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Water treatment and aquaculture products towards halal value chain in ASEAN countries: a retrospective review on Brunei Darussalam

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ABSTRACT

The aquaculture sector in Southeast Asia pursues to establish itself as a significant supplier of animal protein for consumption. It is crucial to comprehend and address the issues that aquaculture in the area encounters to increase farm productivity, preserve the competitiveness of their goods, and enable exportation and sustain conducive water quality. In recent years, the production of fish and shrimp, particularly at marine aquaculture locations, has increased the amount of effluent in ASEAN nations, including nutrients, waste feed, feces, and pharmaceuticals and pesticides which creates a detrimental environment for aquaculture activities. These issues are caused by several variables, including the culture method, species, stocking density, site hydrography, husbandry practices, and feed type. Different aquaculture techniques are the result of interactions between humans and the environment that establish negative effects on the global aquatic environment. Besides, it was observed in some of the ASEAN countries that the raw materials of fish feed derived from imported non-halal sources were used in several freshwater and mariculture farms. In the classical Fiqh, food safety and quality are critical issues for Muslims as their consumption must be halal (permissible in Islamic Law) and Tayyib (safe, hygiene, wholesome, clean, good). Based on above assessments, this study was conducted to assess the current aquatic environmental regulatory practices and Halalan Tayyiban aquatic food products in accordance with halal value chain. The methodology used is mainly library research, such as databases and search engine that cover selected journals and information regarding the subject matters, including references from local or International Fisheries Authorities. However, this review paper has discussed comprehensively water treatment system and aquatic food products which are one of the potential industries that depicts the attention of the halal world in line with the rising halal demand worldwide. This is in line with achieving the highest goals of Shariah towards 'Life below water (SDG 14), Good health and well-being (SDG 3)' which ensured the food security and nutrition' to protect the well-being of stakeholders and environment in Brunei Darussalam and ASEAN as well.

Keywords: ASEAN aquaculture; Good aquaculture practices; Halalan Tayyiban aquatic products; Brunei halal food policies; Value chain in Brunei aquatic products

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1. Introduction

In a region that is overpopulated, the Southeast Asian aquaculture business wants to become a significant supply of animal protein for food. Understanding and resolving the issues that aquaculture in the area encounters is crucial for maximizing farm productivity, maintaining the competitiveness of their goods, and enabling export. The production of fish and shrimp, particularly at marine aquaculture locations, has recently resulted in an increase in effluent levels in ASEAN nations, including nutrients, waste feed, feces, and pesticides and pharmaceuticals. The culture method, species, stocking density, site hydrography, husbandry practices, and feed type are some of the variables that contribute to these issues [1].

According to Imam Shafi'i, Al-Jallalah animals are haram for Muslim eating unless they have undergone a transformation (Istihalah). In the treasury of the Al-Quran, Allah SWT ["Subhanahu Wa Ta'ala" - "Glory be to Him"] clearly said several times on the importance of choosing halal and Tayyib foods concepts (refer Surah Al-Baqarah: 168, 172, 173; Al-Maidah: 1, 3, 4 and 5; Al-Nahl: 114). It is clear from these verses, the significance of nutritional aspects emphasized by the Quran. The implications are tremendous in terms of behaviour, psychology, and even in the laws of Islam. Non-halal (illegal) foods can produce wild behaviour and coward. Therefore, the production of food products, must include the criteria of Shariah-compliant (Ṭayyib and Halalan) as well as needs to be preserved and maintained. Despite the vibrancy of that, consumer, especially Muslims, should be careful in the selection of halal food products and clean (Ṭayyib) of any element of doubt. The issue arises when the food is being produced from the food waste is reprocessed as fertilizer or forage fish [2–4].

One of the crucial components of the halal supply chain is animal feed. Muslims hold that feeding an animal haram animal byproduct will result in the animal being adulterated, rendering it unfit for Muslim consumption. According to research by the Federal Agricultural and Marketing Authority (FAMA) and University Sains Malaysia (USM) in 2010, 40% of feed manufacturers in the nation use mixed animal-based materials in animal feed, casting doubt on the halal integrity of animals fed with these feeds [5]. Muslims in the nation are irate over the problem of cultivated fish being fed pig guts, which was exposed recently in Malaysia. Following that, the Malaysian National Fatwa Council declared non-halal feed for animals to be haram. However, under Malaysian JAKIM's Halal Certification Procedure Manual, animal feeds are categorized under uncertifiable products. The issues of fish farmers started arising due to proper feeding the aquaculture species with non-halal feed [6].

The existing issues involving the production of food products, particularly concerning halal always happens in the community must adhere to the principles in line with Shariah. Since aquaculture produces food for human consumption, halal is a crucial problem. While Tayyib is a process where clean and pure food will be produced and delivers comfort 0% buffered formalin utilizing the scraping technique, which procedures, and practices in the contemporary aquaculture in connection to the notion of halal as a subject. A thorough comprehension of the significance of implementing Halalan Tayyiban principles in aquaculture practices will enhance the aquaculture product and advance local farmers in the halal supply chain. This review paper with anticipation can provide a clearer view on the reality of issues faced by aquaculture sector as well as provide a good potential explanation by the application of halal value chain system [7,8].

1.1. Aquaculture and fisheries production in Brunei Darussalam

In the region of Borneo to the northwest is Brunei Darussalam. The nation has a 269 km long coastline facing the South China Sea with a total land area of 5,765 km^2. About 8,600 km^2 make up the continental shelf, and 5,614 km^2 make up the exclusive economic zone. Capture fisheries, aquaculture, and seafood processing are some of the subsectors of the fisheries in Brunei Darussalam. Small-scale and commercial fisheries both make up capture fisheries. The fishing area is separated into four zones, namely Zone 1 (0–3 nm), Zone 2 (3–20 nm), Zone 3 (20–45 nm), and Zone 4 (45–200 nm), for the purpose of managing fisheries. The Brunei Darussalam fisheries authority is the Department of Fisheries under the Ministry of Primary Resources and Tourism. Aquaculture is the human-assisted production of aquatic creatures in bodies of water, and it is impossible to conduct aquaculture operations without direct human involvement. Diverse aquaculture methods in Brunei Darussalam are the results of interactions between humans and their environment since humans developed aquaculture by modifying freshwater, brackish water, and marine ecosystems [9,10].

Capture fisheries, aquaculture, and fish processing are the 3 subsectors that make up Brunei Darussalam's Fisheries Industry. A comparison of each subsector's GDP contribution to the fisheries sector is shown in Fig. 1. This indicates that aquaculture has grown by 14% over the

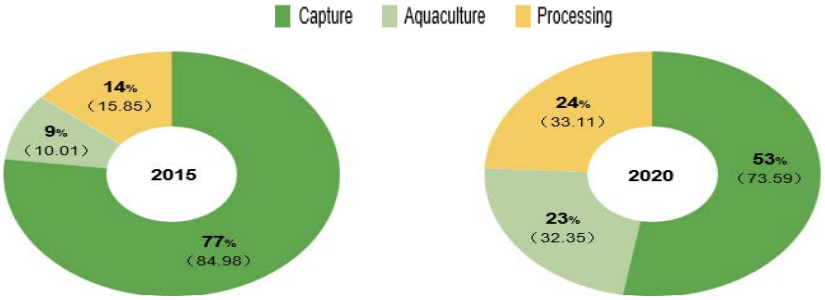


Fig. 1. Brunei fisheries subsector production share, 2015 and 2020 (Source: 11).

past 5 y, which is the biggest growth. Corresponding to that, the processing sector saw a 10% gain over the previous 5 y. On the other hand, the proportion of marine capture, which constitutes the largest share in fisheries, has decreased from 2015 to 2020 by 25% [11].

It is evident from the annual production figures for the aquaculture industry that the increase in value and volume of production was not progressive. After increasing from 2015 to 2017, production fell in 2018 and 2019, but it sharply surged in 2020, rising more than twice as much as the year before, from 10.64 million BND to 32.35 million BND, as shown in Fig. 2 [12].

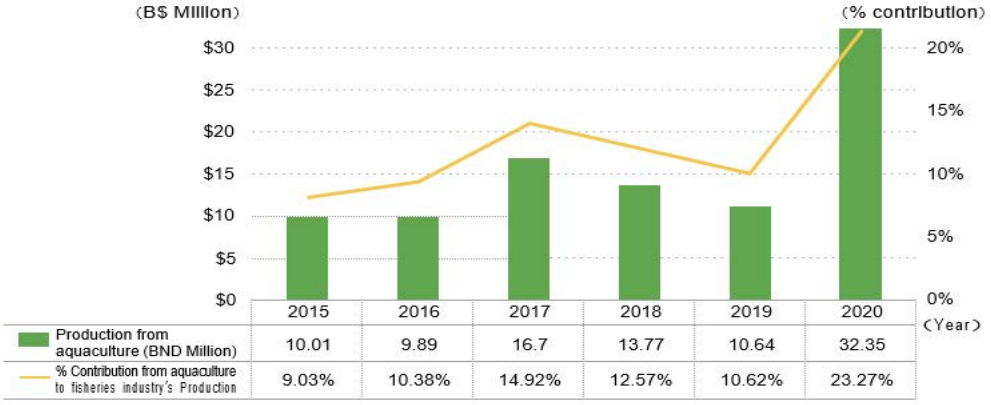
By analyzing the same output numbers from the standpoint of the commodity composition produced by aquaculture, as seen in Fig. 3, marine shrimp has continuously been the sector's largest contributor, followed by marine fish. The graph's steep spike in 2020 is the most striking feature, which has already been mentioned in earlier parts. According to the breakdown, marine shrimp output increased fivefold in a year, which is what caused the sector's production value to significantly increased [13].

1.2. Good aquaculture practices

The aquaculture sector can thrive under conditions of water quality which ensures the optimal ecological parameters for the growing fish. In other words, aquaculture and environmental deterioration are incompatible, thus players in the industry have a responsibility to safeguard the aquatic ecology around them to maintain the viability of the industry. Although aquaculture has been accused of causing aquatic pollution, it is often the case that the opposite is true, as seen when fisheries and aquaculture productivity are hampered by pollution. For instance, aquatic pollution is released into the aquatic ecosystem from a variety of urban or agricultural sources, having deleterious consequences on the aquatic ecosystem and the fish raised in fish farms [14].

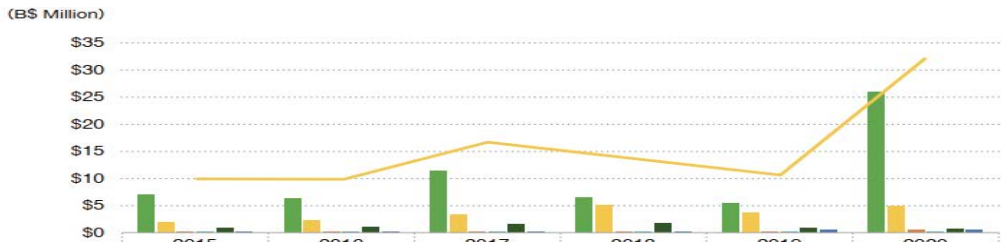
Due to the nutrient load generated from feed waste and organic waste, aquaculture can be a source of pollution under environmental conditions, aquaculture can be a source of pollution due to the nutrient load generation of feed waste, organic and inorganic nitrogen molecules (NH_X, NO_X) and molecular phosphorus. This organic load generated by aquaculture feed can affect the water column in the vicinity of the aquaculture site [15].

Different assessment methods can be applied to monitoring the effects of aquaculture production on the ecosystem. This paper, therefore, seeks to analyze the environmental issues of aquaculture and to advocate on the need for monitoring and controlling aquatic pollution. Additionally, extensive aquaculture systems require more chemicals to



	2015	2016	2017	2018	2019	2020
Production from aquaculture (BND Million)	10.01	9.89	16.7	13.77	10.64	32.35
% Contribution from aquaculture to fisheries industry's Production	9.03%	10.38%	14.92%	12.57%	10.62%	23.27%

Fig. 2. Production value of aquaculture and contribution to fisheries, 2015–2020 (Source: 12).



	2015	2016	2017	2018	2019	2020
Marine Shrimp	7.09	6.36	11.56	6.52	5.51	26.08
Marine Fish	1.85	2.26	3.31	5.1	3.67	4.82
Freshwater Fish	0.07	0.06	0.05	0.09	0.09	0.27
Crab	0	0	0	0.01	0	0.02
Marine Shrimp Fry	0.92	1.03	1.7	1.76	0.84	0.64
Fish Fry	0.07	0.18	0.08	0.3	0.54	0.53
Total	10.01	9.89	17.7	13.77	10.64	32.35

Fig. 3. Aquaculture production by type of species, 2015–2020 (Source: 11).

purify water and increase the usage of medications to cure diseases. Misuse of these substances, particularly aquatic pollution, has a negative influence on the ecosystem. Even more intriguing is the fact that some bacterial species have the capacity to evolve antibiotic resistance, which they then pass on to other bacterial species via plasmids.

The human stomach may allow the antibiotic resistance to spread from human diseases and into the general population [16]. Human-environment interactions in aquaculture are at risk since COVID-19 pandemic because land-based aquaculture is so greatly impacted by pandemic anxieties). Pandemic diseases are now a serious human health concern. The outbreak has had an influence on numerous aquaculture methods all over the world. The pandemic, which has created some issues with the availability of inputs and is currently disrupting grow-out operations, is quite likely to affect aquaculture. COVID-19's appearance demonstrated both its favorable and unfavorable effects on the aquatic environment [17–20]. The freshwater aquatic habitats that make up the aquatic environment are found in a continuum from the upstream estuary to the downstream coastal area to the area used for mariculture and deep-sea fishing. The complex of lotic-lentic water bodies was also greatly influenced by the large coastal environment, numerous lakes, and wetlands in flood plains and/or river basins. Due to the rapid economic expansion, particularly in emerging nations, many of these water bodies are being subjected to environmental stressors associated to anthropogenic activity and climate change. This results in declining water quality, hazardous algal blooms, decreased production, and a decline in biodiversity [21,22].

Noteworthy, since aquaculture produces food for human consumption, halal is a crucial problem. One of the damaging challenges in the aquaculture industry is water quality. The product is recognized and approved as "Halala Tayyiba" fish derived from a freshwater aquaculture because Tayyib is a method where clean and pure food will be produced and provides food security to the user or consumer. Fish are raised in aquaculture in closed areas; therefore, the process will include all production steps, harvesting, and marketing considerations [23].

It was stated on the fact that the Halalan Tayyiban criterion will not be met if fish are raised in ponds that do not follow Shariah compliance, such as using dirty sources for feeding [3]. Currently, Malaysian aquaculture is still dealing with Tayyib difficulties, especially regarding feeds and feed composition, which may hamper efforts to advance fish farming and small farmers into the halal supply chain. The 'Blue Transformation Roadmap 2022–2030' by the Food and Agriculture Organization of the United Nations (FAO) sought to expand sustainable aquaculture in order to meet the world's food demand to be accomplished through the implementation of many objectives, such as decreasing environmental effect in aquaculture [24,25]. In order to promote effective and responsible aquaculture production and expansion, help ensure the quality and safety of the finished product, and promote environmental, economic, and social sustainability, there are a number of factors, procedures, and protocols known as GAqP. Safe aquaculture products for human consumption, GAqP contends that on-farm operations must also include environmental, economic, and social sustainability. This will provide safe aquaculture products to consumers and maintaining the aquatic environment depends on production processes in aquaculture. Some of these elements are important for generating a high-quality and safe aquaculture product, which is often done by farmers in Southeast Asia [26].

However, the tasks ahead are daunting, and challenges will have to be met for the sector to grow sustainably and effectively contribute to fisheries development in the region. Needs to step towards the final formulation of a roadmap for sustainable aquaculture development in the region for the next 10 y and beyond. The following are the vital issues discussed for sustainable aquaculture practices in the ASEAN region [26]. The following water quality parameters and food safety are recommended to be monitored, development of a set of best practices in an 'ASEAN Aquaculture Farm' (Tables 1 and 2).

1.3. Fish food safety

Aquaculture activities should be conducted in a manner that ensures food safety by implementing appropriate national or international food safety standards and regulations including those defined by FAO/WHO Codex Alimentarius. ASEAN Sectoral Working Group on Fisheries [26].

(i) Aquaculture facilities should be in the areas where the risk of contamination is minimized or where sources of pollution can be controlled or mitigated in acceptable levels and according to national law and regulations.
(ii) Where feed is used, aquaculture operations should include procedures for avoiding feed contamination in compliance with international standards or national regulations as determined by internationally agreed standards.
(iii) Feed and feed ingredients used in the aquaculture operation shall not contain unsafe levels of biological, chemical, and physical contaminants and/or other adulterated substances. No prohibited substances shall be used in feed manufactured or prepared on farms.
(iv) Feeds should be handled and stored in such a way to prevent spoilage, mold growth and contamination.
(v) Farmers should only purchase commercial feed that has been registered to the competent authority and properly labelled in compliance with requirements of the competent authority.
(vi) All veterinary drugs and chemicals for use in aquaculture shall comply with national regulations, as well as international guidelines. If veterinary drugs and chemical treatment is necessary, use only registered veterinary drugs and chemicals and follow the instruction on the manufacturers label or as advised by competent authority.
(vii) Probiotics and biological agent inputs should be registered with, and approved by, the relevant/competent authorities.
(viii) Water used for aquaculture should be of a quality suitable for the production of fish which is safe for human consumption.
(ix) The source of brood stock, and seed for culture (larvae, post-larvae, fry and fingerling) should be such that

Table 1
Water quality parameters in ASEAN aquaculture (Source: 25)

Observation	Measures
High temperature (>32°C)	- Exchange water
Low dissolved oxygen	- Increase water exchange
(<3.5 ppm AM, <5 ppm PM)	- Stop feeding until corrected
	- Watch for symptoms of parasites/disease
	- Increase aeration (or beating/stirring of water-moving water increases dissolved oxygen)
Low pH (<6)	- Add alkaline buffer (sodium bicarbonate, lime)
	- Reduce feeding rate
	- Check ammonia concentration
High ammonia (TAN > 0.25 mg/L) or	- Exchange water
pH higher than 9	- Reduce feeding rate
	- Watch for symptoms of parasites/diseases
Transparency too low (<30 cm)	- Exchange culture water
	- Reduce feeding rate
	- Watch for symptoms of parasites/diseases
Dark green or dark brown colour	- Exchange water
	- Reduce feeding rate
	- Measure dissolved oxygen

Table 2
Fish food safety in ASEAN aquaculture (Source: 25)

GAqP topic	Good practice
Feed origin	The bags with feed contain should be ensured a label that indicates the composition of the feed, batch number, recommended storage conditions, expiry date, feeding rate, the name and contact details of the manufacturer, and other necessary guidance in an adequate language.
Feeding practices	A systematic approach needs to be followed by the aquaculture farmers to make sure, all the feeds will be eaten. by the fish and the water quality will not deteriorate.
Feed storage	This practice ensures employees will not easily make a mistake when selecting the appropriate pellet size, this in turn ensures that the feeding efficiency is maintained.

it reduces the risk of carryover of potential human health hazards into the growing stocks.

(x) Data related to food safety should be recorded, kept, maintained, and made accessible during culture and for at least 24 months after production.

(xi) Aquaculture facilities should be designed, operated, and maintained in ways that prevent contamination from workers, sewage/toilets, domestic animals, machinery oil/fuel and other possible sources to maintain hygienic conditions.

(xii) Appropriate harvesting and post-harvest handling, of aquaculture products within the farm should be practiced minimizing contamination and physical damage. Water and ice used during harvesting and grading should be of quality suitable to produce food which is safe for human consumption.

1.4. Production of fish and seafood

In recent years, Brunei's entire fishery production has increased, rising from $110.84 million BND in 2015 to $139.05 million BND in 2020 (Table 3). The output of aquaculture, one of the three subsectors of the fishing industry - capture, aquaculture, and processing contributed significantly to the increase from $10.01 million BND (9% in share) in 2015 to $32.35 million BND (23% in 2020). The growth in fishing production appears to be driven by the growth in aquaculture production, which has climbed from 9% in 2015 to 23% in 2020 [27].

Aquaculture production in the last decade has been particularly substantial in terms of growth rate. Although the number declined in 2018 and 2019, production appears to have recovered in 2020 with the highest production quantity as it is evidently shown in Fig. 4.

In terms of the precise species raised in Brunei, Fig. 5 demonstrates that the output of blue shrimp was much higher in 2018 when compared to that of other species. Brunei also produces other high-value species, such as Grouper and Barramundi, although their volume is still low when compared to that of blue shrimp. Given its size, grouper seems to be making a significant value contribution. Even if their volume is relatively small, high-value fish can nevertheless make a significant contribution to production values through the year 2020, as is the case with grouper

Table 3
Total fisheries industry production between 2015 and 2020 (Source: 10, 26)

Year	2015	2016	2017	2018	2019	2020
Value (BND million)	$110.84	$95.34	$111.90	$109.52	$100.15	$139.05

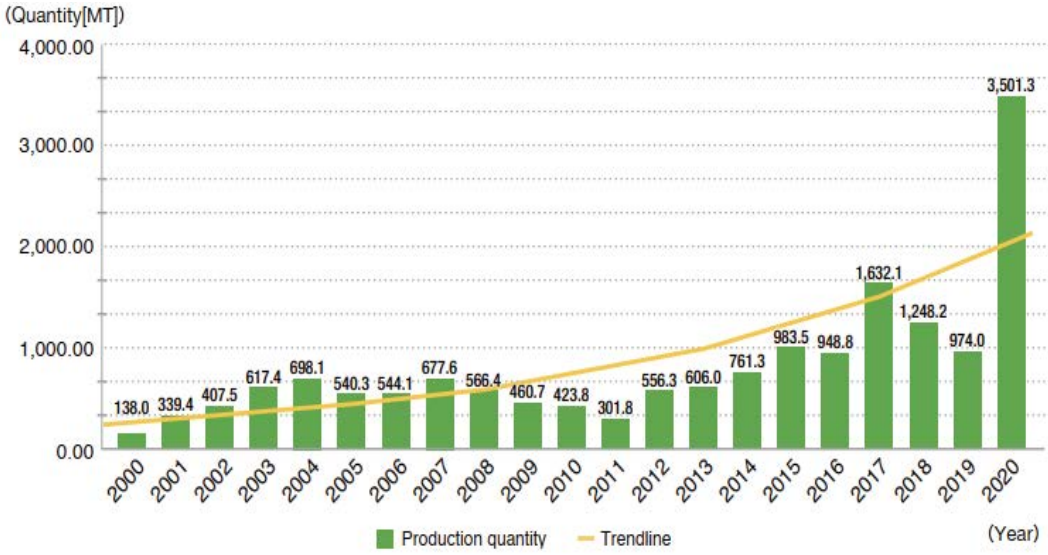


Fig. 4. Production of aquaculture industry between 2000 and 2020 (Source: 10).

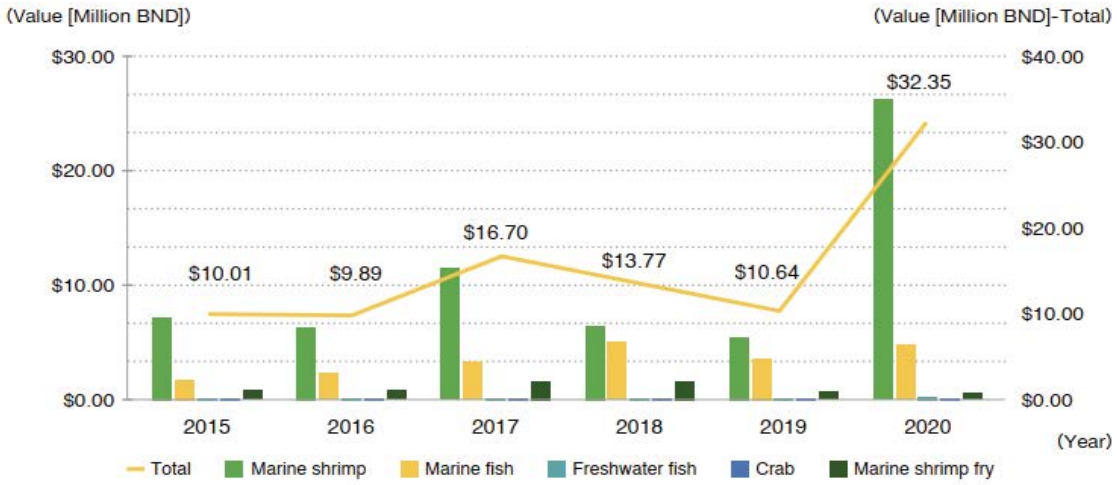


Fig. 5. Aquaculture production by types of fish in Brunei between 2015 and 2020 (Source: 10).

fish. To sustain wholesome and healthy aquaculture, diseases in aquaculture continue to be a key biosecurity risk that must be addressed [10].

1.5. Aquatic products processing

Apart from marine capture and aquaculture, a new business called fish and seafood processing has emerged. In addition to aquaculture and marine capture, a new industry called fish and seafood processing has developed. Fish and seafood products can either be sold directly to the local market after being obtained through marine capture and aquaculture, go through packing and preparation for export, or be transported to facilities for processing. Whole fish or shellfish are processed into a variety of products, including fish fillets, fish steaks, frozen goods, parts of breaded fish, canned goods, and smoked goods. Secondary processors can further process these prepared foods into products that are ready to eat or to heat and serve [10].

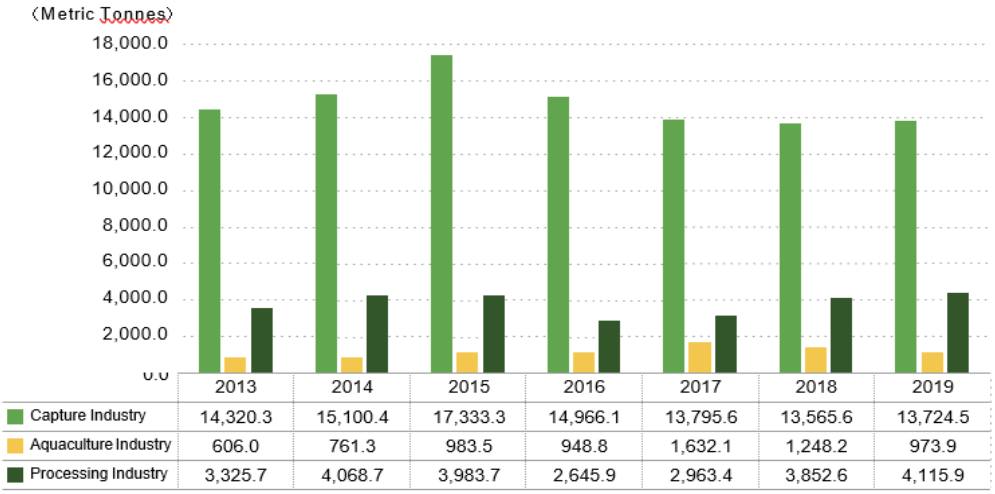
In fact, the total volume produced by each subsector of Brunei's fisheries having a significant volume difference from marine capture, the processing business comes

in second. In recent years, the processing industry's output volume has varied. After falling between 2014 and 2016, it rose during the next 3 y, reaching a value of 4,115.9 metric tonnes in 2019 (Fig. 6).

On the contrary, Fig. 7 shows the production of Brunei fisheries per subsector in terms of value in BND in the past 7 y. While the processing industry is still far second to marine capture, there is a noticeable difference in the trend where processing production has increased steadily compared to the decline in capture fisheries. The value of the aquaculture industry increased from 2013 to 2015 before slightly declining in 2016. It then continued to increase in 2017 where it peaked at 22,190 million BND. But then, this declined in the following 2 y with the value dropping to 15,440.1 million BND in 2019 [10,28].

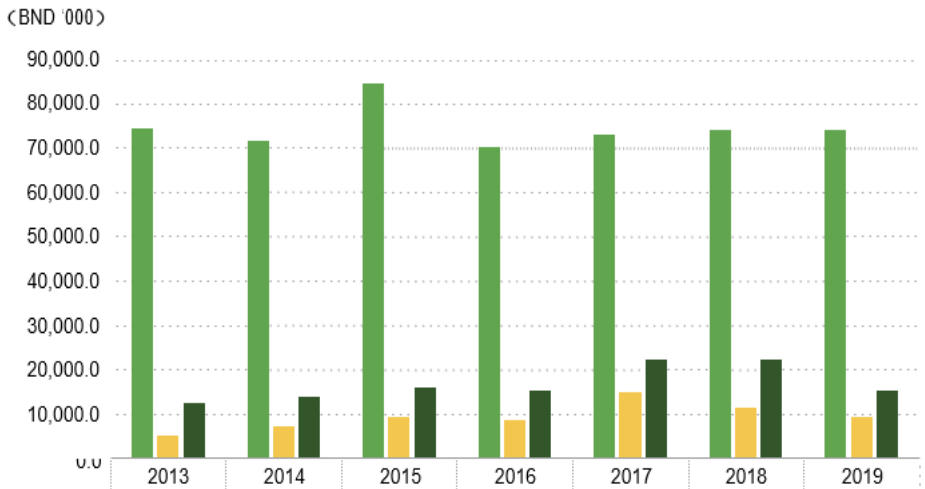
1.6. Halalan and Tayyiban in food products

The terms halal and haram are frequently employed to denote the dos and don'ts for Muslims in every area of life, making this subject crucial to Islamic teaching. Halal is an Arabic word that means "permitted, allowed, lawful or legal" (Halla, Yahillu, Hillan, Wahalalan). Contrarily, the Arabic word for banned, unlawful, or illegal, haram, means these things [29]. In the Qur'an and Hadith, there are references to relate to both halal and haram, some of which are as follows: Eat well and carry out good actions, O Messengers; I am aware of everything you do. (51) Al-Mu'minum Eat from the good things We gave you, O you who believe. (172 in Al-Baqarah). "All flesh fed by haram deserve nothing but hell" (At-Tirmizi: 641). "It is unlawful for you to shed



	2013	2014	2015	2016	2017	2018	2019
Capture Industry	14,320.3	15,100.4	17,333.3	14,966.1	13,795.6	13,565.6	13,724.5
Aquaculture Industry	606.0	761.3	983.5	948.8	1,632.1	1,248.2	973.9
Processing Industry	3,325.7	4,068.7	3,983.7	2,645.9	2,963.4	3,852.6	4,115.9

Fig. 6. Production of fisheries per subsector in metric tonnes, 2013–2019 (Source: 10, 27).



	2013	2014	2015	2016	2017	2018	2019
Capture Industry	74,608.2	71,500.8	84,982.3	70,113.9	73,037.3	73,805.8	74,072.1
Aquaculture Industry	4,872.2	6,992.6	9,055.6	8,688.1	14,919.9	11,713.0	9,268.4
Processing Industry	12,168.0	14,202.0	15,826.0	15,329.0	22,190.0	21,940.0	15,440.1

Fig. 7. Value of fisheries per subsector in metric tonnes, 2013–2019 (Source: 11).

the blood of one another or take (unlawfully) the fortunes of one another" (Muslim: 1218) As this article is about halal aquaculture, which might be called halal food production, the meaning of halal in terms of food should be defined. Currently, halal firms exist in a variety of industries, including food and beverage, banking and finance, hotels, services, and others. The demand for halal products on the global market skyrockets each year. The value of the global market for halal foods was estimated by a researcher to be around 1.4 trillion US dollars in 2017 and is expected to increase to 2.6 trillion US dollars in 2023. Worldwide halal trade is anticipated to reach USD 3 trillion (RM12.4 trillion) in Malaysia by 2021, with halal food accounting for the lion's share and being valued at USD 1.9 trillion (RM7.84 trillion). The fast-growing global halal business is being driven by three main factors, according to a group of experts [30,31].

1.7. Brunei Halal policies and management

The current global market has displayed strong acceptance of halal products with increasing demand for halal pharmaceuticals products and health supplements. While the trend of halal pharmaceutical products and health supplements offers a vast opportunity or platform for the country, several factors play a role in determining the halal or haram status of such products. Brunei strives to become a regional and global center for the halal business as a nation that upholds Islamic Law as a way of life and a tenet of government. For Brunei, the halal markets have enormous potential, particularly in terms of ensuring the food security of Muslims living in. nations that do not practice Islam. In ASEAN and the BIMP-EAGA (Brunei, Indonesia, Malaysia, and the Philippines) East ASEAN Growth Area, Brunei has persistently sought to build a halal business. The Sultanate has also been concentrating on the development of its halal human foods, drinks, cosmetics, medications, and fish feed for aquaculture. In fact, the Ministry of Religious Affairs (MoRA) in Brunei, which issues and regulates halal certification, is known as the Brunei Islamic Religious Council (MUIB) [32].

The Halal Food Control Division under the MoRA is responsible for the enforcement of Halal Meat Act, Chapter 183 and its regulations, and Halal Certificate and Halal Label Order, 2005. All restaurants and food manufacturers catering to the Muslim community are required to obtain a halal certificate or halal branding under this order. Halal Authorities in Brunei Darussalam. The Islamic Religious Council of Brunei or Majlis Ugama Islam Brunei (MUIB) is the ruling body that was established per section 5 of the Islamic Religious Council and Kadhi Courts Act, Chapter 77. MUIB has the most authority to advise and guide His Majesty the Sultan in making and formulating Shariah law in the country. The Ministry of Religious Affairs also has a major role in the implementation of the Halal Certification System in Brunei Darussalam through the Department of Syariah Affairs. Adding on to the country's implementation of Syariah Law, it will further enhance the confidence that Brunei is fully determined to set its goal as a halal industry hub regionally and internationally. In realizing the initiative, Brunei *via* BIMP-EAGA Vision 2035 (BEV 2025) provides the policies that give significant advantages to local businesses and their alliances to expand within the region [33,34].

The Brunei Darussalam BIMPEAGA Business Council's (BD-BEBC) strategic initiatives aim to promote the development of the BIMP-EAGA region as the main economic platform to move towards a halal economy. Brunei works towards becoming a halal industry hub regionally and internationally. The halal markets hold vast potential for Brunei, especially in providing food security for Muslims in non-Islamic practicing countries. The council focusses on branding the BIMP-EAGA region as an international trade hub based on Syariah Compliance Value Stream and Trade Services. In addition, the council promotes the ASEAN Economic Community (AEC) to develop as an industry and production base for the global Islamic market. The initiative was further strengthened when the council launched its e-commerce platform, a joint initial investment between GTWO International Co., Ltd., Thailand; IHTHS Corporation, Brunei; and PT Winmas, Indonesia. The platform comprises products from BIMP-EAGA and beyond with a category for the Syariah-compliant products [35].

The government is a key player in the logistics sector, according to every study we've looked at. Considering the information presented here, several suggestions for potential actions the government of Brunei might take to promote the adoption of HLog are made. The Brunei government wants to diversify its economy, and the halal sector has been selected as a promising area to explore into, according to an illustration displayed in Fig. 8. This is even though the worldwide halal market is enormously profitable and expanding. The importance of HLog should not be disregarded if the goal is to be achieved. The six pillars stand for proposed realistic actions that ought to be performed to encourage the adoption of HLog across the nation (Fig. 8) [36].

1.8. Domestic value chain on aquatic products in Brunei Darussalam

Aquaculture production requires several operations to create and transfer the product to the market and consumers. The value chains are therefore essential in creating a setting where all parties involved in the process - relevant departments, industry, and stakeholders - can profit from one another. It seeks to maximize the value of the finished product through many efficient divisions, including as management, market information systems, and transportation, by examining each stage of the manufacturing process.

The Department of Fisheries under the Ministry of Primary Resources (MPRT), Tourism, and Brunei Economic Development Board have recognized Brunei's native fisheries ecosystem. It demonstrates how Brunei's fishing sectors are intertwined and how fish and seafood products are produced along a value chain from pre-production to distribution. The growth of fry, fingerlings, feeding, storage, and certification are all included in this process. Fig. 9 captures the basic flows of the industry and some spin-off industries that are created in the production process [10,37].

Fig. 10 shows a generalized image of the fisheries ecosystem, specific value chains for specific areas have been developed from the strategic plan of the Department of Fisheries (DOF). Figs. 9 and 10 depict the current value

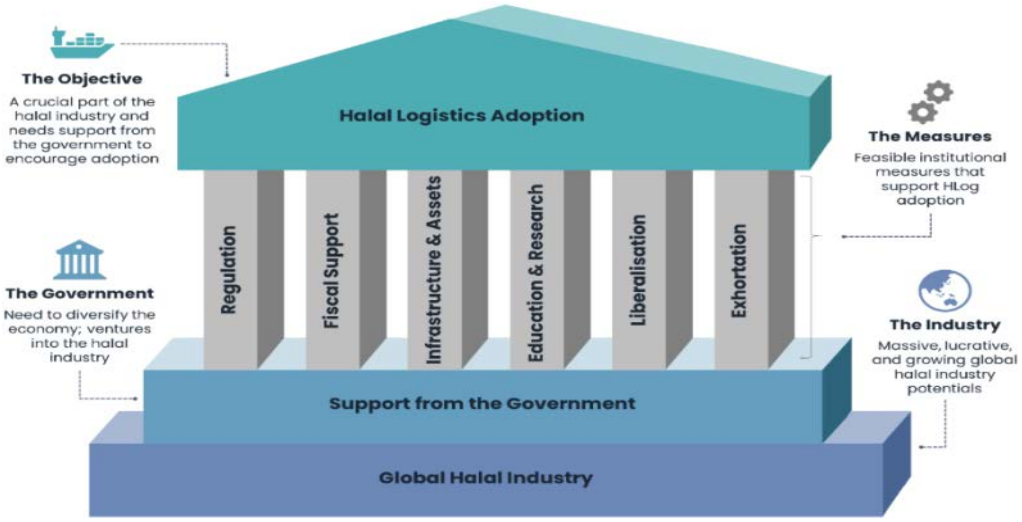


Fig. 8. Government measures to support Halal Logistics Adoption in Brunei Darussalam (Source: 35).

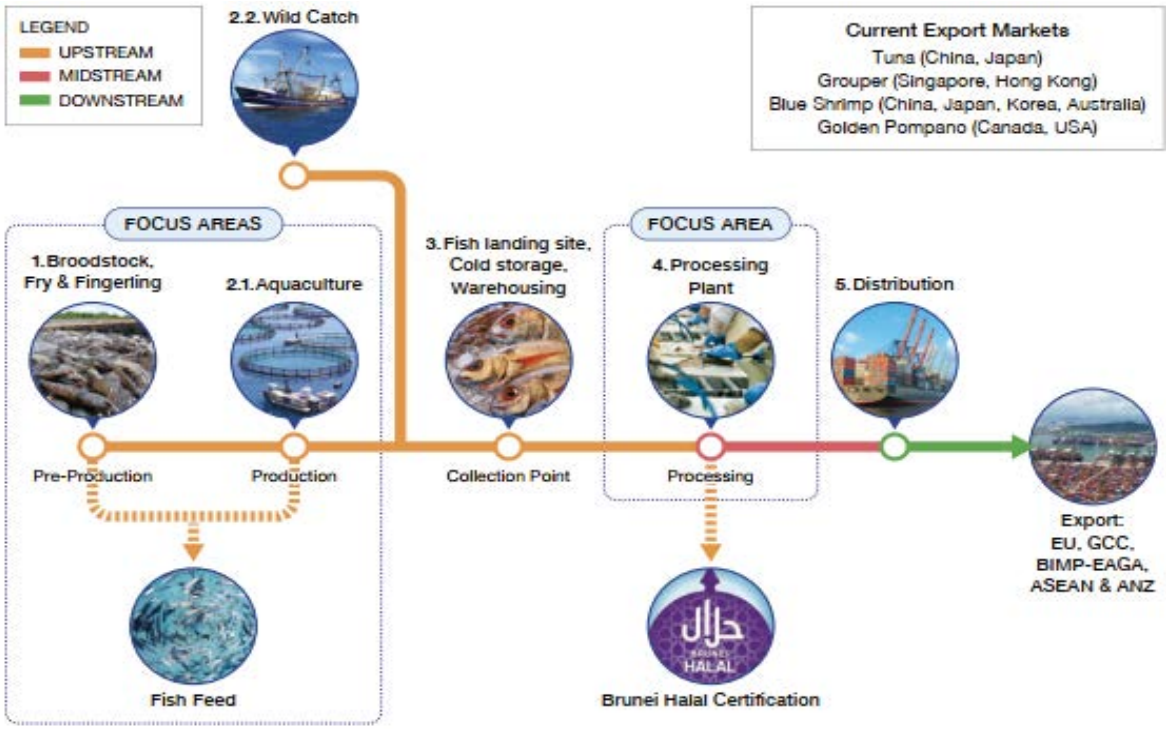


Fig. 9. Generalized image of the fisheries ecosystem (Source: 10, 27).

chain and the process of the aquaculture and seafood processing industries in Brunei. It captures the basic flows of the industry and some spin-off industries that are created in the process of production [38].

Researchers have been inspired to explore and review the concept and application of Istibra' as an instrument that may be used as a solution to overcome the difficulties of unethical animal feeding practices because of the increased use of non-halal animal feed as aquaculture feed. Many sellers and buyers are unaware of the importance of Istibra' or quarantine as a catfish purification process. Few research, particularly in the aquaculture industry, have suggested Istibra as a purification method for Jallalah animals. In the aquaculture industry, halal blockchain technology can be used to improve the present halal supply chain in a more effective and digital way. Freshwater fishes are almost identical to chicken goods in that they don't require the slaughtering procedure, which is the most important halal control point to consider when dealing with animals. Halal blockchain technology can be applied in aquaculture sector to improvise the current halal supply chain in a more efficient and digital way. Almost similar to poultry

products, freshwater fish however does not involve the slaughtering process, which is the most critical halal control point to be looked out for when dealing with animals. The focus will be more on good farming practices, feed and feeding practices, logistic (storage and transfer process) and integrity to maintain the good record keeping in each step of the process in the supply chain until safely served to the consumer [39,40] (Fig. 11).

1.9. Potential issues on 'Halalan and Tayyiban' in fish and fisheries products

Aquaculture may be a cause of pollution due to the nutrient load creation of feed waste, organic and inorganic nitrogen molecules (NH_X, NO_X), and molecular phosphorus. The organic load produced by aquaculture feed may influence the water column surrounding the aquaculture site [41].

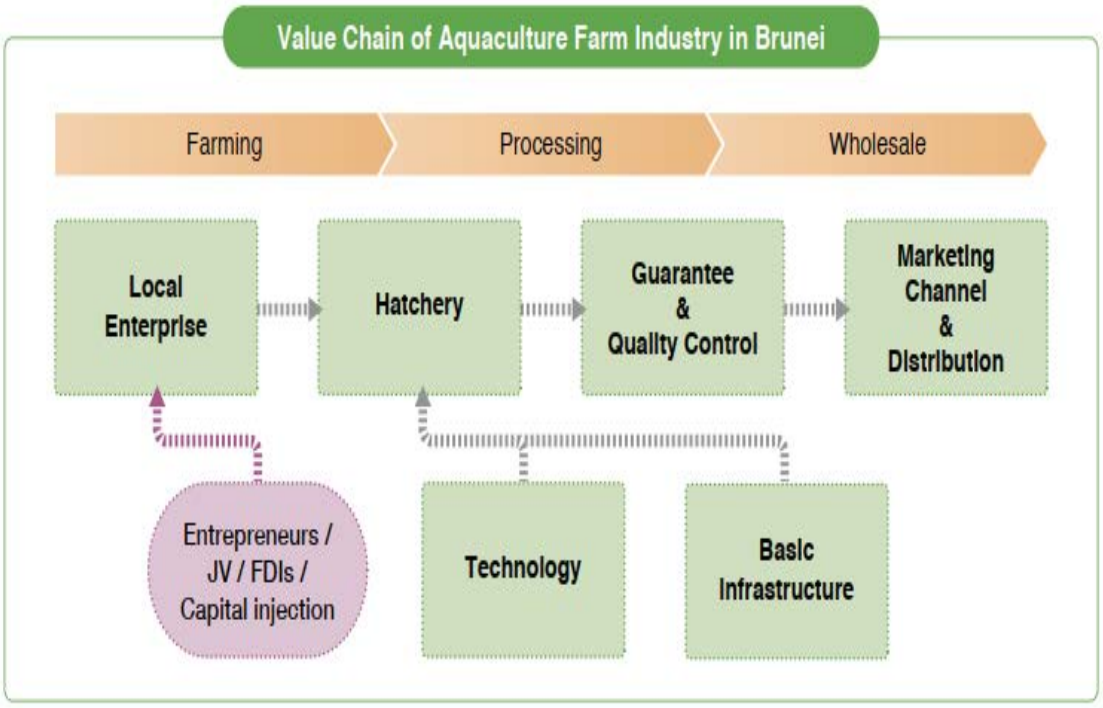


Fig. 10. Depict the current value chain and the process of the aquaculture and seafood processing industry in Brunei (Source: 10, 27).

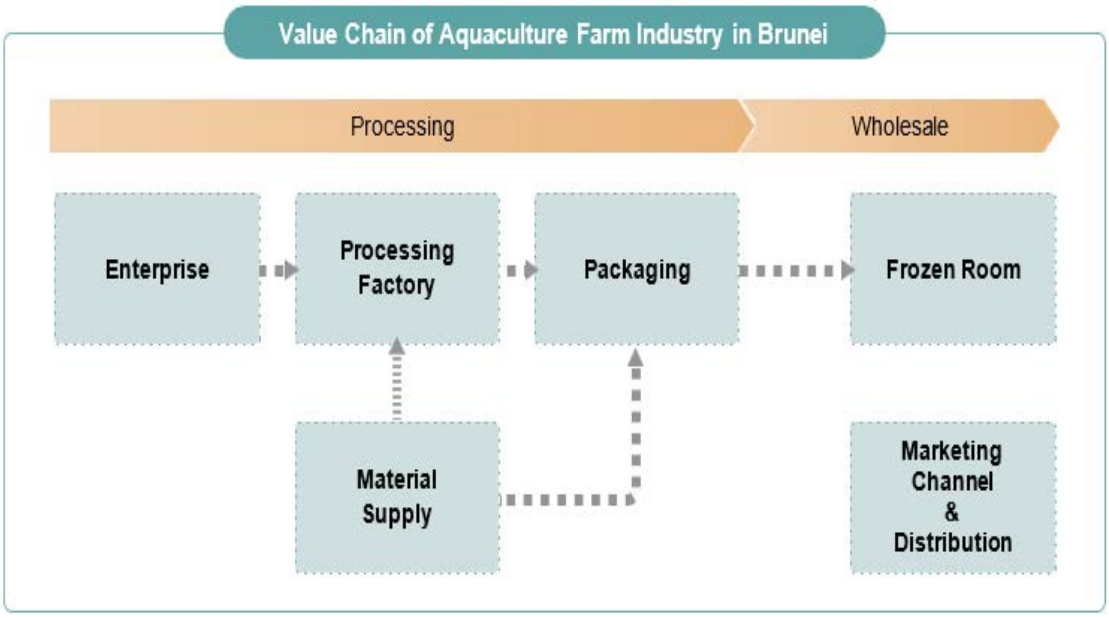


Fig. 11. Value chain and spin-off industries of seafood processing in Brunei (Source: 10, 27).

Eutrophication is a frequent environmental concern connected with freshwater aquaculture activities. Eutrophication is a phenomenon in which water bodies become richer in dissolved nutrients (such as phosphorus), promoting the growth of aquatic plant life but often depleting dissolved oxygen. As natural water bodies become eutrophic, the development of toxic algae, known as algal blooming, can expedite water quality degradation. This is since when these algae die, microorganisms that consume dissolved oxygen disintegrate them. Water quality limitations especially temperature, and ammonium level, when are outside the preferable of the fish species range will induce stress, compromising their immune system and making them vulnerable to many opportunistic pathogens [42]. Aquaculture in at this point still facing Tayyib issues, particularly in the feeds and feed composition which may affect the effort to bring forward fish farming and small farmers into the halal supply chain [3]. While at the same time, the Food and Agriculture Organization of the United Nation in their Blue Transformation Roadmap 2022–2030 aimed to intensify sustainable aquaculture to satisfy global demand for food. This aim was planned to achieve through the implementation of different targets including minimizing environmental impact and the use of resources efficiently [24]. Regarding feed issue is the disease which has become the main threat to the aquaculture industry. Aquaculture practices and environmental quality in the operation are related to fish health. Water quality deterioration showed a direct impact on the high prevalence of ectoparasites on cultured fish [23]. Fish being cultured in overcrowded and poor water quality conditions had been reported as the factors responsible for the development of parasitic copepod disease [43]. Environmental quality obviously relates to the Tayyib concept. This is where the concept of Halal and Tayyib needs to be highlighted as a comprehensive approach to support the FAO roadmap and become the opportunity to influence the government policies in implementing mandatory Good Aquaculture Practice for aquaculture operators to resolve some SDGs parameters in ASEAN countries and globally as well [44].

1.10. Potential challenges and policies in ASEAN Halal Industry

One of the primary obstacles confronting the region pertains to the absence of uniformity in Halal Certification and Accreditation. The circumstances have resulted in a state of perplexity amongst the clientele and commercial entities, thereby impeding the progress of the sector. To tackle this challenge, ASEAN endeavors must achieve harmonization of its Halal Certification and Accreditation Standards. The successful execution of this endeavor necessitates a meticulous partnership between the constituent nations and pertinent players within the industry. By establishing a common set of standards, ASEAN can enhance the credibility of its Halal Certification and Accreditation Processes and create a more conducive environment for the growth of the industry. An additional domain that necessitates consideration is the advancement of Halal Tourism within the ASEAN region. The locality boasts an excess of halal-certified culinary options and a wealth of cultural traditions, both of which can be harnessed to entice global Muslim travellers. It is imperative to cultivate tourism infrastructure and services that are accommodating to the halal lifestyle to effectively serve the requirements of Muslim voyagers. Notwithstanding the obstacles, there exist grounds for sanguinity regarding the prospects of the halal sector in the ASEAN region. The locality has evinced a resolute dedication towards fostering the sector, and there is an escalating cognizance of the prospective advantages it can yield. By implementing appropriate policies and strategic measures, the ASEAN region has the potential to establish itself as a pre-eminent player in the halal sector, thereby unlocking a plethora of economic and societal advantages [45].

Brunei Darussalam becoming a potential halal hub in ASEAN region by strengthening its halal certification value-chain or system. The halal supply chain is a system that implements the notion of 'Halalan Tayyiban' compliance with Islamic Law all the way through the supply chain, from the sources of supply to the consumers. The activities involve which must adhere to Shariah law - include transportation, handling items, inventory management, procurement, and order management along with these procedures as well as potential biological, chemical, or physical risks, affecting their status as 'Halalan Tayyiban' in the process. However, it should be emphasized here that the state of the fish is important when it comes to determining the 'Halalan Tayyiban' status of the fish feed imported from overseas [46].

Conversely, if the fish is newly caught and fresh but reared in the pond that does not adhere with Shariah compliance, for instance using filthy sources for feeding, the 'Halalan Tayyiban' specification will not be achieved. As for the practices in aquaculture which does not involve slaughtering, the consumers are still emphasized to know the status of the products they receive, to ensure that their rights are preserved in terms of the safety and the wholesomeness of their consumption [46].

2. Conclusion

The halal industry is continuously growing and drawing interest from professionals throughout the world. The industry is comprehensive and has permeated all facets of the economy, which attracts corporations to invest in it as a unique product since the opportunities are endless. This paper has reviewed some Quranic verses and Islamic values from Jurists that are highly associated with the implementation of good aquaculture practices. Some aquaculture practices are far from ideal as humans are naturally materialistic and they only care about profitability.

The positive outlook presented here demonstrates the ASEAN region's constant commitment to innovation and progress and foretells a positive future for the 'Halal Aquaculture Industry' both inside and outside of its boundaries. There is great intellectual fascination surrounding the ASEAN region's enormous potential for growth and development. The developments made in this area are an indication of the intensified levels of cooperation, investment, and trade prospects being pursued. As the Halal Industry receives greater recognition and exposure globally, it is likely to follow this path in the future. Through certification and the implementation of religious

authorities' policies in 'Halal Aquaculture Products', which are essential for the expansion of the halal industry, governments, and the business sector each contribute to the halal ecosystem's long-term viability. The developments made in this area are an indication of the intensified levels of cooperation, investment, and trade prospects being pursued. It is obvious that the ASEAN area will continue to experience positive success as given the numerous stakeholders that are actively engaged in supporting this essential business towards SDGs 14 (Life below water) which ensured the Food Security and Nutrition to protect the well-being of stakeholders and environment in Brunei Darussalam.

However, one of the key links in the aquaculture halal supply chain is seen to be the management of aquaculture farms. The practice of handling fish and their feed in an unsanitary manner and failure to follow the normal procedure for maintaining acceptable water quality will encourage the growth of pathogenic organisms that will infest the fish and reduce their nutritional value. So, preserving a strict protocol and standard operating procedures for aquaculture activities could be a way to improve the 'Tayyib' practice and quality of the product in the industry. Healthy fish with halal ingredients in fish feed will increase demand and activate the halal supply chain with increasing productivity and better visibility in Brunei Halal Branding, as it can provide more international markets for Brunei made aquaculture products globally.

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