab; (5) fresh crab meat; (6) pasteurized crab meat; and (7) sterilized crab meat. China, Mexico, Nicaragua, Tunisia, and Venezuela are substitute countries that export crab products in value-added or processed crab products. They supply pasteurized crab and make a 87.80% contribution to the total export volume of 11 main exporting countries to the USA market (Figure 2). Frozen crab meat constitutes 5.63% of this volume, with China alone contributing 44% or 37 million lbs. Frozen raw/cooked crab, and sterilized contributed 4.22% and 1.12% respectively of the total crab export volume. For the last nine years, China has dominated the supply of frozen raw/cooked crab meat to USA with 40.85 million lbs of the total frozen raw cooked crab meat export volume. The supply of value-added crab meat is 1.07% of the total volume of crab exports, the majority of which also comes from China. Fresh crab meat is exported to USA by only two countries: China and Mexico, with a split of 29% and 71% contribution respectively to the total fresh crab meat exports. Pasteurized crab remains the most popular product in the USA market, with a 93.43% contribution to the total export volume (Figure 3), although there is no contribution from substitute countries.

The pasteurization preserves crab meat and makes it easier to store for practicality. Pasteurized crab products have been well received by consumers in the USA, especially in the seafood, restaurant and food industry sectors that require fresh crab with a longer shelf life. This data show a shift in preferences and higher demand regarding practicality and ease of serving. In addition, consumers are looking for alternative options due to the high price of pasteurized crab meat in the USA (White 2023). Pasteurized crab meat from China and Vietnam is cheaper than cooked or pasteurized fresh crab meat from other countries. However, it has a different meat taste from being frozen prior to cooking. Consumers prefer high-quality crab meat to enhance the dining experience, thereby increasing the demand for premium crab meat (Future Market Insights 2023). Sterilized and frozen crab meat exports from the primary exporting countries, excluding substitute countries, accounted for 3.17% and 1.88% of the total export volume, respectively. In contrast, frozen raw/cooked and value-added crab meat constituted 0.97% and 0.55% of the total export volume, respectively. Fresh crab meat and fresh crab have not been supplied to the USA market other than by substitute countries for the last nine years (0% contribution to total export volume, Figure 3). This condition shows the dominance of substitute countries, namely Mexico and China, in supplying these two types of crab to the USA market.

Pasteurized crab meat dominates the USA crab export market, especially from exporting countries; Indonesia, Philippines, Vietnam, India, Sri Lanka, Thailand, and

China. Frozen raw/cooked crab meat is dominated by China, Indonesia, and India. On the other side, China, Tunisia, and Venezuela mainly export frozen crab meat. Furthermore, Mexico and China are the two dominant countries that export fresh crab meat to the USA market.

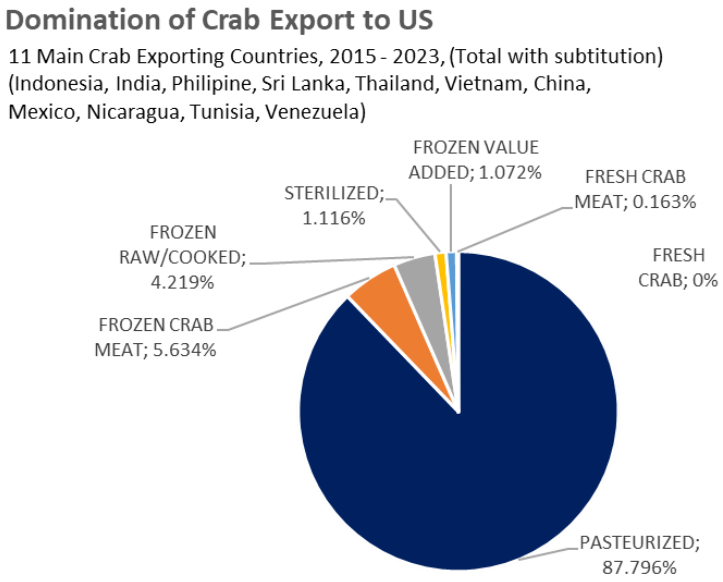

Figure 2. Domination of crab export to the USA (with substitution).

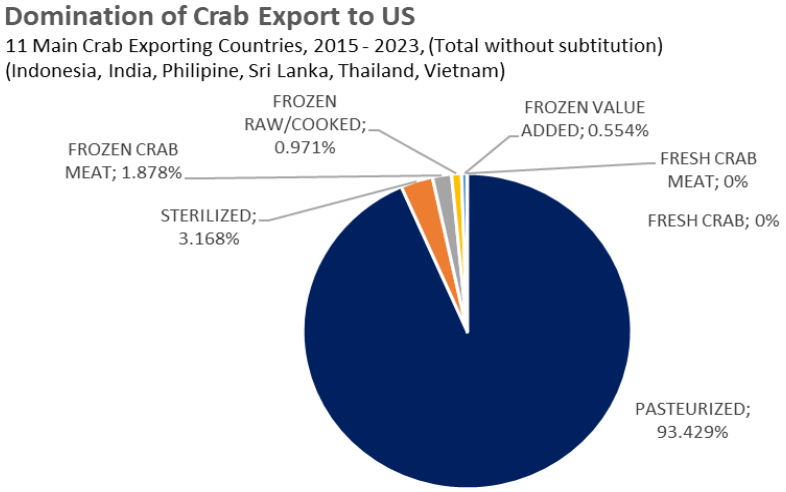

Figure 3. Domination of crab export to the USA (without substitution).

Trend of pasteurised crab exports by volume to the USA. The dynamics of pasteurized crab exports to the USA reflect the complexity of the global seafood industry influenced by consumer demand and trade regulations. The shifts in export trends reflect shifts in the consumption patterns and USA market preferences, where awareness of the health benefits of marine products and demand for sustainable products are driving export growth. Trend analysis is deemed necessary to understand the global market and the future of the pasteurized crab industry. The export trend of pasteurized crab and fresh crab meat from 11 major exporting countries in the last nine years (2015-2023 YTD) has decreased by 10% by the end of 2023 (see on Table 1). The significant decline in the export trend of pasteurized crab occurred due to the higher inflation rate in the USA. The ongoing war between Russia and Ukraine also brought significant impact on global economic activity. The price increase was not only triggered by factors related to the pandemic and problems in the supply chain but also from the conflicts (Sainal 2022).

Table 1

Exports of pasteurized and fresh crab meat by volume (million lbs) to USA during 2015-2023 and projection of 2024-2026

Origin	*YTD 2015*	*YTD 2016*	*YTD 2017*	*YTD 2018*	*YTD 2019*	*YTD 2020*	*YTD 2021*	*YTD 2022*	*YTD 2023*	*%Chg 9 Ytd*	*Prediction*		
											YTD 2024	*YTD 2025*	*YTD 2026*
Indonesia	17.98	17.67	15.14	17.53	19.21	20.11	22.95	19.76	18.98	6%	21.47	21.94	22.40
Philippines	5.75	6.09	5.12	5.70	5.39	3.20	7.15	4.35	3.39	-41%	5.15	4.37	3.23
Vietnam	3.84	4.63	3.77	3.64	3.39	2.98	3.91	5.61	5.89	53%	6.05	6.23	6.41
India	2.07	2.46	2.44	2.89	3.85	1.38	3.77	4.33	4.50	117%	4.53	4.81	5.08
Sri Lanka	0.60	0.69	1.96	1.71	1.29	0.81	1.05	0.41	0.84	40%	0.71	0.67	0.63
Thailand	2.14	0.45	0.66	0.78	0.64	0.45	0.25	0.15	0.08	-96%	-0.13	-0.30	-0.47
Total without substitution	32.38	31.99	29.09	32.25	33.77	28.93	39.08	34.61	33.68		37.78	37.72	37.28
China	11.48	9.26	7.97	10.17	4.94	3.93	8.57	6.59	5.62	-51%	7.93	4.46	4.30
Nicaragua	0.15	0.57	0.24	0.19	0.30	0.12	0.20	0.31	0.38	150%	0.28	0.28	0.28
Venezuela	-	-	0.08	0.09	0.59	0.95	0.45	0.42	0.82	939%	0.92	1.02	1.12
Mexico	0.42	0.02	0.02	0.01	-	0.16	0.26	0.07	-	-100%	0.07	0.06	0.05
Tunisia	-	-	-	-	-	0.07	0.44	0.63	0.40	475%	0.50	0.58	0.65
Total substitution	12.05	9.85	8.31	10.46	5.83	5.23	9.92	8.02	7.22		9.70	6.40	6.40
Other	4.61	8.89	4.39	2.11	5.46	7.72	13.43	7.71	8.02	74%	9.68	10.25	10.81
Total	49.04	50.73	41.79	44.82	45.06	41.88	62.43	50.34	48.92		57.16	54.37	54.49

Notes: YTD = year-to-date; %Chg 9 Ytd = percentage of changes during nine years (2015-2023). Data source: Foreign Trade (2023).

Over the last nine years, Indonesia's pasteurized crab exports has increased by 6% (Table 1) and reached its peak in 2021. The seasonal crab fishing in Indonesia influences export trends, with the peak landing season in the USA occurring in February-March and June-October (Taylor 2013). During this transitional period, Indonesia has low crab stocks in nature (Utomo et al 2022). Meanwhile, the low landing season or work period to prepare for crab exports for the next period occurs in April-May and November-January. This period coincides with the transition of the east to the west season with abundant crab stocks in nature and favourable weather conditions for fishermen to fish.

Over the past nine years, China, a significant crab supplier to the USA, has experienced a mild fluctuation in exports due to trade tensions and COVID-19-related disruptions (Xiao 2022). The peak export season for China typically begins in August and extends through September, with catching or production occurring from August 17 to April 30, and closed seasons for net and trap catches from May 1 to August 16 and May 1 to August 1, respectively (Liu & Lin 2019). Meanwhile, the Philippines has seen a 41% decrease in crab exports to the USA, attributed to challenges in international market competition (Selina Wamucii 2024). Its peak fishing season falls in July and January, aligning with peak spawning periods in August and January, while July to October marks the peak for crab exports (Mesa et al 2018).

Vietnam saw a 53% increase in crab exports, driven by demand for frozen soft-shell crabs in the USA (Volza Grow Global 2023). Peak season is March-April, with spawning in March and catching from April-August (Poseidon ARM Ltd 2017; Seafood Watch 2023b). India's crab exports to the USA have risen consistently, peaking from December to June (Dineshbabu et al 2008; Seafood Watch 2022). Indonesia also experiences peak crab abundance from May to June, continuing into the September production period (Wiyono & Ihsan 2018). Sri Lanka's exports surged due to economic stability, infrastructure, and policy reforms (Wuryandani & Meilani 2011), peaking between February and May and again in June and August, averaging 0.05-0.09 million lbs per month for eight years (de Croos & Sivanthan 2014). Crab spawning peaks in Sri Lanka in September-October and June-July (Haputhantri et al 2022).

Thailand experienced a decline in crab exports, where the peak fishing season for crab fishermen occurred in May-September. The abundance of crab stocks occurs in the dry season, especially May-July as affected by favorable salinity and water temperature. The closed season for crabs in Thailand occurs in October-December, with the peak spawning season in March (Kunsook et al 2014; Seafood Watch 2023b). The decline in Thailand's exports in 2015-2018 was influenced by an increase in GDP and domestic consumption of 3.1-4.3% (Barne & Wadhwa 2018).

Nicaragua has reached higher export volume over the last nine years. Peak crab season in Nicaragua occurs between September and April, with an average volume of 0.01-0.02 million lbs produced for export to the USA market. Pasteurized crab exports to the USA are essential to the global market, with an estimated compound annual growth rate (CAGR) growth of up to 4.7% from 2023 to 2028 (Market Data Forecast 2023; Technavio 2023).

Consumer awareness of the health benefits of crab meat has driven an increase in demand for crab products (Market Data Forecast 2023). Demand for crab products in the export market is influenced by changes in consumer preferences towards healthy protein choices, increased awareness of the nutritional benefits of seafood, and demand for sustainable and traceable seafood (Future Market Insights 2023). However, strict regulations regarding food safety, labelling, traceability, and the availability of imitated fish meat at lower prices are the obstacles in the crab export market in the USA (Market Data Forecast 2023; Technavio 2023). Russia's diminished crab supply (Langat 2023) has led to a rise in pasteurized crab exports to the USA.

Figure 4 illustrates the projected annual contribution of crab meat exported to the USA by country (in lbs) until 2026. Indonesia is projected as a leading contributor to surpass other nations in exporting both pasteurized and fresh crab meat. In nine years, the percentage change of export volume of Vietnam is expected to hold the second position, with China, India, and the Philippines trailing behind in third, fourth, and fifth places, respectively (Table 1).

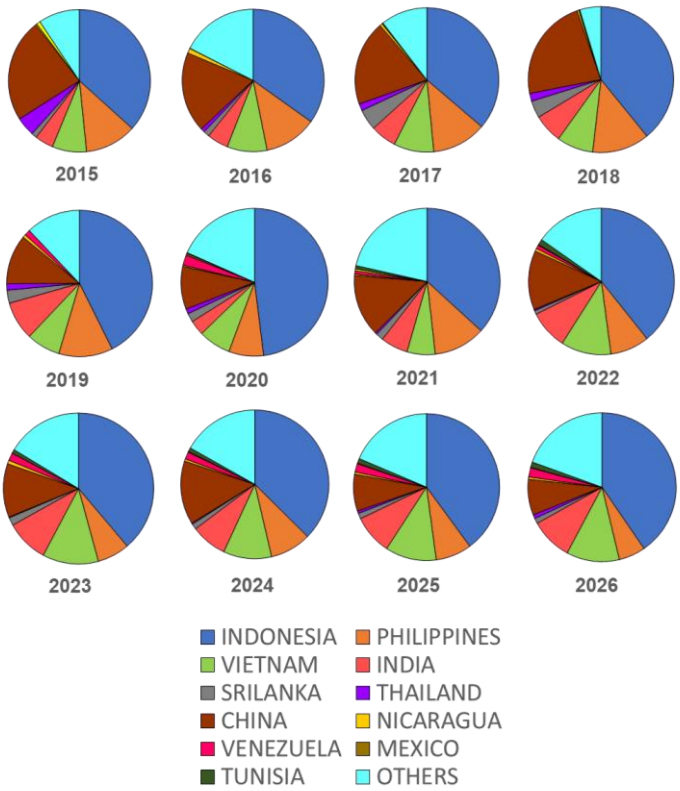

Figure 4. Contribution of pasteurized and fresh crab meat to USA by year (2015-2026).

Conclusions. This research provides an overview of crab export trends and the contribution of exporting countries to the USA market during the 2015-2023 period. Indonesia, as a non-substituting country, and China, as a substitute country, are the main contributors in supplying crab to USA. Pasteurized crab is the pioneer of crab fisheries export products from both non-substituting and substitute countries with high demand in the USA market. In the last nine years, there have been fluctuations in trends based on the volume of crab exports. Indonesia, Vietnam, India, Sri Lanka, Nicaragua, Venezuela, and Tunisia experienced increases until the end of 2023. On the contrary, China, Philippines, Thailand, and Mexico experienced significant decreases. The increase was probably affected by higher consumer demand, while the decline was due to trade wars between countries and high domestic consumption, as happened in Thailand. Trade regulations and climate change play pivotal roles in shaping the cyclical patterns of crab export. This research underscores the importance of considering these factors in policy-making and industry strategies. Prioritizing sustainability and responsibility in the blue swimming crab industry allows stakeholders to maintain this valuable resource's long-term viability.

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Conflict of interest. The authors declare that there is no conflict of interest.

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