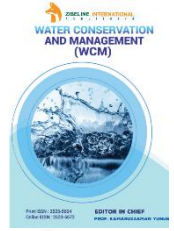




ZIBELINE INTERNATIONAL™
P U B L I S H I N G
ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD

Water Conservation & Management (WCM)

DOI: <https://doi.org/10.26480/wcm.02.2022.01.05>



RESEARCH ARTICLE

OVERVIEW OF HALAL FRESHWATER AQUACULTURE SYSTEM: MALAYSIAN PERSPECTIVES

Betania Kartika^a, Sitti Walida Parson^a, Zaleha Kassim^a, Ahmed Jalal Khan Chowdhury^b

^aInternational Institute for Halal Research and Training, (INHART) International Islamic University, Malaysia (IIUM) Kuala Lumpur, Malaysia

^bDepartment of Marine Science, Kulliyah of Science, International Islamic University, Malaysia (IIUM) Kuala Lumpur, Malaysia

*Corresponding Author E-mail: jkchowdhury@iium.edu.my

This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 05 October 2021
Accepted 09 November 2021
Available online 12 November 2021

ABSTRACT

In line with the increasing halal demand around the world, one of the sectors that attract the halal world attention is the freshwater aquaculture for fish food. The demand goes higher day by day as the marine catch start to deplete and world needs an alternative to suffice the demand for protein supply. This paper discusses the overview of current freshwater scenario in Malaysia and reported issues regarding the depreciation of halal of freshwater fish exposed by media for the last few years up until the recent time. The issue of water pollution which is synonymous in freshwater aquaculture activity is also briefly discussed. Moreover, this paper also outlines the potential issue that is often overseen even by the farm operator in order to obtain the halal farm certified. Solution is also given in this paper by proposing the application of halal block chain technology in freshwater aquaculture sector. The methodology used is mainly the library research from various reliable sources, such as database and search engine that cover selected journals and information regarding the subject matters, including references from local or international fisheries authorities. Expert views focusing on block chain technology through article writing in mass media are also taken as a reference. The discussion in this paper hopefully can provide a clearer view on the reality of issues faced by the freshwater fish aquaculture sector as well as provide a good potential solution by the application of disruptive technology of block chain system in accordance with the government recommendations in Industrial Revolution 4.0.

KEYWORDS

Freshwater aquaculture, halal issue, halal block chain technology

1. INTRODUCTION

The issue of halal and haram is very important in Islamic teaching as these terms are usually used to indicate the dos and don'ts for Muslim in every aspect of life. Halal is Arabic word, *halla, yahillu, hillan, wahalalan* that gives the meaning of being permitted, allowed, lawful or legal. Oppositely, haram which is also the Arabic word which means forbidden, unlawful or illegal (Miskam et al., 2015). Dalil related to both halal and haram are mentioned in Quran and Hadith, some of them are stated as follow:

"O Messengers, eat of the good things, and do good deeds; verily I am aware of what you do" (Al-Mu'minum: 51)

"O those who believe, eat of the good things that We gave you" (Al-Baqarah: 172)

"All flesh feed by haram deserve nothing but hell" (At-Tirmizi: 641).

"It is unlawful for you to shed 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. In terms of international standards, the United Nations FAO (2001) has given a broad definition and criteria for halal to which member nations can refer.

Halal food is defined as food that is permissible to consume under Islamic Law if it meets the following criteria:

- 1) It is free of anything deemed to be banned under Islamic Law.
- 2) According to Islamic Law, no instrument or facility should be used for preparation, processing, transit, or storage if it has been polluted with illegal substances.
- 3) Preparation, processing, transportation, or storage must not come into direct touch with any food that does not meet the above-mentioned criterion one and two.

The rules further said that while preparing, processing, or storing halal food in distinct sections or lines inside the same premises where non-halal foods are produced, essential precautions to avoid contact or contamination between halal and non-halal food must be taken. For the case of preparation, processing, transportation or storage of halal food using facilities which have been previously used for non-halal foods, proper sanitation guidelines based on Islamic requirement that have been observed must be provided.

In Malaysia, Department of Islamic Development Malaysia (JAKIM) is the authority that is in charge for the Islamic affairs including halal certification in Malaysia. It establishes regulations authorized by the

Quick Response Code



Access this article online

Website:
www.watconman.org

DOI:
10.26480/wcm.01.2022.01.05

cabinet and issues the halal certification mark for certified items that adhere strictly to halal criteria as defined by Shariah rules. These policies and standards are operated by JAKIM for the purpose of halal certification. The halal status of the product must be determined at each stage and process involved by conducting an official site inspection on the facilities to evaluate how the raw material's halal status is maintained and managed at all times. For the imported halal products from foreign countries, reputable and credible foreign halal certification bodies must be registered and recognized by JAKIM based on the capability to comply with the Malaysian procedures & guidelines. As per December 2020, there are 84 foreign halal certification bodies recognized and officially registered under JAKIM ("Foreign Halal Certification Body," n.d.).

Currently, halal businesses include food and beverage, finance and banking, hotel, services, agricultural, pharmaceutical, medical, and others. Each year, the worldwide halal market's demand skyrockets. According to a researcher, the worldwide market value for halal foods was roughly 1.4 trillion US dollars in 2017 and is predicted to climb to 2.6 trillion US dollars in 2023 (Shahbandeh et al., 2018). In Malaysia, according to Thomson Reuters statistics, worldwide halal commerce is estimated to exceed USD 3 trillion (RM12.4 trillion) by 2021, with halal food accounting for the lion's share, valued at USD 1.9 trillion (RM7.84 trillion) (Neo, 2018). According to a group of researchers, there are three major causes driving the rapidly expanding global halal sector (Azam and Abdullah, 2020). The first is the Muslim population, which is expanding at a pace of 1.8 percent each year. The second reason is that economic growth is increasing, which gives Muslims more purchasing power, and the third reason is the creation of a potential halal market in non-Muslim countries and halal industry participants. The aquaculture sector is viewed as a prospective industry capable of meeting the need for halal food by producing halal and cleanliness fish to fulfil the demand for protein supply. According to the Fish Site (2020), overall fish output is expected to rise from 179 million tonnes in 2018 to 204 million tonnes in 2030 (Fish Site, 2020). This aquaculture production is predicted to reach 109 million tonnes in 2030, up 32% (26 million tonnes) from 2018. (Towers, 2013).

2. OVERVIEW OF AQUACULTURE INDUSTRY

Aquaculture has traditionally been performed by catching and storing aquatic animals in ponds, lagoons, or lakes for extended periods of time in order to make them available for food, particularly at the individual or household level. However, in recent years, this basic process has swiftly spread and become commercialised in order to meet global fish market demand. The factors that contribute to this high demand include the developing world's growing affluence, increased urbanisation, and ongoing population expansion (Msangi and Batka, 2015). According to a researcher, while catch fish output levels have not improved over the last decades, aquaculture hopes to be able to meet global demand in the next decades (Barbaroux et al., 2012). Surprisingly, for the first time in history, the majority of fish for human consumption came from farms rather than wild catch, reaching about parity in 2012. There are several factors that have led to the decline in wild fish harvest. According to a United Nations assessment, more than two-thirds of the world's fisheries are completely harvested or overfished, and more than one-third are in decline owing to habitat loss, rising pollution levels in seas and rivers, and climate change. Aquaculture is viewed as one of the best choices to meet the scarcity of fish supply, provided that it is conducted in a sustainable manner, which implies that it has a positive influence on the environment, helps to local social community development, and generates an economic benefit.

Malaysian fish aquaculture began in the 1920s with considerable polyculture of invading Chinese carps, notably bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), and grass carp (*Hypophthalmichthys molitrix*) (*Ctenopharyngodon idellus*). As a result, fish aquaculture expanded rapidly until the mid-1950s, when significant freshwater fish culture was initiated in earthen ponds. Freshwater fish culture techniques and systems such as freshwater fish culture in ponds, ex-mining pools, concrete ponds, and pen culture in inland wetlands or shallow lakes have already been successfully operated or are being developed in Malaysia. In floating net cages, freshwater fish are also farmed. n.d., "FAO Fisheries and Aquaculture - National Aquaculture Sector Overview - Malaysia." As sea fish resources dwindle, it is vital to investigate our "backyard" of rivers, mining pools, and lakes as a viable option for producing fish and other aquatic food supplies. Mining pools are irregularly shaped bodies of water formed as a result of Malaysia's massive tin-mining industry. They serve as water resource ponds for working mines, but they are deactivated after the mine's supplies are gone. For decades, these ponds have been utilised for fish farming (Liong et al., 1988).

Malaysian aquaculture operations are classed as major, medium, or small based on the monthly and yearly volume of production yields. During the early years of aquaculture operations in Malaysia, most farmers ran small-scale aquaculture farms that were purely focused on supplying their personal needs, with any excess being sold in the market. Their operations were perilous since they were typically conducted in open water sources without appropriate understanding on how to operate advanced agricultural equipment. Furthermore, they had limited access to seed supplies and lacked institutional assistance to improve their agricultural abilities (Edwards, 2000). A lack of sustainability and dependable aquaculture was one of the key issues that caused losses and suggested poor management at the time (Hamdan et al., 2015). The government, through the Department of Fisheries (DOF), has developed one initiative, Aquaculture Industrial Zone (AIZ), to assist in the growth of the aquaculture sector in Malaysia. This programme involves the establishment of 49 zones situated throughout Malaysia. DOF has designated priority locations for the development of downstream operations such as fish seed cultivation, feed mills, fish processing facilities, and other supporting industries (Yusoff, 2014).

The government has committed to allocating large sums for physical and financial infrastructure for this initiative with the aim that Malaysia's aquaculture sector can be turned into a more technologically driven activity with a high market contribution. As a result, the aquaculture industry is capable of sustaining national food security while also resolving insufficient marine fisheries landings and exploitation of marine fish [FFTC, 2020; Fisheries Development Authority of Malaysia, 2020]. For example, the government promoted integrated cage farming enterprises through EPP4 programmes to develop large-scale aquaculture operations. The employment of advanced technology for modern agricultural processes, notably by aquaculture producers, has led to increased production in the field (DOF, 2020). Aquaculture technologies involve many aspects of aquaculture methods, systems, facilities, engineering, feeding technology, and biotechnology (FAO, 2014). Essentially, these types of aquaculture technology are simple since they include just minor changes to previous technologies that can boost the development and survival rates of aquaculture species. Aside from that, the contribution of Fisheries Research Centers and Fisheries Institutes to Aquaculture Research and Development in Malaysia in terms of developing relevant aquaculture technologies and good aquaculture management has highlighted the importance of environmental and social aspects in ensuring sustainable and safe aquaculture production. Recognizing the significance of sustainable aquaculture practises and food safety, Malaysia established the Malaysian Good Agricultural Practices (MyGAP) in 2013, as a rebranding of the former Malaysian Farm Certification Scheme for Good Agricultural Practices (SALM), Livestock Farm Practices Scheme (SALT), and Malaysian Aquaculture Farm Certificate (SPLAM) (Hamdan et al., 2015).

3. FRESHWATER USAGES AND PRODUCTS

Freshwater is defined as water with fewer than 1,000 milligrammes of dissolved particles per litre, most often salt (USGS, n.d.). Water is classified into two types: salt water and fresh water. Saltwater accounts for up to 97 percent of all water on Earth and is usually found in oceans and seas. This indicates that just 3% of the water on Earth is freshwater. Glaciers, lakes, reservoirs, ponds, rivers, streams, wetlands, and even groundwater are all examples of freshwater bodies on Earth. These freshwater environments encompass less than 1% of the world's total surface area yet house 10% of all known animals and up to 40% of all known fish species (WWF, n.d.) Freshwater is used as a medium in aquaculture to develop various varieties of fish, shrimp, crabs, and mollusks. The benefit of freshwater is that it may serve as a backup to meet the increased demand for protein sources as a result of the loss of marine wild catch. However, the unmanaged and poor methods of carrying out this activity have had an impact on the water quality as well as the habitat of flora and wildlife.

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 have an effect on the water column surrounding the aquaculture site (Mavraganis et al., 2020). 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 (Tang et al., 2020). This is due to the fact that when these algae die, microorganisms that consume dissolved oxygen disintegrate them. Low oxygen concentrations make it hard for fish to thrive, endangering aquatic life by disrupting the food chain. Algal

blooms have a considerable influence on drinking water supplies, fisheries, and recreational value, in addition to hurting freshwater farming operations, owing to diminished water clarity, bad odours, and toxicity (Michael et al., 2013).

There are a few precautionary measures and remedies that may be implemented to tackle this situation. To begin, wastewater such as sewage and pond effluent should only be discharged into a river or other water system after it has been properly treated. Filter and remove nitrates and phosphates from wastewater before it is dumped into a river, for example. Next, employ proper aquaculture procedures, such as selecting the best feed formulas and administering them at the right measurement. Uneaten feed as a result of overfeeding will produce silt, hastening the eutrophication process. The use of fertiliser in aquaculture ponds must also be controlled and provided only, when necessary, as excessive fertiliser use is one of the factors that lead to eutrophication. If algal blooms have already grown, they must be removed from the water. Algae should not be disposed of in water after death because breakdown generates plant nutrients that encourage algal growth to continue. Finally, algicides such as CuSO₄ can be used to suppress algae development in water (Karki, 2018). The health and well-being of freshwater must be safeguarded for the sake of future generations. Catfish (*Clarias* sp.), Tilapia (*Oreochromis niloticus*), Patin (*Pangasius* sp.), Javanese carp (*Puntius gonionotus*), common carp (*Cyprinus carpio*), large head carp (*Ctenopharyngodon idella*), and marble goby are the principal freshwater food fish species produced in Malaysia (*Oxyleotrix marmoratus*). Apart from being cooked in a variety of methods and recipes, freshwater fish may also be made into other goods such as surimi, frozen fillet, and canned food, which increases the diversity of freshwater fish products while also extending their shelf life. Freshwater fish can also be highly effective in nutraceuticals and pharmaceutical goods due to the extraction of bioactive peptides with antioxidative characteristics. The peptides also exhibit antibacterial capabilities that might be used to generate innovative antimicrobial medications in the future. In the long run, these antimicrobial peptides might be used as vaccines to prevent certain illnesses, as well as food preservatives and supplements. Because hazardous bacteria are becoming increasingly resistant to existing antibiotics, it is critical to study new antimicrobial chemicals (Babji et al., 2015).

4. REPORTED ISSUES IN HALAL AQUACULTURE

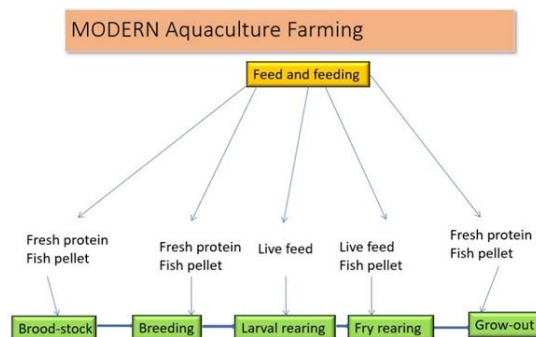
Series of cases involving the non-compliance to halal specification for fish aquaculture have been reported before. It happened in several places over the past few years up until this recent year. Below is the list of reported cases by the local medias exposed as a result of reports and observations made by the public who concerned towards this issue:

- *Harian Metro* on January 2006 reported the issue of "*Patin Babi Rebus*" that there was some owner of freshwater catfish ponds especially in Perak feed their livestock using boiled pig internal organs and bowels.
- Berita *Harian* on January 2006 reported on Tilapia being fed with pig waste as a result of operations carried out by the Perak Islamic Department at the fish farms in Tronoh, Papan and Batu Gajah. Farmers claim that the action of feeding their fish with pig waste able to boost the growth of fish and can be marketed within three months as compared with a year if not given such food.
- *Kosmo* on May 2009 revealed that some of the fish farmers were using cultivated fish to purify the wastewater of the pig farm.
- The New Straits Times on April 2010 reported that there were assertions on catfish feeding in Agrotech Park Smart Jaya, Kuala Selangor were fed with the stomach, waste, carcasses and internal organs of pigs.
- Selangorku on November 2013 reported that a farmer was convicted of feeding cultivated Patin with pig intestines.
- Sinar *Harian* on July 2014 revealed that animal skulls and bones were spotted at the base of the fish pond due to broken sewer line. The result then published in Sinar *Harian* on August 2014 which revealed that collected animal skulls and bones analyzed was positive for swine DNA.
- Sinar *Harian* on August 2014 reported that some of the restaurant's owner in the state had taken a precautious step from serving non-halal

food to the Muslim consumers by not selling Patin-based meal as it might be fed with pig-based sources.

- Sinar *Harian* on December 2014 reported another similar case in Perak whereby whole pig carcass was used as the nutrition for cultivated Tilapia

The issues of bad feeding practices were still continuously reported up until now, recently on 16th February 2021, with the title of 'Disgusting Catfish!', *Harian Metro* stated that fish farmer in Masjid Tanah, Melaka was feeding their fish with filthy sources such as chicken carcass, rotten egg as well as chicken blood. This unethical act of the pond operator which lasts for more than 10 years is said to be able to make the catfish grow faster, thus giving them a lucrative return. However, the activities of the operators were revealed following their action of releasing the pool water into the open river causing a foul smell around the area. The black and foamy pool water was released into river Baru at Masjid Tanah, causing thousands of river life to die. Apart from the issue of bad feeding practice, another issue reported was about the location of the fish farm which is next to the pig farm and the source of water use to cultivate the fish is believed came from the drainage that connected from the pigsty directly into the pond. The condition of fish that constantly being fed and live in a filth and dirty condition will raised the concern on al-jallah issue (Mamat, 2021). Another issue that is often overlooked and neglected is the ingredients of animal feed. In modern aquaculture farming, fish pellet usually used as feeding in early stages of the culture as well as for grow-out.



However, few individuals are aware of the true composition of animal feed. According to a 2010 study conducted by the Federal Agricultural and Marketing Authority (FAMA) and the University Science Malaysia, 40 percent of the nation's feed manufacturers use mixed animal-based components in animal feed, raising concerns about the halal purity of animals on such diets. Some of the elements utilised in fish pellet formulation are blood meal, cow stomach meal, fat (pig), fat (fish oil), fish meal, feather meal, liver meal, lung meal, flesh, and bone meal. The presence of these compounds in fish raises the issue of where the animal was caught. Is it a halal or haram animal in Islam? If it's halal, is it slaughtered in line with Islamic principles? (Saidin and Rahman, 2016).

Malaysian halal food preparation guidelines do not outline the parameters for halal animal feed. Despite the fact that MS1500:2009 requires animals to be fed clean and safe ingredients in order to be declared halal, animal feed is not included as a certifiable product in the Department of Islamic Development Malaysia (JAKIM) manual processes. This scenario looks to be prohibiting animal feed manufacturers from producing halal and safe feed, which means farmers will be unable to utilise halal feed because certified halal feeds are not on the market. Because feeding animal components (by-products) to animals is prohibited, Halal certification in animal feed is essential to remove confusion about the raw materials used in feed production. Certain halal animals may not be halal because to the animal feed they are fed. The increasing use of non-halal animal feed as aquaculture feed has also taught scholars to analyse and examine the concept and usage of *istibra'* as an instrument that may be used to tackle the issues of unethical animal feeding practises. Few research has suggested employing *istibra'* as a purification process for jallah animals, notably in the aquaculture industry (Wan Norhana et al., 2012).

The rising use of non-halal animal feed as aquaculture feed has also educated researchers to study and review the idea and use of *istibra'* as an instrument that may be employed as a solution to solve the challenges of unethical animal feeding practises. Many dealers and purchasers are unaware of the significance of quarantine or *Istibra'* as a purifying step for catfish. Few studies have proposed using *istibra'* as a purifying procedure for jallah animals, particularly in the aquaculture business. According to the investigation, animal feed imported from China, Thailand, and Taiwan

contains evidence of swine DNA. The vendors, on the other hand, have not been notified of the specific elements of the manufactured animal feed, as well as the need for a quarantine process for fish infected with such feeds. The issue is exacerbated by unscrupulous fish farmers' feeding of fish with pig intestines and other non-halal substances (Nurlaina and Saidin, 2016). In response to the issue, the Department of Fisheries declared its full commitment and cooperation with the Department of Islamic Development Malaysia (JAKIM) in performing inspections in the implementation and enforcement of the catfish quarantine process, as well as regular inspections in all fish cultivation ponds of approximately a thousand catfish farmers throughout the country. Al-jallalah are animals that consume the faeces of other animals, carrion, or pigs and its derivatives on a regular or frequent basis until their physical, structure, odour, taste, and colour change (Aizat et al., 2011; Norhana et al., 2012).

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 clearly said in several times on the importance of choosing halal and tayyib foods concepts (refer Surah al-Baqarah: 168, 172, 173; al-Maidah: 1, 3, 4 & 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 (tayyib 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 (tayyib) of any element of doubt. The issue arises when the food is being produced from the food waste are reprocessed as fertilizer or forage fish (Nadirul et al., 2020). Based on above purposes, 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.

5. OVERVIEW OF BLOCKCHAIN TECHNOLOGY

Blockchain technology was created to address a problem in the banking industry (Zheng et al., 2017). Blockchain is a secure database that keeps track of all transactions. Each ledger corresponds to a single active individual inside a specific dispersed network of computers. As a consequence, everything involved in each transaction is saved and logged, assuring the integrity and veracity of all disseminated information. The system is plausible due to the distributed consensus mechanism. Blockchain, like our DNA structure, is not centralised in a single area. As a result, it is dispersed around the globe on several servers (Tieman & Darun, 2018). All blockchains are encrypted and connected together to form the distributed blockchains. As a result, they may function as a public ledger that everyone can rely on. The value may be inspected by any user, but no user can control it. Smart contracts are agreements reached by all parties involved to ensure compliance in each node (Kiayias et al., 2017).

6. APPLICATION OF BLOCKCHAIN TECHNOLOGY FOR HALAL AQUACULTURE CHAIN AND PROCESS FLOW

A group of researchers describe the Halal food supply chain as the management of the acquisition, transportation, storage, and handling of animal parts, materials, and semi-finished food inventory (Bahrudin et al., 2011). The procedure also keeps track of non-food and food-related data, as well as supply chain documentation flows. All operations are conducted in line with Sharia Law. The Halal food supply chain, according to the proposed structure, comprises of transporters, suppliers, production plants, warehouses, wholesalers, distributors, retailers, and ultimate consumers. The process starts with the suppliers, and it is critical to verify the Halal status of the raw ingredients, food additives, and packaging materials at this stage (Ab Talib et al., 2015). When an animal is utilised to produce raw materials, food additives, or packaging materials, it is vital that the animals get hygienic, high-quality, and nutritional animal feed. If genetic modification is employed, it must be proven that no Haram chemicals are used. They must likewise be slaughtered according to Shariah Law. Food additives that contain khamr or other Haram components should be avoided as well. The suppliers' Halal certification must also be strictly maintained, notably the expiry date information (Soon et al., 2016). It is vital for carriers to assess the vehicle's segregation level if non-Halal commodities are also transported on the same truck. If the truck area has previously been used to transport non-Halal commodities, the Samak procedure must be followed before loading the truck with Halal products. At the production factories, the manufacturing process must be carried out on a Halal-only line. Shariah-compliant cleaning requirements must be followed by Halal equipment and labour practises. Monitoring the segregation of Halal and non-Halal commodities,

storage conditions (temperature, impacts, humidity), and effective management of contamination with non-Halal products in warehouses is crucial. Items from the warehouse are subsequently dispersed to wholesalers, distributors, and retailers. A halal blockchain might give complete transparency throughout all halal supply chain transactions that have ever taken place. The blockchain has detailed information about the addresses and their journey from point of origin to point of customer purchase. Blockchains foster confidence in a brand owner's halal supply chain and value chain, allowing the brand owner to ensure halal integrity more effectively. They may also be included into larger economic and corporate responsibility frameworks in order to broaden the brand's appeal beyond Muslim clientele. It is also necessary to understand the degree of separation between Halal and non-Halal items, storage conditions (temperature, impact, humidity), and effective contamination management with non-Halal products (Zailani et al., 2010). The halal certification procedure may be readily replaced by a blockchain environment, assuring that the halal assurance system is always update for blockchain members, including Halal Certified Bodies. Furthermore, the introduction of a new manufacturing method, a new product variant, the validity of a supplier's halal certificate, or the introduction of a new or different supplier may all be simply and automatically validated for compliance using blockchain technology. Halal blockchain technology can be applied in aquaculture sector to improvise the current halal supply chain in more efficient and digital way. Almost similar to the poultry products, freshwater fish however does not involve slaughtering process, which is the most critical halal control point to be looked out when dealing with animal. The focus will be more on good farming practices, feed and feeding practices, logistic (storage and transfer process) and also integrity to maintain the good record keeping in each step of the process in the supply chain until safely served to the consumer.

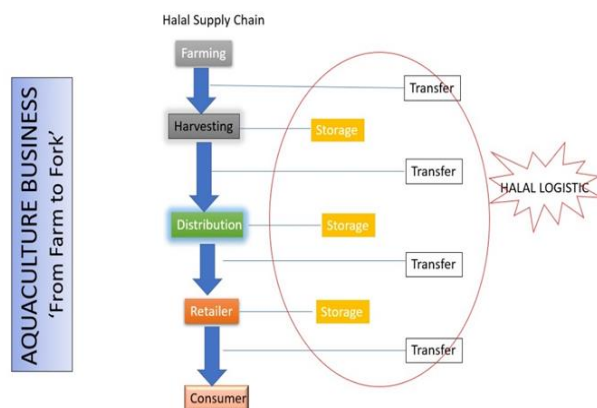


Figure 1. Halal supply chain in freshwater fish aquaculture

7. POTENTIAL ISSUES TO BE CONSIDERED RELATED TO HALALAN TOYYIBAN IN AQUACULTURE

The Halal business is steadily expanding and attracting global attention from industry participants. The industry's completeness, which has been interwoven into all aspects of the economy, makes it an appealing one-of-a-kind product for businesses to invest in, since the possibilities are limitless. The Halal sector is likely to continue this route in the future as it gains more attention and exposure throughout the world.

The moment is perfect for present and potential Halal sector players, government agencies, and investment corporations to invest in the Islamic Economy across all major pillars and earn significant returns. Governments and the business sector both contribute to the Halal ecosystem's long-term viability through certification and policy execution by religious authorities, which is critical for the Halal industry's growth. Religious leaders from several nations are also collaborating to create a global Halal standard to safeguard the industry's long-term viability.

There are several chances to adopt correct halal processes in the product manufacturing process. With the rising number of Muslims in China, specifically in Linxia area, this market sector is projected to develop quickly. Those chances come with a lot of responsibilities. These issues, as described above, should be addressed further by the authority entities concerned to overcome these concerns. As a research student in the halal sector, I believe that the Chinese government should be actively involved in the industry's preparation, growth, and facilitation for participants to be able to participate in this Halal ecosystem.

REFERENCES

- Ahmed, W., Arsalan, N., Hafiz, M.F., Shaharyar, A. 2019. Consumer Behaviour towards Willingness to Pay for Halal Products. *British Food Journal* 121(2): pp. 492-504. <https://doi.org/10.1108/bfj-02-2018-0085>.
- Akhtar, N., Jin, S., Wasim, A., Muhammad, N.A. 2019. The Effect of Non-Verbal Messages on Muslim Tourists' Interaction Adaptation: A Case Study of Halal Restaurants in China. *Journal of Destination Marketing & Management* 11: pp. 10-22. <https://doi.org/10.1016/j.jdmm.2018.10.001>.
- Ali, A., Guo, X.L., Mehkar, S., Adnan, A. 2017. Factors Affecting Halal Meat Purchase Intention. *British Food Journal*, 119(3): pp. 527-41. <https://doi.org/10.1108/bfj-10-2016-0455>.
- Billah, A., Md Ahabur, R., Md Tareq, H. 2020. Factors Influencing Muslim and Non-Muslim Consumers' Consumption Behavior: A Case Study on Halal Food. *Journal of Foodservice Business Research*, 23(4): pp. 324-49. <https://doi.org/10.1080/15378020.2020.1768040>.
- Dar, H., Azmi, N., Rahman, R., Malik, R. 2013 (Eds), *Global Islamic Finance Report*, Edbiz Consulting Limited, London, pp. 209.
- El Boujoui, M., Mustafa, A., Benkorichi, O., Teller, J. 2020. COVID-19 and Ethnic-Oriented Shopping. *Advance: Social Sciences & Humanities*. Sage Submissions. Preprint.
- Haeffele, S., Anne H., Virgil, H.S. 2020. Coming Back from Covid-19: Lessons in Entrepreneurship from Disaster Recovery Research. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3592966>.
- Halal Journal. 2008. Halal Food Market a Multi-Billion Dollar Global Opportunity, Halal Journal.
- Hashim, A.J., Rosidah, M. 2014. Factors Influencing Attitude towards Halal Cosmetic among Young Adult Urban Muslim Women: A FOCUS Group Analysis. *Procedia - Social and Behavioral Sciences*, 130: pp. 129-34. <https://doi.org/10.1016/j.sbspro.2014.04.016>.
- Hong, M.C., Sizhong S., A.B.M. Rabiul, B., Zhangyue, Z. 2019. Determinants of Halal Purchasing Behaviour: Evidences from China. *Journal of Islamic Marketing*, 10(2): pp. 410-25. <https://doi.org/10.1108/jima-03-2018-0053>.
- Jamal, A., Juwaidah, S. 2015. Perceived Value and Perceived Usefulness of Halal Labeling: The Role of Religion and Culture. *Journal of Business Research*, 68(5): pp. 933-41. <https://doi.org/10.1016/j.jbusres.2014.09.020>.
- Khaliq, A. 2013. Police in China Seize Pork Being Sold as Halal Beef. *The Muslim News*. November 29.
- Latif, M.A. 2011, January 24-26. Definition of Halal terms and Malaysia Halal standards and industries. Paper presented at the First Gulf Conference on Halal Industry and Its Services, Holiday Inn Hotel, Al-Salmiyah, State of Kuwait. Lautenschlager,
- Latif, M.A. 2011. Definition of halal terms and Malaysia standards and industries, *The First Gulf Conference on Halal Industry and Its Services*, State of Kuwait.
- Ma, I. 2014. An Empirical Study on Halal Markets in China, *International Journal of Science Commerce and Humanities*, 2(2): pp. 142-143.
- Pillsbury, Barbara L.K. 1981. The Muslim Population of China: Clarifying the Questions of Size and Ethnicity. *Institute of Muslim Minority Affairs. Journal*, 3(2): pp. 35-58. <https://doi.org/10.1080/02666958108715835>.
- Post, The Jakarta. 2021. Halal Food Rising in Popularity amid Covid-19 Pandemic, Reports Indicate. APSN. Accessed October 13, 2021. <https://www.asia-pacific-solidarity.net/news/2020-05-08/halal-food-rising-popularity-amid-covid-19-pandemic-reports-indicate.html>.
- Riaz, M.N., Chaudry, M.M. 2003. *Halal Food Production*, 1st Edition. CRC Press.
- Sekaran, U., Bougie, R. 2009. *Research Methods for Business: A Skill Building Approach* (5th Edition). *International Journal of Information Technology and Management - IJITM*.
- Shaharudin, M.R., Jacqueline J.P., Suhardi W.M., Shamsul J.E., Daing, M.S. 2010. Purchase Intention of Organic Food in Malaysia; a Religious Overview. *International Journal of Marketing Studies*, 2(1). <https://doi.org/10.5539/ijms.v2n1p96>.
- Shahzad, M.A., Dong, J., Gull, N., Ahsan, Z. 2020. Causation of Halal Food Consumption in China. *Journal of Islamic Marketing*, 12(2): pp. 249-63. <https://doi.org/10.1108/jima-07-2019-0153>.
- Swimberghe, K., Dheeraj, S., Laura, F. 2009. An Exploratory Investigation of the Consumer Religious Commitment and Its Influence on Store Loyalty and Consumer Complaint Intentions." *Journal of Consumer Marketing*, 26(5): pp. 340-47. <https://doi.org/10.1108/07363760910976592>.
2011. *The Future of the Global Muslim Population: Projections for 2010-2030*. Washington, D.C.: Pew Research Center Forum on Religion & Public Life.
- Yukari, S. 2014. Policy, Practice and Perceptions of Qingzhen (Halal) in China. *Online Journal of Research in Islamic Studies*, 1(2), (May 2014).
- Zainalabidin, M., Rezai G., Mad, N.S. 2011. The complementary effect of Halal Principles and sustainable concept. *Journal of Environmental Science & Engineering*, 5: pp. 652-659.
- Zannierah S.M., Sharifah, Collin M. H., and Paul W. B. 2012. "Restaurant Managers' Perspectives on Halal Certification. *Journal of Islamic Marketing*, 3(1): pp. 47-58. <https://doi.org/10.1108/17590831211206581>.
- Zhu, L., Hui, Z.J., Ji, S.X., Yan, J. 2011. [The Hui's Economic Ideology]. *Ningxia ren min chu ban she*, Ningxia.

