



Name of Project

Strengthening tilapia seed market systems and promotion of better production technologies among farmers in Bandarban & Cox's Bazar District

Implemented by

Chittagong Meridian Agro Ind. Ltd.



MESSAGE from Chairperson

Chittagong Meridian Agro Ind. Ltd. was established in 1997. Since then, we have grown because of our commitment to building human capacity, attracting the best talent in the industry and adapting to Climate acclimatizing newer technology. We understand the importance of sustainable and ethical business practices. We are honored to be recognized for our efforts over the 12 years. We focus on farmers and increase their access to quality Fisheries inputs for retailers. We go beyond providing access by increasing capability through knowledge transfer sessions, providing business advice as well as technical support and helping them take advantage of the network. We think long term and so we invest in people— first rate agriculturists, well trained farmers and researchers, not only grow at our company but are developing the Fish & Fisheries industry in the whole country.

Feed the Future Bangladesh Aquaculture and Nutrition Activity of WorldFish to strengthen aquaculture market systems, with special attention paid to expanding opportunities for women and youth and increased awareness and adoption of nutrition-related behavior, specifically focusing on women and youth. Considering the importance to produce value added fish product and Find out the scope of process fish product development and their marketing channel. Meridian Agro Industries Limited highly pleased to generate the report to scope of process fish product development and their marketing channel by the Consultant with Feed the Future Bangladesh Aquaculture and Nutrition Activity of WorldFish and funded by USAID under the Activity Title of “ Strengthening tilapia seed market systems and promotion of better production technologies among farmers in Cox’s Bazar and Bandarban districts”. The report contains general process fish feature, Processed fish available in Bangladesh, General development of Processed fish products and Market system of this product.

I want to thank the Consultant & publisher of Report on “scope of process fish product development and their marketing channel” and acknowledge the WorldFish & USAID to support us for generating this report.

Kohinoor Kamal
Chairperson

Aknowledgement

Aknowledgement

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Thanks, with best regards
The Author

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EXECUTIVE SUMMARY

Fish is by far the most commonly consumed animal-source food which plays a crucial role in dietary patterns, livelihoods and culture of the millions of people in Bangladesh. A regular and increasing level of fish consumption can significantly boost developmental changes. In Bangladesh, fish provides a rich source of micronutrients and accounting for almost 60% of animal protein intake.

Whilst an increasing demand of consumable aquatic resources such as fish in our daily staple is observed, there is a significant gap of knowledge on, how these vast populations will respond to potential ready-made (both ready to eat and ready to cook) fish products in the local market and their international counterpart. In the year 2018-19, Bangladesh exported about 68,655 tons of fishes and a fisheries product that is equivalent to \$455 million indicates the country's increasing ability of production and export capacity. However, despite producing a significant amount of fish, the number of processed fish products to export was very negligible. This suggests that there is potentially a far-fetched platform to develop processed fish product industry both for the national and international market. Simultaneously, it will also open a window of opportunity for thousands of stakeholders to develop and improve a strong marketing channel. Importantly, this will also create more opportunity for the stakeholders those occupied at the bottom of the chain such as fishermen or farmers and other successive investors to gain higher economic profit through value addition.

The term value addition is defined as any activity along the supply chain that increases the usability, culinary attribute or economic viability of a food item. Value addition means a measure of factors added to the total worth of a product at each stage of its production. Thus, this process provides more convenience to the user to use either ready to eat or ready to cook product. For example, value addition can be a process of transforming fish fillets into products that are perceived by the consumers as having added quality and interest.

Following a rigorous literature review on the existing and potential processed fish products, their production processes, available marketing channel and rules and regulations associated with the fish product development, three types of resource persons was communicated and discussed on these relevant topics in the form of an unstructured interview. The results show that the country has two major types of value-added fishery products; dry and frozen fish which end up with a specific list of at least twenty one processed fish products (includes both ready to eat and ready to cook fish products). This growing list of processed fish and fishery products can be marketed through a channel where there are many intermediaries (fish traders, distributors, wholesalers and retailers) work between the producer (fishermen or farmers) and final consumer (customer).

During this whole process, one of the very crucial aspects is to ensure the quality of the processed fish product since deterioration starts immediately after the catch owing to the several reasons but not limited to bacterial invasion, enzymatic autolysis, chemical oxidation and growth of microbes. Application of Hazard Analysis and Critical Control Point (HACCP), a complete food safety system in which fish or fish products are scientifically analyzed during every step of manufacturing, storage and distribution have a very important role to play in this process. Following a few rejections of export consignments in the last decade, HACCP significantly improved with the assistance of the Government of Bangladesh yet more improvement could be made with extending facilities and manpower.

This study finds that the processing of fish into a wide variety of value-added products is now becoming common with the increase in demand for food products that are ready-to-eat or require little preparation before serving. This study thus suggests that if necessary steps are taken and appropriate investment are made, ready-made fish products could bring a revolution in the development of processed aquatic products in Bangladesh. This can significantly contribute to the country's economy and simultaneously creates employment opportunities for millions of people in Bangladesh. While a list of processed fish products is identified as the potential item to be marketed, the next step would be to find out exactly which items consumers prefer most by doing a consumer preference survey in the major cities of Bangladesh.

INTRODUCTION

WHAT IS A PROCESSED FISH PRODUCT

The word 'fish' is typically used to describe all kinds of edible finfish, mollusks (e.g., clams and oysters), and crustaceans (e.g., crabs and lobsters) that inhabit an aquatic environment. Fish from the marine and freshwater bodies are a major source of food for mankind worldwide since before recorded history. Harvesting wild fish from fresh and marine waters and raising fish in ponds were some of the practices of ancient Egyptians, Greeks, and other Mediterranean peoples. Rudimentary processing techniques like sun-drying, salting, and smoking was employed by these ancient groups to stabilize the fish supply. Modern methods of processing and preservation techniques have encouraged people to consume various species of fish worldwide. The term fish processing refers to the processes associated with fish and fish products between the time fish are caught or harvested, and the time the last word product is delivered to the customer (Britannica, 2020). The term refers specifically to fish, however, in practice it's extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or open water fish farming. Fish products from the fish industry are usually sold to grocery chains or intermediaries. As fish are a highly perishable commodity, the main concern of fish processing is to prevent fish from deteriorating, and this remains an underlying concern during all steps involved during processing operations.

Fish processing is often subdivided into several sections; where fish handling is the preliminary processing of raw fish, and thus the manufacture of fish products. Another subdivision within the primary processing involved is filleting and freezing of fresh fish for onward distribution to fish retail and catering outlets. This leads to secondary processing that produces chilled, frozen and canned products for the retail and catering trades.

The fishery is a very perishable food product that requires maintaining proper handling and preservation techniques to increase its shelf life and to retain its quality and nutritional values for a longer period (Thakur, 2016). It may also involve a value-adding service to produce a wide variety of products (Scribd, 2020). A number of methods are used to preserve fish. Few of the techniques widely exercised are techniques based on temperature control, using ice, refrigeration or freezing; others on the control of water related activity for example drying, salting, smoking and freeze-drying (Mustafa, 2012). Techniques may rely on the physical control of microbial fish loads, such as through microwave heating or ionizing irradiation or chemical control of microbial activity and loads by adding acids, for example, to fish products. Techniques could also be based on oxygen-reduction, such as vacuum packaging. Most often, a combination of different techniques is used to preserve fish (scribd, 2020).

Value addition is the most widely used word in the food-processing industry, particularly in export-oriented fish processing industry owing to the increased realization of valuable foreign exchange (Datta, 2015). According to (Datta, 2015), a value can be added to fish and fishery products according to the requirements of the different markets. These products range from live fish and shellfish to ready-to-serve convenience products. In general, value additions mean any additional activity that in one way or another changes the nature of the product. Thus, adding to its value at the time of sale (Datta, 2013). As far as the fish-processing industry is concerned, value addition is one of the best possible approaches to raise

profitability since this industry is becoming highly competitive and increasingly demanding and expensive (Surasani, Kudre, & Ballari, 2018).

There is a great demand for seafood/seafood-based products in ready to eat convenience form (Thakur, 2016). Several such diverse products have already been invaded by western markets. One crucial factor responsible for such a situation is more and more women getting educated and taking up the employment opportunities. Besides, reasonably good expendable income, education, awareness and consciousness towards hygiene and health as well as an increased emphasis on leisure pursuits are some of the other reasons. Marketing of value-added products is completely different from traditional seafood trade. The process is dynamic, sensitive, complex and very expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine the successful marketing of a new product. Most of the market channels currently used are not suitable to trade value-added product. A new appropriate channel would be a supermarket chain; which want to procure directly from the source of supply (Datta, 2015). Appearance, packaging and display are all important factors leading to the successful marketing of any new value-added product. The retail pack must be clean, crisp and clear to make its contents appear attractive to the consumer. The consumer must be given confidence to trial with a new product from, target group, market area, species used and so on. The latest packaging industries must also keep well-informed with the latest technology. A large number of value-added and diversified marine products both for export and internal market based on shrimp, lobster, squid cuttlefish, bivalves, certain other species of fish and minced meat from low priced fish have been identified (Datta, 2015). The technology for their production is readily available.

Fisheries industries in Bangladesh

Bangladesh has approximately 47 million hectares of inland water areas and 118,000 square kilometers of marine areas for the exclusive economic zone. Fishery plays a crucial role in the diet of the people of Bangladesh. Fish contributes almost 60% of the domestic animal production in Bangladesh. In 2010 -2011, around 3.1 million metric tons of fish were caught in the country, comprising 2.5 million metric tons from inland fishery and 0.60 million metric tons of saltwater fish. From 2011 to 2012, the total amount of aquatic products summed up to 3.26 million tons. This is equivalent to almost 2.46% out of the total amount of foreign exchange earnings in the financial year. More than 17 million people, including about 1.4 million women depend on the fisheries sector for their livelihood by fishing, fish farming, fish handling, processing etc. According to a report published by the Department of fisheries, in 2015, the total number of employed (full-time & part-time) people in this sector is about 17.80 million; Out of 17.80 million, women employment is 1.40 million, which is about 8.5% of the total fisheries sector employment.

Wide variety of fishery resources

Bangladesh fishery products can be classified into marine and inland fishery production which is further divided into closed water and open waters. Thus, based on the water areas, fishes of Bangladesh can be divided into marine and freshwater species including both fish and shrimps; 300 fishes and 20 shrimps. Among these, the hilsha fish contributes about 12.00% in the total fish production and more than 1.00% in the GDP of Bangladesh.

Table 1: Sector-wise annual fish production in inland and marine fisheries, 2017 - 2018. (DoF, 2019)

Sectors of Fisheries	Water Area (Ha)	Prod. (MT)	% of Production
A. Inland Open Water (Capture)	3927142	1163606	28.14
1. River and Estuary	853863	271639	6.57
2. Sundarbans	177700	18086	0.44
3. Beel	114161	98117	2.37
(a) Natural	101428	83178	2.01
(b) Beel Nursery	12733	14939	0.36
4. Kaptai Lake	68800	9982	0.24
5. Floodplain	2712618	765782	18.52
(a) Subsistence Fisheries	2317175	622521	15.06
(b) Fry Released Program	166620	47178	1.14
(c) Haor	228823	96083	2.32
B. Inland Close Water (Culture)	833752	2333352	56.44
6. Pond	384700	1833118	44.34
7. Seasonal cultured waterbody	136273	215547	5.21
(a) Paddy Field/ Floodplain	127638	200801	4.86
(b) Boropit	8635	14746	0.36
8. Baor	5488	8002	0.19
9. Shrimp/Prawn Farm	272717	246406	5.96
(a) Shrimp/Prawn Production		130296	3.15
(b) Fish Production		116110	2.81
(c) Crab Production	27010	14421	0.35
10. Pen Culture	7564	13368	0.32
11. Cage Culture	1.10 lakh cu. Meter	2490	0.06
C. Marine Fisheries	-	637476	15.42
12. Industrial		108479	2.62
13. Artisanal		528997	12.79
Total Fish Production		4134434	100.00

Fish is mainly sold fresh in local markets close to landing sites. Fish and shrimp for the export market (either from capture fisheries or aquaculture) are frozen and processed. In the last decade, export consignments have frequently been rejected on the European market due to several reasons. Bangladesh also voluntarily closed exports for six months, in response to which the Department of Fisheries conducted an awareness campaign among the shrimp farmers and processors to make sure the improved quality of fish products. Shrimp is one of the major export items from Bangladesh. Total shrimp and prawn production both from captive and wild have increased from 1, 60,000 MT in 2002-03 to 2, 46,000 MT in 2016-17. This increase in the amount of export commodity can be attributed to the recent steps taken by the sectors in ensuring HACCP procedure and traceability regulation according to the requirement of the European Union (e.g. Netherlands, Germany, Belgium, France) and the USA. The EU and USA account for 80% of the total shrimp export made from Bangladesh in 2015. Other shrimp export destinations include the UK, China, Russian Federation, Japan and Saudi Arabia.

Most of the exported products are highly-priced and therefore beyond the purchasing capacity of the local people. Consequently, the local people are mainly dependent on Tilapia, Pangas and other low-cost fish which are locally cultured and available in the market. Among the aquaculture species in Bangladesh (Table 2), the maximum production is recorded for Pangas (23.24%) followed by Tilapia (16.46%) and Rui (12.58%). Tilapia and Pangas comprise about 40.00% of the total culture production but possesses low monetary value in the local market. Hence, if value-addition takes place for these species, it will increase the per-unit sell value for Tilapia and Pangas in the local market. Subsequently, fish farmers will get more benefit receiving greater cash culturing Tilapia and Pangas.

Table 2. Species Composition of Annual Fish Production of Ponds (Culture), 2017-18.

Sl. No.	Species	Production (Metric Ton)	%
1	Rui(<i>Labeorohita</i>)	234154	12.77
2	Catla(<i>Catlacatla</i>)	153092	8.35
3	Mrigal(<i>Cirrhinus cirrhosus</i>)	154796	8.44
4	Kalibaus(<i>Labeocalbasu</i>)	25889	1.41
5	Bata(<i>LabeoBata</i>)	33405	1.82
6	Ghonia(<i>Labeogonius</i>)	14365	0.78
7	SilverCarp (<i>Hypophthalmichthys molitrix</i>)	169853	9.27
8	Grass Carp(<i>Ctenopharyngodon idella</i>)	34153	1.86
9	Common Carp (<i>Cyprinus carpio</i>)	64425	3.51
10	OtherExotic Carp	15507	0.85
11	Pangas(<i>Pangasius pangasius</i>)	499471	27.25
12	Boal/Air(<i>Wallago attu/Sperataaor/Sperataseenghala</i>)	763	0.04
13	Shol/Gazar/Taki(<i>Channa striatus/C.marulius/C.punctatus</i>)	1872	0.10
14	Koi(<i>Anabas testudineus</i>)	40333	2.20
15	Singi/Magur(<i>Heteropneustes fossilis/Clarias batrachus</i>)	16853	0.92
16	BigShrimp/Prawn	2365	0.13
17	SmallShrimp/Prawn	4336	0.24
18	Tilapia/Nilotica(<i>Oreochromis mossambicus/O. niloticus</i>)	306556	16.72
19	Sarpunti(<i>Puntius sarana</i>)	43128	2.35
20	OtherInland Fish	17803	0.97
	TOTAL	1833118	100.00

Value addition in fish

Value addition is defined as any activity along the supply chain that increases the usability, culinary attribute or economic viability of a food item (Ninan, 2018). Processing of fish into a wide variety of value-added products is now common with the increase in demand for food products that are ready-to-eat or require little preparation before serving (Datta, 2015). Usually, value-added fish products are perceived to be those that have added ingredients such as a coating (breaded/battered) or a sauce, are prepared neatly or in some way provide more convenience to the user. It indicates a measure of factors added to the total worth of a product at each stage of the production. Value addition ties in with consumer convenience. For example, value addition can be a process for transforming fish fillets into products that are perceived by the customer as having added quality and interest.

The four major reasons for value addition are-

- (i) for higher profit,
- (ii) for improved processing utilization
- (iii) to keep pace with consumers'
- (iv) to provide a variety of products.

There are numerous varieties of fish species and they differ widely from one another depending on the shapes, size, flavors, texture etc. Though fish flesh is nutritionally more or less similar, their market prices could vary drastically. For example, certain varieties of fish are very expensive, while other varieties within a similar category may be very cheap. The low-cost fish is often from having poor/no preference as food among the consumers due to several factors but not limited to small/unconventional size, ugly shape, too much spiny body, unfriendly flavour/taste etc. Therefore, these low-cost fish are often used as animal feed or by-product production. In some cases, these fishes are discarded into the sea. However, with the application of available technologies and modern marketing approach, these fish can be directly used for human consumption through value addition.

The necessity of value addition

There are several factors responsible for value addition. Primarily, producers and exporters aim at satisfying the cumulative demand for value added products from customers. Simultaneously, while value addition takes place in producer country, rather than in the importing country, it can make sure greater benefits by creating new employment opportunities and thus higher financial transactions. International trade in fish and fishery products has grown substantially over the last decades. Nowadays, only fish caught with the highest quality and presentation, enters the international market for direct human consumption.

Whilst developing countries account for approximately 50% of the global fish exports (FAO,2005), developing countries like Bangladesh export mainly raw products and only a small amount of processed products. The former is mostly done in industrialized countries. By doing so, countries that are largely involved in exporting raw products fail to maximize the benefits from their aquatic resources. Consequently, more and more development experts and institutions are now advocating the transfer of value addition technologies, know-how and investment capital to these developing countries. These steps look very promising since the process involved in value addition could make more employment opportunities and boost countries foreign exchange earnings. However, despite the handiness of technology, many projects included the value-adding process for export did not sustain. The careful observation was not given to the various aspects of their viability, including quality assurance, marketing, distribution and trade barriers

before boarding on a value-adding fish process. In the developed countries, the value-added invention is mainly focused on increased convenience foods and a wider variety of high value-added products, mainly in fresh, frozen, breaded, smoked or canned form. These necessitate sophisticated production equipment and methods and, hence, access to reasonable capital. The resulting fish products are commercialized as ready and/or portion-controlled, uniform- quality meals.

Fishermen often complain about structurally low prices and stringent selling conditions. Indeed, the exercise of power between fish producers and distributors often is not stacked in favor of producers. Also, the contribution of local markets in selling the fishery and aquaculture products varies from 60% to 80% of the total volume consumed across countries. Actions aimed at adding value to the product could enable producers to recover part of the value that is usually lower while generated further down the supply chain. Likewise, with the certain structured initiatives based on collective bargaining, the power relationship between players in the top and the bottom of the chain can be re-balanced. However, regardless of the action taken and growing demand for fishery products, some business operators could still face difficulties in selling their products. One of the many reasons is failing to supply products with the highest quality that meets the prerequisite and demands of consumers at the European market. It is, therefore, necessary for producers to understand their market, to be able to adapt their products to the changing needs and expectations of consumers, and therefore to derive optimum value from their production.

Objectives

Hence, considering the above facts, the Meridian Group has decided to perform research on the broad topic “Scope of processed fish product development and their marketing channel”. The main objectives of the research are to find out-

- a) What are the general processed fish products?
- b) Are there any processed fish products available in Bangladesh?
- c) General development of processed fish products?
- d) What is the market system of these products?

Methodology

To gather in-depth knowledge on the processed fish products, their production processes, available marketing channel and rules and regulations associated with the fish product development, an intensive literature review was conducted. Through the initial literature review, it was found that three types of resource persons are available in this sector. They are –

- a. University Professors/Researchers – use to teach students about the fish processing, product development, storing methods for future selling, and the necessary rules and regulation to export in the foreign countries as well as for local consumption.
- b. Government officers –used to implement the rules and regulations related to fish processing and fish product development.
- c. Processing experts – used to process the fish and fish products following the scientific methods and also ensures the rules and regulations implemented time to time from government and consumers point of view.

So, every type of resource persons was communicated, visited and discussed with about the aims and objectives of the present research. The discussion was mainly in the form of an unstructured interview as it is the best approach to use unstructured questionnaires to explore new ideas as it is unlikely to know what to expect from the respondents.

Initially, we discussed the ‘processed fish products’ with University Professors. After their expert opinion about the ‘processed fish products’ successive consultation was made with the Experts from different fish processing industries to know about the processed product they are currently producing. Finally, we discussed with the Government Officers to know about the rules and regulations to produce the products and the potential marketing system of the products. Simultaneously, extensive secondary data and available literature were reviewed. Follow-up consultation was made with the appropriate resource persons when felt necessary.

Information synthesis

All the collected information was categorized into the following subsections –

- What is a processed fish product, how to produce them and are these products available in the local market?
- Are these products for human consumption or use in other purposes?
- Common rules and regulations regarding production.

Research Questions

The following research questions were also ascertained through information synthesis:

- What products are made from fish?
- What are the methods of fish processing?
- What are the uses of fish and fish product?
- Why is fish processing important?
- What is value addition and why it is necessary?
- What types of value-added products are available in the local market?
- What types of value-added products we can produce?

Results

List of processed fish products

Through the rigorous consultation with the resource persons following list of processed fish products was prepared.

Products	Purpose	Preference	Status
Frozen fish	For export	Ready to cook	Available in Bangladesh
Frozen shrimps	For export	Ready to cook	Available in Bangladesh
Dry fish	For export; local consumption	Ready to cook	Available in Bangladesh
Dry shrimps	For export; local consumption	Ready to cook	Available in Bangladesh
Fish fillets	For export; local consumption	Ready to cook	Available in Bangladesh
Fish fingers	Local consumption	Ready to cook	Not available in Bangladesh
Fish cutlet	Local consumption	Ready to cook	Not available in Bangladesh
Fish roll	Local consumption	Ready to cook	Not available in Bangladesh
Fish nuggets	Local consumption	Ready to cook	Not available in Bangladesh
Fish samosa	Local consumption	Ready to cook	Not available in Bangladesh
Fish singara	Local consumption	Ready to cook	Not available in Bangladesh
Salted fish	Local consumption	Ready to cook	Not available in Bangladesh
Smoked shrimps	Local consumption	Ready to cook	Available in Bangladesh
Fish chanachur	Local consumption	Ready to eat	Under research
Fish biscuits	Local consumption	Ready to eat	Under research
Fish chips	Local consumption	Ready to eat	Under research
Fish sauce	Local consumption	Ready to eat	Under research
Fish scale	For export	Medicinal purpose	Under research
Trash fish meal	Local consumption	Use in the fish/shrimp/poultry feed mill.	Available in Bangladesh
Fish offal's	Local consumption	Use in the fish/shrimp/poultry feed mill.	Under research
Fish silage	Local consumption	Use in the fish/shrimp/poultry feed mill.	Under research

What is the value addition

Value addition is defined as any activity along the supply chain that increases the usability, culinary attribute or economic viability of a food item. Usually, value-added fish products are perceived to be those that have added ingredients, such as a coating (breaded/battered) or a sauce that is prepared neatly or in some way provide more convenience to the user. This means a measure of factors added to the total worth of a product at each stage of its production. For example, value addition can be a process of transforming fish fillets into products that are perceived by the consumers as having added quality and interest. Processing of fish into a wide variety of value-added products is now common with the increase in demand for food products that are ready-to-eat or require little preparation before serving. Value addition thus ties in with consumer convenience.

Reasons for value addition

The four major reasons for value addition are;

- (i) for higher profit,
- (ii) for improved processing utilization
- (iii) to keep pace with consumers' preference, and
- (iv) to provide a variety of products.

There are numerous varieties of fish and they differ widely from one to another depending on the shapes, size, flavors, texture etc. Though flesh of all types of fish are nutritionally more or less similar, their market prices could vary substantially. There are certain varieties of fish which are very expensive, while others are cheap. The low-cost fish as a whole has poor/minimal preference among the consumers due to the various factors. Some of these include small/unconventional size, irregular shape, too much spiny body, and unfriendly flavor/taste etc. Therefore, these low-cost fish are often used as animal feed or for by-product production. In some cases, these fishes are even discarded into the sea. Application of available modern technologies, however, can help to process these fish directly consumable for human through value addition.

Value-added fishery products in Bangladesh:

The market for value-added fish and shrimp are growing at a greater pace throughout the world. The increasing rate of solvency and thus the capacity of purchasing high valued products, fast lifestyle, an increasing number of nuclear families and to mention a few more are some of the main factors responsible for an increase in demand for these processed products in Bangladesh. Especially in urban areas, the rich and upper-middle-class prefers value-added fisheries products in their food menu. Therefore, an opportunity exists for:

- i. Dry fish: Sun-dried or mechanical-dried fish in pouch.
- ii. Frozen fish: Ready to cook retail pack of fish and shrimp of different types.
- iii. Canned fishes: for hotel chains, expatriates, tourists, the rich and upper-middle-class of cities.
- iv. Fish fillet: Whitefish in the form of frozen fillet, dressed fish, setae, etc.
- v. Surimi and Mince-based products: surimi and mince-based products like fish sausage, burger, finger, cutlet, nugget, ball etc.
- vi. Salted fish/shrimp: Salted and dehydrated fishes in retail packs.

General fish preservation methods and principles (Means of Processing)

Fish is highly susceptible to spoilage due to the bacteria, enzymatic activities and chemicals present in the fish which is further exacerbated with the presence of low connective tissues, highly unsaturated fatty acids and near-neutral pH. Hence, different types of preservation methods (either single or on a combined form) widely used for processed fish products. Most commonly used fish preservation methods are; chilling, freezing, curing (drying, salting and smoking), canning, marinating, boiling and fermentation. The other methods like preservation by irradiation, freeze-drying, modified atmospheric packaging, retort pouch packaging are also used for preserving fish.

Chilling

Chilling is a very common preservation system by lowering the temperature of the fish as low as possible (near to 0°C) to delay both biochemical and microbiological processes. This process act to delay the growth of microorganisms and enzymatic activities within the fish and keep the fish and fishery products intact for a certain period. The lower the fish temperature, the higher the chance of keeping enzymes and microorganisms inactive.

Freezing

Due to the low temperature in freezing, the shelf life of the fish products become extended due to the mechanical rupture of the microorganisms during ice formation. Freezing also drains out the major fraction of water in the substrate thus contributes to stopping the enzymatic activities. Glazing the fish and fishery products before freezing also stops the oxidative rancidity problem.

Modified Atmospheric Packaging (MAP)

The preservation in MAP is by retarding the growth of microorganisms by changing the gaseous composition of the environment, thus by creating unfavorable conditions for microbial growth (mainly due to the effect of carbon dioxide on microorganisms) and by avoiding the lipid oxidation.

Curing (drying, salting and smoking)

Curing preserves the fish by rendering the medium

unsuitable for microbial proliferation. Increasing the concentration of soluble substances in the medium either by abstracting water or by causing soluble substances to diffuse in (salting, brining or sugar curing) is the principal means of completing this process. In addition to concentrating the soluble substances by brining and dehydration, smoking preserves depositing bacteriostatic chemicals like formaldehyde and phenols in the system.

The addition of salt is more effective because salt ionizes to a sodium cation and a chloride anion each of which attracts a sheath of water molecules. These ionically associated water molecules are therefore unavailable to use by micro-organisms. There is also a tendency for the ionic forces to pull water molecules from the microbial cells by dehydrating them into a point where they die or sporulate and lie dormant. Sucrose also withdraws water molecules from the system and holds them by hydrogen bonding. However, far fewer molecules become bound or unavailable in this way than is the case for an equal mass of sodium chloride. This availability of water in the system could be used by microorganisms directly relates to the effectiveness of preservation and can be represented physically by the water activity (Shiksha, 2020).

Canning and retort pouch packaging

In both the process, preservative acts by subjecting the products in hermetically sealed containers/pouches, to high temperatures to bring the commercial sterility, where most of the microorganisms cannot survive, except highly heat-stable spore formers. In this method, the products are heated to high temperatures (121°C) for a certain period to achieve commercial sterility to avoid the risk of pathogens and toxins, mainly *Clostridium botulinum*, which is a high heat resistant spore-forming and toxin-producing bacteria occurs in canned foods.

Marinating

The marinades are preserved by keeping them in an acidic medium (acetic acid and propionic acid) containing salt at a pH4.5. At a pH 4.5 or below, all food poisoning bacterial growth is retarded and most of the spoilage stops occurring, resulting in a product that has a characteristic flavor and an extended but limited shelf life. Acetic acid controls

the pH and selectively allows the autolytic reactions to take place. The salt (sodium chloride) causes the removal of water and coagulates the protein. It also controls the hydrolytic action and allows it to proceed within the desired limits. However, some bacteria and enzymes will remain active and cause spoilage, which can be slow down by storing at low temperatures (below 10°C). The amounts of acid and salt required can be reduced when the product is kept chilled until eaten.

Boiling

The action of boiling fish in the water at normal temperatures and pressures denatures (cooks) the proteins and enzymes and kills many of the bacteria present in the fish. The normal spoilage that occurs in a dead fish is thus stopped or drastically reduced. Often salt is added before, during or after processing; high levels of salt in the final product will help to extend the shelf life.

Fermentation

The fermentation processes are those in which organic catalysts (enzymes or ferments) break down complex organic molecules to simpler ones. Many of the processes used in fish preservation aim at keeping the fish flesh as near as possible to its original condition. With fermentation, however, we are considering methods by which the wet protein is broken down to simpler substances which are themselves stable at normal temperatures. In some of the processes, only partial breakdown occurs and is controlled by the addition of salt; thus the process is designed to produce a particular flavor as well as to preserve the product.

Irradiation

Food irradiation is a process for the treatment of food products to enhance their shelf life and to improve microbial safety. Electromagnetic radiations, namely gamma, and X-rays having a short wavelength (< 300 μm) and higher energy level than visible light which can significantly penetrate the material including foods causing ionization of atoms and molecules by removing electrons from their outer shell. The inactivation of living cells (microbial cells) by irradiation is essentially due to scission of single or double

strands of DNA, which is essentially caused by the OH radicals formed by radiolysis of water. In addition to DNA damage, ionizing radiation has also been shown to cause damage to the membrane and other structures causing sub-lethal injury.

Freeze-drying

Freeze-drying is a dehydration process typically used to preserve a perishable material or to make the material more convenient for transport. Freeze-drying works by freezing the material and then reducing the surrounding pressure to allow the frozen water in the material to sublimate directly from the solid phase to the gas phase (i.e., it does not transit through the liquid state) under vacuum. Freeze-drying benefits heat-sensitive products by dehydrating in the frozen state without an intermediate thaw. Freeze-drying of meat yields a product of excellent stability, which on rehydration closely resembles fresh meat. Adequate control of processing conditions contributes to satisfactory rehydration, with substantial retention of nutrient, color, flavor, and texture characteristics.

Hurdle technology

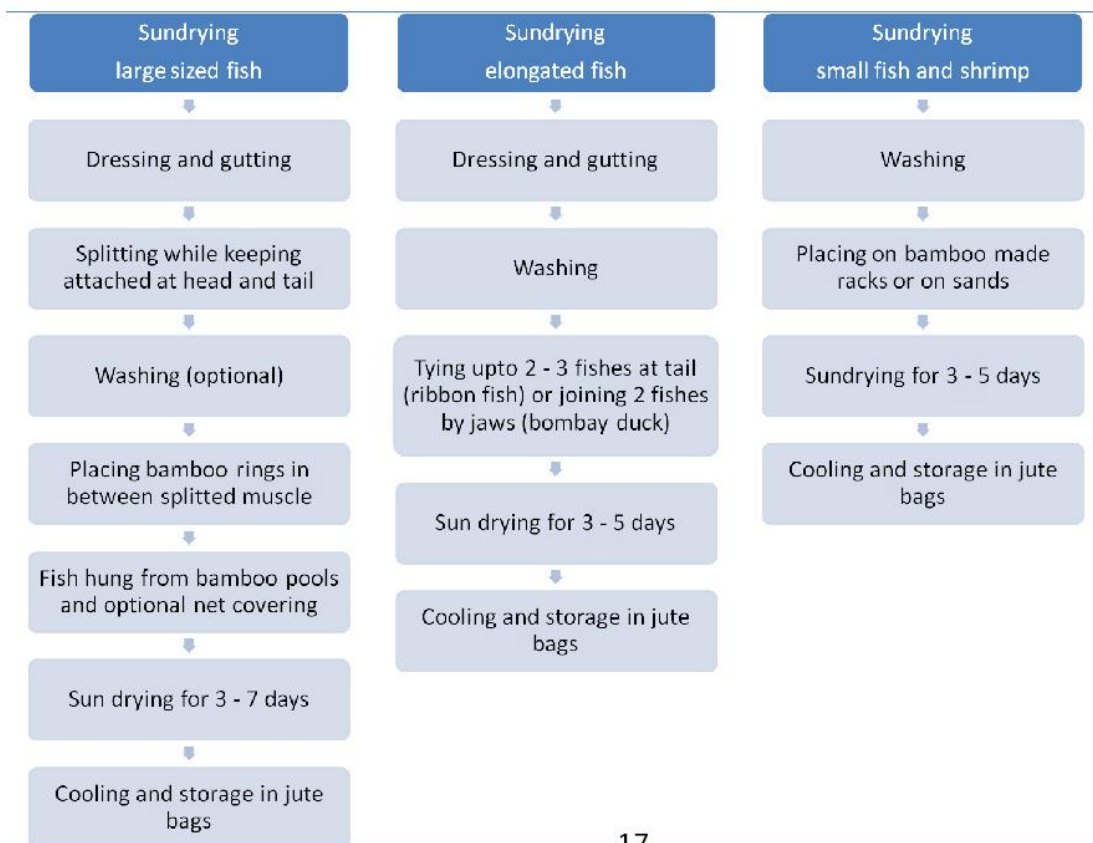
Hurdle technology (also known as combined methods, combined processes, combination preservation, combination techniques or barrier technology) advocates the deliberate combination of existing and novel preservation techniques to establish a series of preservative factors (hurdles) that any microorganisms should not be able to overcome.

Value-added fishery products and production methods in Bangladesh

i. Dry fish : In Bangladesh, around 25% of fishes are consumed as dried fish. The nutritional quality of dried fish remains intact, sometimes retains higher quality standards compared to fresh fish (as per unit weight). The special flavor of dry fish is highly cherished by a different ethnic community. The product of dried fish is easily transportable, marketable and storable (Nowsad, 2007). Drying of marine fish is a very common practice in the entire coastal areas of Bangladesh. Dry fishes have growing demand both in the domestic and international market although people those involved in the preliminary production chain (fishing and drying) add relatively more value but make little profit. The reasons for this less value addition at small- scale producer level are presumed to be the poor product quality and lack of market access due to the various institutional and non-institutional barriers e.g. high transportation cost/toll/taxation and middlemen (price exploitative market players) between producers and consumers. In the coastal belt, fish drying

generally starts in October and ends in March. In some coastal villages, it starts sporadically in early September and lasts until the end of May (Nowsad, 2005). The common dried fish in Bangladesh are Loitta (*Harpodonnehereous*), Poa (*Panna microdon*), Parse (*Liza persia*), Phasa (*Setipinnaphasa*), Taposi (*Polynemusparadiseus*), Chhuri (*Lepturacanthussavala*), Boiragi (*Coiliadussumieri*), Fatra (*Racondarusseliana*), Rupchanda (*Pampuschinensis*), Pama (*Otolithespama*) etc. The fishermen (mainly fish drier) spread the fishes under the sunlight and let them dry in the trays, racks and even on the ground. Drying takes normally 3 to 5 days. Quality control becomes a major issue in this phase. The sun-dried fishes suffered from both qualitative and quantitative loss due to different causes like – insect infestation (fly larvae), spoilage, meteorological disturbance, handling and transportation. Furthermore, fishermen (fish drier) frequently use insecticides and pesticides to preserve the dry fish which caused a human health hazard. The packaging and storing system of dry fish is also considered to be poor in quality.

Figure 1 : Schematic flowchart of traditional fish drying system in Bangladesh.

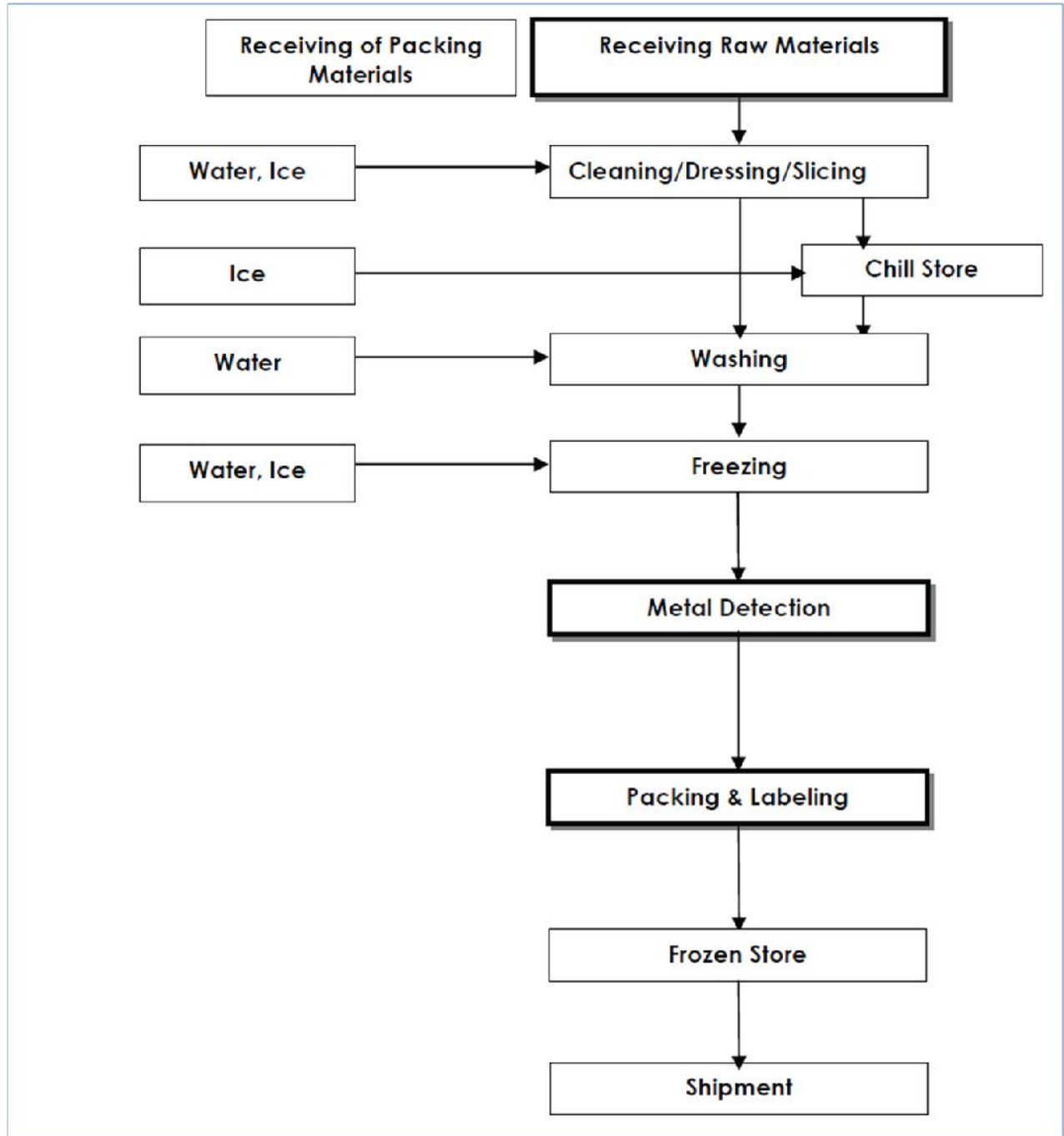


ii. Frozen fish : In Bangladesh, a number of fish processing industries are processing fish and shrimp products for foreign export. However, these processing industries do not sell their products in Bangladesh. Bangladesh exports fishes and fisheries products to over 50 countries of the world, including the USA, China, Japan and Russia. About 68,655 tons of fishes and fisheries products were exported abroad in the outgoing fiscal year of 2018-19, while collected revenue was amounted to Tk3,845 crore (\$455 million) by exporting fishes and fisheries products (DhakaTribune, 2019). Among the total export amount, 31,158 tons were shrimp worth Tk2,916 crore, and the rest comes from fishes and fish related products. The main frozen products are shrimp (whole), shrimp (beheaded), degutted fish and to some extent fish fillets. Recently some mollusks, cephalopods (squid) are being exported to foreign countries. The main principle of freezing of these products is to reduce the fish temperature and thus retarding bacterial decomposition, autolysis and enzymatic activities within the fish body. Water accounts for 75-80% of the weight in most of the fish (Burt, 2001). This water contains several dissolved organic and inorganic substances like sugars, salts and other compounds (Novelo, 2015). Also, more complex organic molecules such as proteins are present in the colloidal suspension (CIFT, 2019). Hence, the water in fish is essentially a suspension of solids which needed to cool down to a temperature at which the solute phase and the solvent phase will have the same vapour pressure. So, the freezing begins in the fish usually at a temperature of -1 to -2°C (Johnston, 1994). After some processing, finally, it is stored at a temperature of -18°C in the big freezing room.

The main principle of fish freezing

Fresh raw fishes are used to purchase from approved suppliers and brought to the factory in crates/boxes by insulated trucks. On arrival of raw material, the source code number is given according to the purchase date, center and arrival number. After preliminary washing and weighting, the raw material is taken for dressing, blood skimming and graded manually. Dressing and scaling are performed immediately in a smooth way. Gutting is done expertly. Offal is immediately preserved in receptacle leaving no scope of contaminating other products. The graded dressing material is sorted out to get rid of species mix, other organoleptic defective material and thereafter washed by which the vegetative and foreign matters, are cleaned off. In the next step, cleaned and graded material is used to put within ice with proper labeling. Weighing is done as per specifications and the material is set to the freezer pans along with the label. These pans are filled with the glazed water, covered with a polythene sheet along with a stainless steel lid. Trays are then placed on the Blast freezer for freezing. It takes approximately 6.0 to 7.0 hrs at -40°C inside a freezer. After freezing, the products are unloaded and passed through a metal detector and packed in master cartons as specified by the buyer. Each master carton is identified with code, grade and packed number. Packed master cartons are transferred to the frozen store where the temperature is maintained at -18°C or below. Shipment is done using refrigerated containers maintaining the minimum temperature at -18°C or below and shipped out.

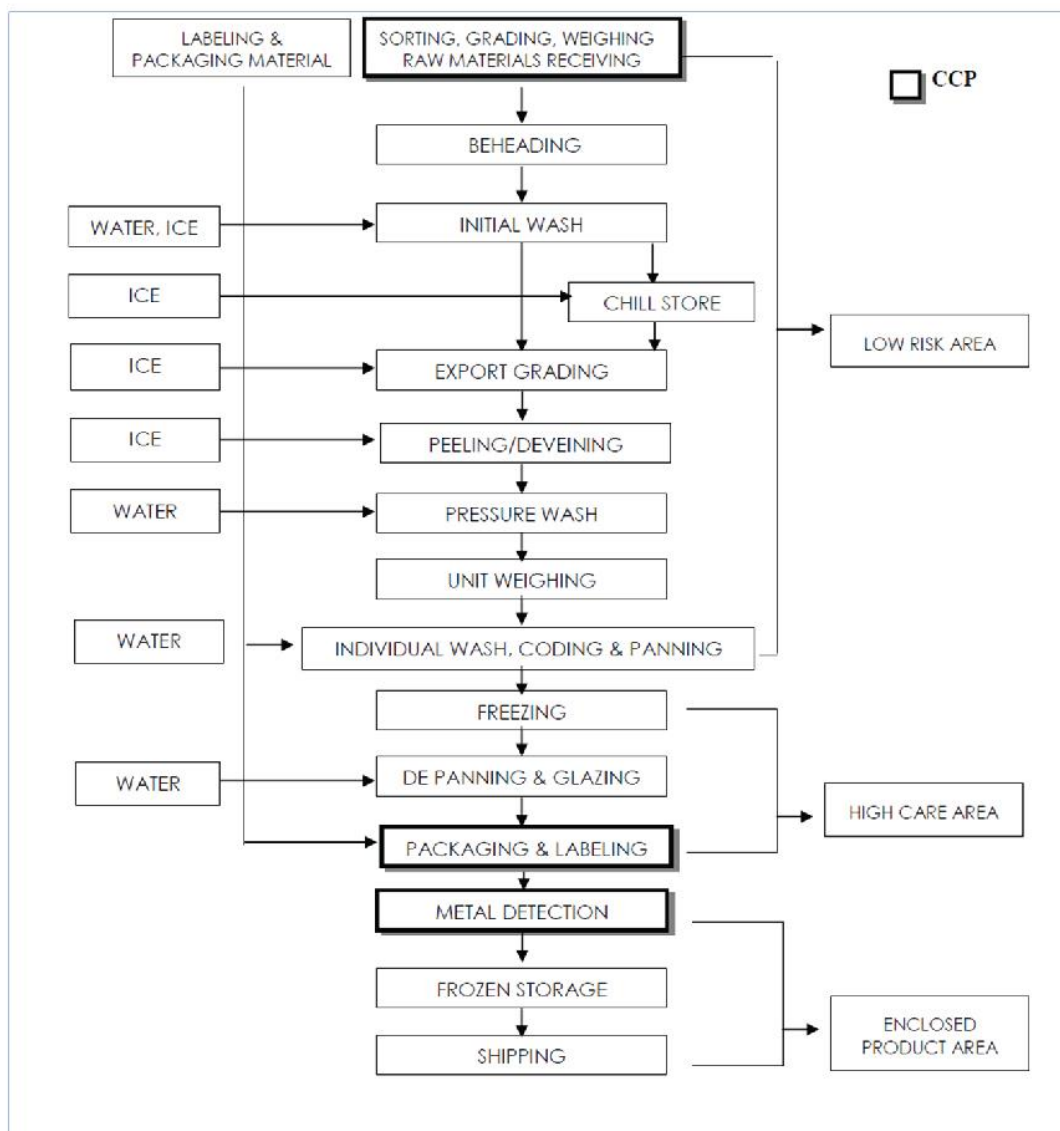
Figure 2 : Process Flow Chart of IQF Raw White Fishes Whole/Gutted/Slice/Cleaned - Fresh & Sea Water in the processing plant.



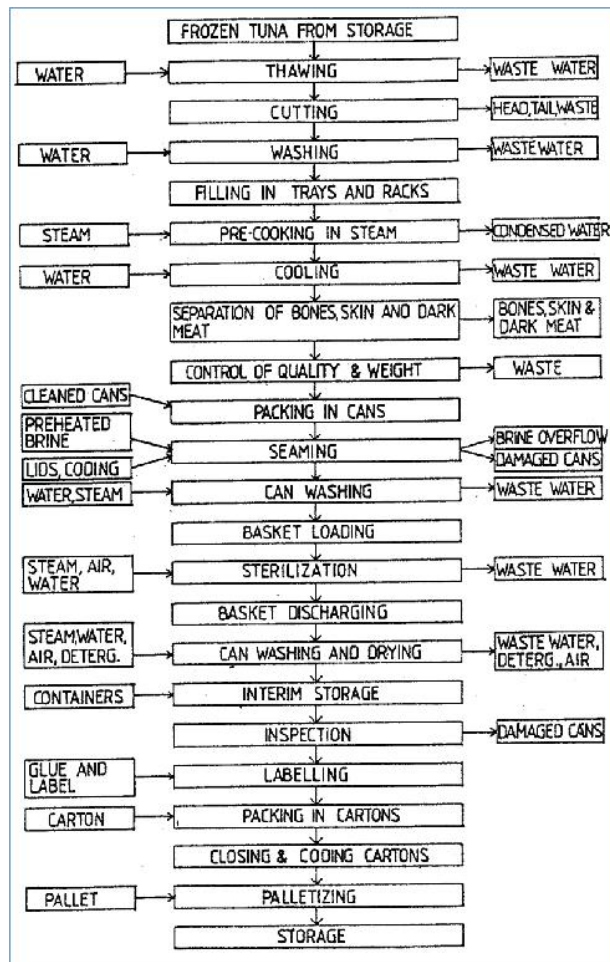
iii. **Frozen Shrimp** : Fresh raw shrimps is used to purchase from approved suppliers and brought to the factory in crates/boxes by insulated trucks. On arrival of raw material, the source code number is given according to the purchase date, center and arrival number. After washing and weighing, the raw material is taken for de-heading and then washed and graded manually. Peeling, de-veining (if relevant) is done manually as per requirement. The graded material is sorted out to get rid of mix species, other organoleptic defective material and then washed by which the vegetative and foreign matters, veins, legs, antennae etc., are cleaned off. Hereafter, the cleaned, graded material used to keep with ice with proper labeling. Weighing is done

as per specifications and the material is set to the freezer pans along with the label. These pans are filled with the glazed water, covered with a polythene sheet along with a stainless steel lid. Trays are then placed on the plate freezer for freezing. Next, plates are kept under -40°C for 2 - 2.5 hrs inside a freezer . After freezing, the blocks are unloaded and passed through a metal detector and packed in master cartons as specified by the buyer. Each master carton is identified with code, grade and packed number. Packed master cartons are transferred to the frozen store where the temperature is maintained at -18°C or below. Shipment is done using refrigerated containers maintaining the temperature at -18°C or below.

Figure 3 : Flow chart of frozen shrimp processing in the processing plant.



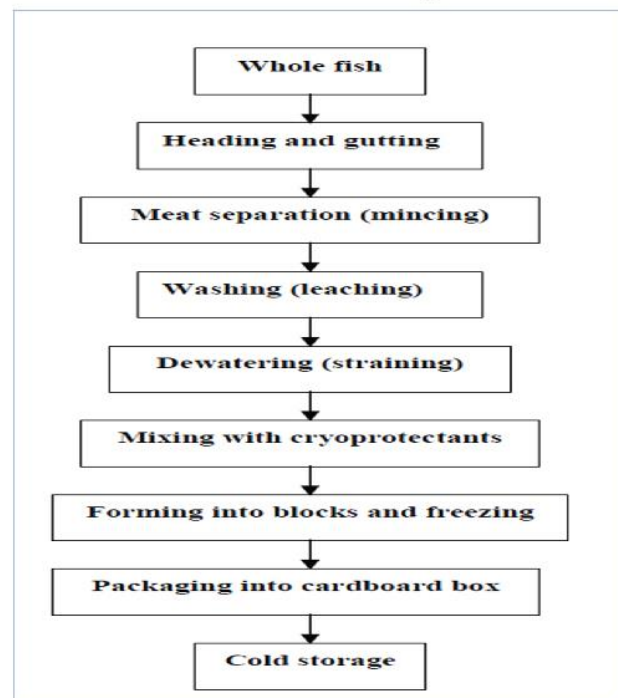
iv. Canned fish : fishes/shrimps are canned with spices and preservatives for a long period. Generally, sardines, tuna, mackerels are preserved as canned fish products. As soon as fish are caught, it is advisable to kill them with a knife and allow the blood to run out. Then scales are removed



from the fish. Skinning of fish depends on the size of the fish. Then the fish is thoroughly washed with the clean water. The fish is kept in brine water (25 g salt in 1-litre water) from 15 minutes to an hour, depending on the thickness of the pieces and the softness of the flesh. Blanch is done in boiling water from three to five minutes to remove the strong fish flavor and clean the outside of the fish. Immediately after blanching, the fishes are cold-dipped to make the flesh firm. Then the fish are placed in a can containing hot water and sealed immediately. The cans are placed in canner and process in boiling water for five hours. Three – five hours of sterilization will ensure fresh products are used and the blanching and other works are

carefully done. If canning is done with a steam-pressure canner or a pressure cooker, the product needs to sterilize for one hour and a half under 10 to 15 lbs. pressure. At the end of the sterilizing period, the cans are cooled quickly after which sealing is completed. The tin cans may be cooled by immersing them in cold water. Finally, cans are stored out for future use. Nowadays, different types of vinegar, sauce, dressers, pickles etc. are used as the preserving media for canned fish. If the fish are canned with the above mentioned edible material, they are readily eatable. This is a very effective method but comes with a little bit of cost. This way of processing keep the product in very good condition and retains much of its flavor.

v. Surimi and mince-based products : This one is the most common fish processing technology. In Bangladesh, people generally used to make a fish ball or fish cutlet through this process for household purpose. Surimi is a term that describes highly processed seafood products made by the removal of soluble proteins, lipids, pigments and odorous compounds from the fish flesh which, with the addition of cryoprotectants (CP), can be stored in the frozen state. The most common way of separating edible flesh from waste is by filleting, but a greater amount of flesh can be recovered in the form of a coarse mince by putting either the un-filleted fish or leaving the waste after



filleting, using a bone separator. The total yield of the flesh of low bone content is higher than with filleting alone; up to twice as much can be recovered by separating flesh directly from headless gutted fish. After the first fillet made from fish, an additional 8-12 percent flesh can be separated from the filleting waste. The whole whitefish such as cod and haddock should be gutted and headed. Besides, the section of backbone, immediately above the belly cavity, should be removed. This is because blood along the backbone causes discoloration and spoilage of the mince. Whole fatty fish should be gutted and headed as well, and then split to make them easier to pass through the bone separator. The skin should be removed from soft-skinned species before putting them through the separator. This would help to stop too many fragments of skin to pass through the mince and ultimately deteriorate the quality of the products. Surimi a high value-added fishery product in Japan. After preparing the minced products, different types of spices and other grounded vegetables are mixed with fish products to give different types of shapes. These are either battered or breaded. Depending on the shape, these products have different names like – fish springs, fish balls, fish fingers, fish sausages, fish cutlet, fish nugget, crabsticks, fish cakes etc. The basic preparation is however almost the same.

vi. Cured Fish (drying, salting and smoking) :

Curing in all its forms is the oldest of the techniques available to preserve fish. As curing is based on the simplest technologies such as air-drying and the use of salt and smoking (and combinations of these processes) still has application today. Fish curing technology can be found in countries without access to higher technologies (such as freezing and canning) and in those developed countries which have a long cultural association with curing, which has been retained despite the introduction of higher technologies (Iceland and Scandinavia for example). In Bangladesh, it is also a very primitive way of fish preservation, especially for shrimp.

vii. Salted Fish : The salting process employed mainly depending on the size of the fish. Small fish can be salted whole (no gutting) as the skin is a poor barrier to salt penetration in this situation. In contrast, bigger fish must be gutted and split open

to keep enough salt around the body. In Bangladesh, most of the dried fish either small or large are processed with salt during drying. However, the most famous salted fish in Bangladesh is salted hilsha fish (nonailish).

viii. Smoked Fish : In Bangladesh, smoked fish and shrimps are very popular within the ethnic community. After washing, the medium-sized fish or shrimps are spread on a perforated tray generally made of bamboo sticks. This tray is then placed under low wooden fire keeping a distance that will not boil the fish and shrimp but gradually dehydrate the product.

ix. Fish fermentation : 'Shidal' is a home processed fish food, usually prepared from a small-sized fish (Punti). A large number of people of our country especially in Brahmanbaria, Mymensingh, Netrokona, Kishoreganj, Jamalpur and Tangail region are involved with this fermented product production and marketing. Production of 'Shidal' is done by fermenting traditional sun-dried method of small-sized 'punti'. After sun-dry, 'punti' are tightly (jam-packed) placed in the 'motka' and the mouth of motka are covered with a layer of clay and a sheet of polythene. Then, the filled motka is half-buried and kept in a dark room to allow fermentation for about 4 to 6 months until the characteristic flavor and colour appear in the product. Fermentation takes place in large earthen jars called (motka). However, some people in Bangladesh do not like this due to its strong 'dry fish' flavor.

READY-TO-COOK FISH PRODUCTS IN BANGLADESH :

From the market survey, it was found that ready-to-cook products in Bangladesh are very few. Though there is misleading information that this product is available in Bangladesh, we did not find any ready-to-cook fish products (made in Bangladesh) in the bigger super shops. These products are still limited only in the research phase in the different Universities in Bangladesh. Presently, no industry is officially producing ready-to-eat products on a commercial basis in Bangladesh. Nevertheless some have taken permission from the appropriate authority. Few of them started their production but closed soon due to the high production cost of the products. Some 'tuna fish cans' are available in big super shops but

those are imported from foreign countries. After discussion with the salespersons, it was found that people usually ask for local products. They also reported that they get frequent queries on this across their outlets throughout the country. However, due to non-availability of the local ready-to-cook fish products in Bangladeshi super shops, consumers are pushed to switch to foreign products. This indicates that there is a big demand for ready-to-cook fish products in Bangladesh. However, ready-to-cook fish products are found to be available in the local rural markets of some regions of Bangladesh. The ready to eat fish products may be categorized under the following names :

- i. **Frozen Fish** : The most common ready-to-cook fish products is perhaps the processed frozen fish. Fish are duly processed, packed and stored to the freezing room. Consumers will collect these frozen blocks from the retail stores and cook the fish according to their eating preference.
- ii. **Fish fillet** : Boneless fish fillets are duly processed packed and stored in the freezer room. Consumers will collect these frozen blocks from retail stores and cook the fillets according to their preference. Generally, fish fillets are eaten as a deep-fried condition.
- iii. **Salted fish** : This is not a regular/common item. Especially in Bangladesh, consumers are inclined to only 'salted hilsha' fish occasionally. They use different types of recipes to cook 'salted hilsa' fish. However, for salted fish consumers generally prefer to use hot spices recipe.
- iv. **Frozen shrimps** : This is another common ready to cook fisheries item. There are lots of recipes to cook the shrimp in our country. It starts from fried shrimp to shrimp curry, shrimp gravy, shrimp with vegetables etc.
- v. **Smoked shrimps** : Another very common item which is available almost all over the country. It is generally taken as a spiced hot mesh condition. It is a starter in the majority of the meal. However, smoked shrimp is also used as a curry with vegetables.
- vi. **Fish fingers** : This is a breaded fish product. Fish are minced and processed accordingly. With minced fish, spices are mixed according to the consumer's preference. Then the

shape of fingers is given in the mixed dough. Finally, these are packed in a filmed coated polyethylene film pouch and preserved in the refrigerator at a temperature of -40°C.

- vii. **Fish cutlet** : This is also a breaded fish product. Likewise fish fingers, these are minced and processed. With minced fish, spices are mixed according to the consumer's preference. Then the shape of the cutlet is given in the mixed dough. Finally, these are packed in a filmed coated polyethylene film pouch and preserved in the refrigerator at a temperature of -40°C.
- viii. **Fish nuggets** : This is a breaded fish product too. The preparation process is the same and spices are mixed following the preference of the consumer. Then the shape of the nugget is given in the mixed dough. The shaped nuggets are breaded. Finally, these are also packed in a filmed coated polyethylene film pouch and preserved in the refrigerator at a temperature of -40°C.
- ix. **Fish samosa** : This is a battered fishery product. Here, the processed minced fishes are fried with spices. Then this fried product is poured into a fried triangular pastry shell made from all-purpose flour dough. Then, the product is again kept for deep fry at a temperature of 350°C and served.
- x. **Fish roll** : This is another battered fish product. Chopped fish filets are mixed with spices and then marinated. These marinated filets are boiled with onion and other preferable spices. After cooling down, the boiled fillets are semi-meshed or meshed with all the mixed spices and seasonings. These meshed mixtures are placed in a thin oval-shaped dough (roti) and rolled up similar to how would roll a burrito. The edges of the dough together sealed by pressing fingers. Finally, the prepared roti is deep-fried and served with hot sauce.
- xi. **Fish singara** : This is a battered fish product too. Processed minced fishes are fried with spices and vegetables. Then this fried product is poured into a triangular-shaped pastry shell to fry. These processed products again used for another deep fry at a temperature of 350°C and served.
- xii. **Fish sauce** : This product is not commonly used by the general people of Bangladesh. It

is an imported product and only served in classified restaurants. In recent times, professional cooks-on-rent (baburci) are found to use this product while preparing a bulk amount of meal.

- xiii. **Shidal** : This is a very special ready to cook fishery item, usually taken as chutney (vorta) by a cluster of the dry fish lover. It gives a strong impression of dry fish odor and could easily make people seemingly uncomfortable who are not used to take dry fish products.

READY-TO-EAT FISH PRODUCTS THAT COULD BE INTRODUCED IN BANGLADESH

- i. **Fried fish** : Deep-fried small fish or fish fillets with salt and spices can be produced and marketed as a ready to eat fried fish product. The spices may vary according to the consumer's preference. The fried fish packets should be filled up with nitrogen (gas) to prevent from oxidizing. Nitrogen is known to be very stable and unreactive gas. A so-called "nitrogen atmosphere" is thus recommended for storing foods that oxidize quickly, like potato chips and bacon.
- ii. **Fish chips** : Fish pastes with spices are mixed with all-purpose flour and dough is made. Afterwards, the dough is kneaded and fed to sheeter rolls and is sheeted into a thin layer which is then cut into slices with a specific shape. The thickness of the sheet determines the final product weight. The sheeting starts when the dough is fed in to a pair of smooth rollers (coated with Teflon); one rotating counter-clockwise and the other clockwise. The gap between the rollers is adjustable so that products of different thicknesses can be produced. The slices then flow into troughs which are filled with oil to fry. Paddles gently push the slices along (Anon, 2020). As the slices tumble, salt is sprinkled above the trough. At the end of the trough, a wire mesh belt pulls out the hot chips. As the chips move along the mesh conveyer belt, excess oil is drained off and the chips begin to cool. These then move under an optical sorter that picks out any burnt slices and removes them with puffs of air. Finally, they

are packed and stored.

- iii. **Fish chanachur** : Chanachur made with fish pest as main ingredients (in Bangladesh it has been only produced by University researchers).
- iv. **Fish biscuits** : Biscuits are made from fish flesh (in Bangladesh it has been also produced by University researchers)
- v. **Shrimp balacho** : Whole (small to medium) smoke-dried shrimp used to prepared with spices (mostly imported; used mainly in Chittagong and Cox's Bazar region)

OTHER PRODUCTS FROM FISH/SHRIMP (NONEDIBLE) CAN BE PRODUCED IN BANGLADESH :

- i. **Fish skin** : For extraction of gelatin; mainly export-oriented. In this process, the fish processor stake the skin off from the fish and preserved the skin to export in the foreignmarkets to produce gelatin. Bangladesh is also capable of producing gelatin from fish skin using trypsin-aided process.
- ii. **Fish scale** : For extraction of gelatin; mainly export-oriented. The process is the same as done for fish skin. The fish processors take the scale off from the fish and preserve it to export which is later used to produce gelatin. This is a readily available method worldwide. However, due to the low availability of fish scale across seasons, it is less likely practiced in Bangladesh.
- iii. **Fish offal** : Fish offal considered as a substitute for a fish meal during fish feed production. Fish offal is also used in combination with a fish meal in the fish feed production, thus reducing the overall production cost. These products are initially collected from various markets.
- iv. **Fish silage** : This is long been used as an ingredient in animal feed. Most cases, these are considered as a good substitute for protein ingredients in fish feeds. This is an alternative way to minimize feed production cost. Simultaneously, it solves the sanitary and environmental problems caused by the lack of proper disposal of the wastes from the fishery industries (production of fish silage still in research stage by University

Marketing channel of fisheries products in Bangladesh

Marketing channel of fresh fish in Bangladesh

There are many intermediaries operate between the producer (fish caught from open water or fish farmers) and final consumer (the fish reach the consumer) in Bangladesh. They are usually known as 'middlemen'. They work as primary fish traders, distributors (baperies), wholesalers and retailers. In every stage of marketing, intermediaries gain a profit margin of about 10% to 25% of the sale value. These intermediaries act as a major driver to increase fish prices (N Mia, 2015). Hence, the manpower engaged in fish marketing/trading can be described as bellow:

Fishermen : The person who catches fish from the sea, river, canals or any type of water bodies.

Fish farmer: Who produces fish or shrimp in the aquaculture farms.

Beparie : Professional fish traders who purchase fish directly from the fishermen or fish farmer and sell the products to the wholesaler through

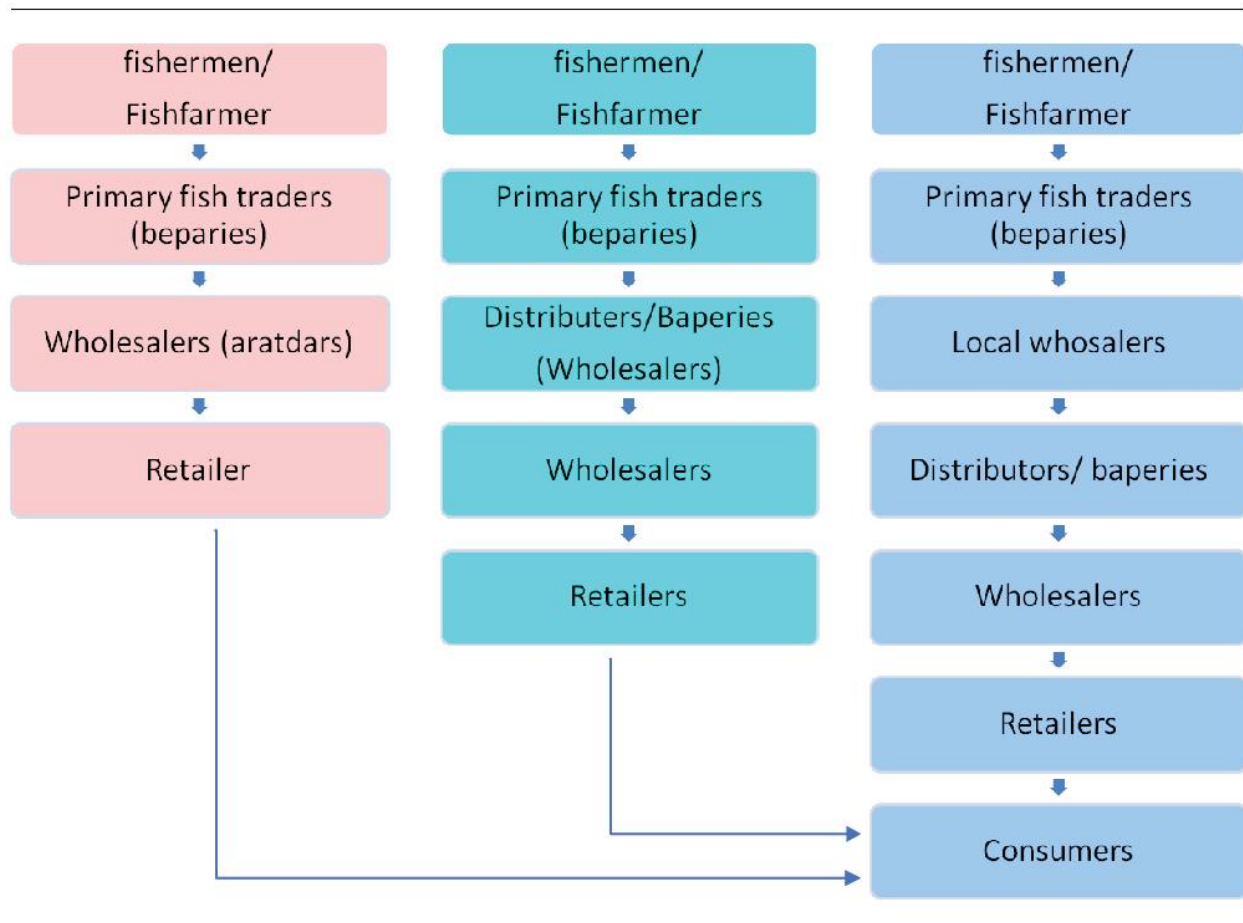
'Aratdar'. Usually, the 'Beparies' collect fish from the fish landing center and go to fish 'Aratdar' for selling the fish.

Aratdar : 'Aratdar' acts like a commissioning agent. He has a permanent place (fish arat) where 'Beparies' or their representatives sell the fish. In return 'Aratdar' charge a certain percentage of sale revenues. They hire laborers to work for loading, unloading, weighing, grading, etc. for selling fish in the market. Around 70% of the total fish, whether it is from capture or culture fishery, used to sell through Aratdar.

Wholesaler : If the 'Aratdar' himself stock the fish or fishery products and sell it to the retailer can be called as a wholesaler.

Retailer : The retailer buys the fish from the 'Beparies' in the place of 'Aratdar' and sale it to the consumers. Retailers sell fish according to the choice of the consumers. They sell their products in the local 'Bazar' daily. However, in rural and some semi-rural areas, they sell fish on a specific day or two locally termed as 'hat bar'.

Figure 6: Marketing channel of local fish market in Bangladesh.



Marketing channel for frozen fish to export

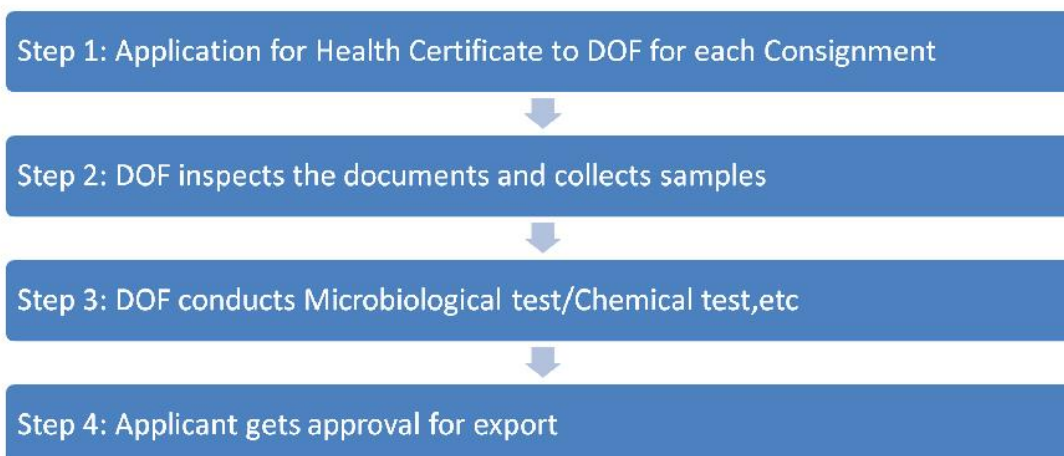
Bangladesh is now producing diversified fishery products and exporting them to around 60 countries of the world. However, major export destinations of Bangladeshi fish and fishery products remain within the member countries of the European Union (EU). Among others, the USA, Russia, China, Japan, Canada, Australia, India, Saudi Arabia, Malaysia, Thailand, Vietnam, etc. are also major importing countries of Bangladeshi seafood (DoF, 2018). Bangladesh export fish and fish product mainly in the following categories –

- Fresh, chilled and frozen fish,
- Fresh, chilled or frozen shrimps (to some extent crustaceans (live crabs) and mollusks),
- Dried, dehydrated, salted or smoked fish.
- shark fins, fish scales, fish skins and shells of shrimps (lower quantity)

However, for exporting, the fish processing industries need to go through some rigorous process. They must have the 'Fish and Fish Product Export Approval License' issued from the Department of Fisheries (DOF), Ministry of Fisheries and Livestock, Bangladesh. To get this certificate the fish exporter needs (Commarce, 2020)–

- i. Trade License,
- ii. License from FIQC of Department of Fisheries,
- iii. Export Registration Certificate,
- iv. Salubrity/Health Certificate from DOF,
- v. Chamber Membership Certificate,
- vi. Membership Certificate from BFFEA (if export from processing plant),
- vii. Export Certificate from BFFEA (if a member of BFFEA), and
- viii. Phytosanitary Certificate (if needed).

The process is as below (Commarce, 2020) :



Other than the above, different countries have different types of quality requirements. This depends on the certificates from the DoF, experts from the exporting country, compliance certificates, etc. (Commarce, 2020).

Export to the EU Countries (Commarce, 2020) :

1. For the approval of exports to the European Union, a committee has been formed in the Ministry of Fisheries and Livestock consisting of four members from the Department of Fisheries, a Public Health Analyst from the Ministry of Health and a Director from the Export Promotion Bureau (EPB).
2. After getting approval from the EU Approval

Committee, the applicant has to comply with EU market access requirements to export to the EU countries.

Export to USA (Commarce, 2020) :

1. Exporter's registration with USFDA is the first requirement to export to the USA, followed by approval and Health Certificate from DOF and other export-related licenses.
2. An online registration facility is available on the USFDA website.

Export to Russia (Commarce, 2020) :

1. Department of Fisheries (DOF) has a Memorandum of Understanding (MoU) with the Russian Veterinary Authority (RVA).

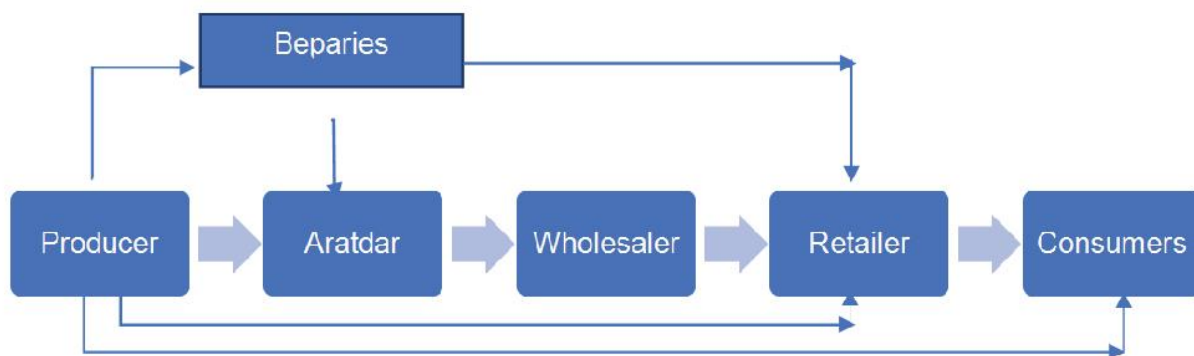
- DOF sends names and profiles of the prospective exporters/applicants to the Russian Veterinary Authority. If the Russian Veterinary Authority is interested to import from a supplier in Bangladesh, it will send a team to inspect factory/processing. Upon successful examination physically, they may approve the grant upon their satisfaction.
- Presently, only one processing plant in Bangladesh is qualified to export to Russia, some more processing plants are in the process.

Export to China (Commarce, 2020) :

- Registration from the Chinese Quarantine Authority is required to export to China.
- Applications are filed at the Department of Fisheries (DOF), which forwards the applicant's profile to the Chinese Authority.

Marketing channel of dried fish

Drying of fish (both freshwater and marine) is a very old occupation and commonly practiced in Bangladesh. According to sources at the Dried Fish Packaging Traders Association, dried fish is now a Tk500 crore industry, with Tk300 crore worth sold domestically and the remaining Tk200 crore in exports (DhakaTribune, 2019). However, marine fishes especially collected from the small-scale fishery in Bangladesh are dried in the rural islands during the winter seasons. After processing, dried fishes from these islands or coastal areas usually come to Chittagong 'Asadgong dry fish market'. From 'Asadgong dry fish market' they are distributed to local markets of different districts of Bangladesh. About 30 to 40% of the total dry fish export to foreign countries like the USA, UK and United Arab Emirates, especially from the other



Marketing channel of ready to cook fishery products

From the market survey, it was found that fish-based ready-to-cook products are very rare in Bangladesh. However, the initiative has been taken by the researcher of some local universities to develop the products. Bangladesh Agricultural University has already developed the products but

did not able to commercialize the product yet. From personal communication, it was found that the fish processing industries are not producing them due to the high manufacturing cost of the products. However, the probable marketing channel of these types of products may be as follows:



Marketing channel of ready to eat fishery products

In Bangladesh, only some potato chips are available in the market comes with fish or shrimp flavor. Some food companies are importing these from abroad (like Meridian food products). Other

than these, no other fish food products are available in Bangladesh. The marketing channel of ready-to-eat fishery products may be similar to ready to cook fish products.



Quality control of processed fish product

Due to the increasing demand for fish and fisheries products in local and the foreign countries, fish landing centers and fish industries especially fish processing plants in Bangladesh have to work intensively to maintain the quality of the processed products according to the quality control requirement of the local and foreign customers. The quality of the fish starts to deteriorate immediately after catching. This deterioration occurs due to several reasons including bacterial invasion, enzymatic autolysis, chemical oxidation and growth of microbes. Fish products with low quality (due to deterioration) may cause harm to consumers and thus lower down the standard exchange value. Consequently, fish processing industries all over the world are working hard to develop better techniques to ensure better quality fish products from catching to consumers. Initially, organoleptic, chemical and microbial tests were sufficient for controlling the quality of fish. However, with the advancement of technology and the requirement of the consumers, various methods have been developed for quality control (QC) of fish and fisheries products. Moreover, hazard analysis and critical control point (HACCP) system has become internationally recognized as the system of choice, concerning the prevention and control of the food (in this case fish and fisheries products) safety hazards (Ward, 2002). So, quality control is one of the prime issues for processed fish product development.

Since the independence of Bangladesh, fish and fisheries products are one of the major export products of Bangladesh. Bangladesh has now a total of 104 fish processing industries (DOF, 2017). The 'Fish Inspection and Quality Control' (FIQC) wing of the 'Department of Fisheries' (DOF) has established well equipped 'Quality Control Laboratory' in Dhaka, Chittagong, and Khulna to ensure better quality fish and fisheries products for

the foreign buyers. FIQC is the sole authority to ensure safe and quality fish and fishery products to global consumers (DOF, 2017). To ensure the quality and to maintain the safety of fish and fisheries products, the following activities are now being carried out by these FIQC Offices.

- i. Permission and license issuing of fish and fisheries processing establishments
- ii. Annual evaluation of establishments (instrumental & operational conditions) and license renewal
- iii. Regular monitoring of establishments' activities regarding HACCP, EU, USDA, Australia, GCC regulations, etc. as per Fish and Fish Products (Inspection & Quality Control) Rules, 1997 (amended in 2008, 2014 & 2017) and Official Control Protocol.
- iv. Monitor water, ice and swab quality of processing establishments and ice factories
- v. Plan and implementation of NRCP (National Residue Control Plan), FRCP (Factory Residue Control Plan) & MMP (Microbiological Monitoring Plan)
- vi. Product inspection and issuance of certificates for exportable fish and fish products
- vii. Surveillance and the mobile court to ensure the safety of fish and fish products
- viii. Implementation of activities under APA
- ix. Conduct awareness meeting
- x. Training of stakeholders
- xi. Inspect imported consignments of fish and fish products on request of Customs Department

Hazard Analysis and Critical Control Point (HACCP)

HACCP is a complete food safety system in which every step of a fish or fish products during manufacturing, storage and distribution are scientifically analyzed for microbiological, physical and chemical hazards. It helps people to eliminate biased views, make judgments on safety matters and ensure that the right staffs with proper training are making decisions. HACCP provides confidence that food safety is being effectively managed by the producers. Most importantly, HACCP plays a major role to satisfy the regulating agencies' reception and abroad. Other than QC, FIQC also monitors the HACCP related activities in every fish and shrimp farms and processing industries. HACCP defined as a scientific, rational and systematic approach to the identification, assessment, and control of hazards during production, harvesting, manufacturing, transport, distribution, preparation to ensure that food is safe when consumed (Noor, 2008). There are seven principles of HACCP which includes (adopted from Noor, 2008) :

- i. Assessment of hazard: In the first step, assessing hazards associated with growing, harvesting, raw materials and ingredients, processing, manufacturing, distributing, marketing, preparation and consumption of food are done.
- ii. Determining the critical control point (CCPs): Secondly, the processes that need to be controlled to eliminate or minimize the hazards are determined. CCP that can

completely control a hazard is usually designed as CCP-1 while CCP that minimizes but not completely controls a hazard is designated as CCP-2.

- iii. Establishment of critical limit: In this step, the establishment of a critical limit (tolerance, target level) is done to ensure that a CCP is under control.
- iv. Monitoring: A procedure is then established to monitor the CCP.
- v. Corrective action procedure: Accordingly, a corrective action procedure is taken if any deviation is identified while monitoring the CCP.
- vi. Record keeping: An effective record-keeping system is followed.
- vii. Verification: In this step, a procedure for verification is established to ensure that the HACCP system is working.

Value-added fish products that can be developed

1. Fish Finger

This is a breaded product. Fish fingers are small to long pieces of fish covered in breadcrumbs, and most often made using whitefish, such as cod, hake, basa, tilapia haddock or Pollock (Collinsdictionary, 2020). They are usually sold in frozen form.

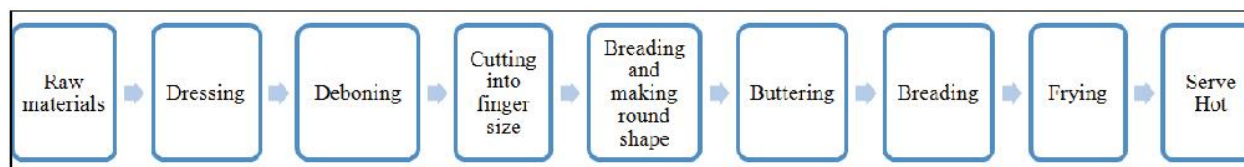


Source: <https://www.independent.co.uk/life-style/food-and-drink/news/fish-fingers-celebrating-their-60th-birthday-how-a-simple-staple-stood-the-test-of-time-10498489.html>

Recipe (Datta, 2013) :

Ingredients	Amount (%)	
Minced fish meat	60	Methods <ul style="list-style-type: none"> ➤ Head, gut, scales, and fins are separated from the fish and washed thoroughly. ➤ Cut the fish into finger-shaped pieces and remove bone from fish flesh. ➤ The pieces should be approximately 1 to 2 cm wide and 6 to 8 cm long. ➤ In a mixing bowl, finger-shaped fish meat is mixed with boiled potato, onion, garlic, ginger, pepper, vinegar, salt, capsicum, green chilli, cumin, carrot, coriander leaves etc. ➤ Finger shaped fish meat is given a round shape after mixing with biscuit powder. ➤ Dip the fish fingers into egg white solution. ➤ Fry the fish fingers in batches in the already hot oil until golden brown. ➤ Remove and drain on a paper towel.
Common salt	as per need	
Sugar	as per need	
Pepper	0.3	
Greenchilli	0.3	
Coriander	as per need	
Ginger	1	
Garlic	1	
Cumin (Jeera)	0.3	
Bengal grams powder	as per need	
Biscuit powder	as per need	
Bread cumbers	as per need	
Potato	10	
Egg white	as per need	
Beet, carrot, capsicum	17	
Onion	10	
Vinegar	2 teaspoons full	
Oil	as per need	

Flow chart :



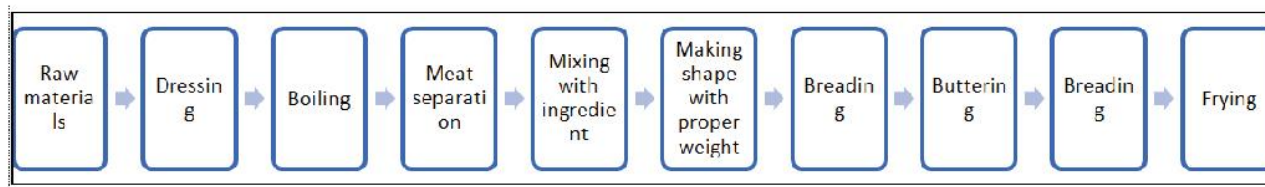
2. Fish cutlet

This is a breaded product. Minced fish are mixed with preferred spices and then breaded. This is a very popular item in the Indian subcontinent. Fish cutlet is crispy on the outside, spicy and juicy inside. This item is rich in spices that are being mixed with it. It is served as oval or round-shaped. This product can be used as an appetizer. These cutlets can be stored in a refrigerator.



Figure 7: fish cutlet
<http://www.myfoodjourneys.com/spicy-fish-cutlets-using-an-airfryer/>

Recipe Ingredients	Amount (%)	Methods (adopted from (myFoodJourneys, 2017)
Fish meat	70	<p>➤ Directions for boiling the fish</p> <p>➤ In a pan, add some oil, then add black pepper powder, turmeric powder, and salt. Add the fish into the pan, and add some water to cover the pan and allow the fish to cook on its own steam. Once the fish is cooked, let it cool down before removing the skin and bones, flake the fish and be sure to drain any excess water.</p> <p>➤ Directions for the cutlets</p> <p>➤ Wash and boil the potatoes with the skin on, cooked until its tender. Peel off the skin of the potatoes, mash it thoroughly to ensure that there are no lumps. Keep it aside.</p> <p>➤ In a food processor, grind together the green chillies, ginger, and garlic. Set aside.</p> <p>➤ Heat oil in a pan and add the chopped onions, sauté it until it becomes translucent.</p> <p>➤ Add the mixture of green chillies, ginger, and garlic, mix well. Then add garam masala powder, chili powder, turmeric powder, fennel powder, black pepper powder. Mix well.</p> <p>➤ Add the flaked fish, salt, and lemon juice, mix well then add the potatoes and coriander leaves. Switch off the flame and keep it aside to cool down.</p> <p>➤ In a bowl, beat the egg thoroughly and add a pinch of salt. Place breadcrumbs on a plate.</p> <p>➤ Start shaping the fish mixture into a small ball and flatten it.</p> <p>➤ Dip these cutlets into the beaten egg.</p> <p>➤ Coat the cutlet in breadcrumbs.</p> <p>➤ Fry the cutlets in a frying pan at a temperature of 150°C – 180°C until it becomes brown.</p> <p>➤ Serve it hot.</p>
White pepper	0.3	
Cumin (Jeera)	0.3	
Coriander leaves	as per need	
Bread crumbs	as per need	
Potato	16	
Egg white	as per need	
Common salt	as per need	
Onion	10	
Garlic	1	
Ginger	1	
Green chilli	0.3	
Bengal grams powder (Chola chatu)	as per need	
Oil	as per need	



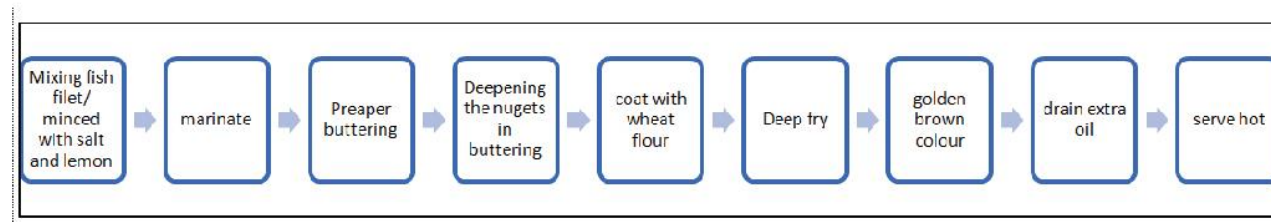
3. Fish nugget

This is a breaded product. Almost the same like as fish fingers. The only difference is due to shape. Fish fingers are generally given a finger shape while fish nuggets are served in a triangular or rectangular shape. Fish nuggets can be also made from marinated fish filets.



Figure 8 fish nuggets
(<https://us.kiwilimon.com/recipe/food-for-children/fish-nuggets>).

Recipe	amount	Method
Minced fish fillets	900 g	<ul style="list-style-type: none"> ➤ Mix the minced fish with salt or lemon. If it is fillet marinate it with salt and lemon juice. ➤ Keep for half an hour. ➤ In a medium-sized bowl beat egg, milk, salt, and chilli pest together. ➤ In another medium-sized bowl, combine all dry ingredients with marinated fish filets or fish mince. ➤ If it is minced fish then give them your preferred size (maybe triangular or rectangular or whatever you want). ➤ Dip nuggets into the egg and milk mixture. ➤ Drain and coat well with the flour mixture. ➤ Heat sufficient oil in a deep pan, slide in a few nuggets at a time and deep-fry. ➤ Fish will float when golden brown and done. ➤ Drain onto absorbent paper and serve right away with tartar or cocktail sauce.
Milk to taste	As required	
Lemon juice	1 teaspoon	
Oil for deep fry	As required	
White pepper powder	½ teaspoon	
Cornflower/ corn starch	1 cup	
Refined flour (Maida)	½ cup	
Chili pest (Green)	½ teaspoon	
Garlic powder	¼ teaspoon	
Onion powder	½ teaspoon	



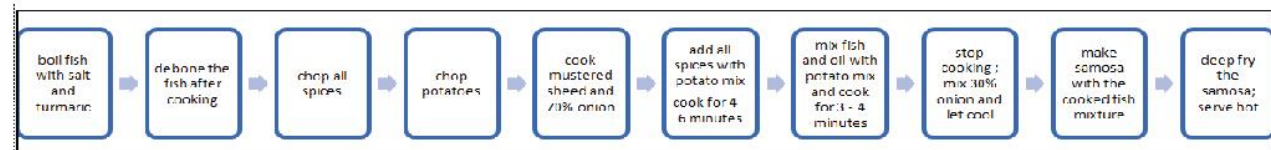
4. Fish samosa

It is a battered product. Fishes are initially boiled, deboned and mixed with spices with chopped potato. Then the mixtures are poured into a triangular-shaped small roti made from all-purpose flour and sealed with wheat flour paste. Then these items are deep-fried and served hot with sauce.



Figure 9: fish samosa
(<http://godavariaqua.com/html/fish-products.htm>)

Recipe: Ingredients	Amount	Method (adopted from (Rocy, 2020))
Fish – (Flesh only after boiled)	200g	<ul style="list-style-type: none"> ➤ Take the fish, clean, and rinse well. Place them in the cooking pot. Add salt and turmeric powder. ➤ Add the water and mix them well. Add the right amount of water to boil the fish completely. ➤ Switch on the flame. Cook covered under the high flame until the fish boils and all the water disappears. ➤ Let the fish pieces to cool down. ➤ Now take off the flesh from each fish piece. Carefully break the flesh without a single bone. Crush them with your fingers. ➤ Chop the onion, mince the garlic clove, chop the green chilies, and chop the curry leaves. ➤ Get ready with curry powder, mustard seeds, salt, and lime. ➤ Chop the potatoes into small pieces. ➤ Heat the oil in a cooking pan and add mustard seeds. Let it splutter. ➤ Add the onion and cook until it gets translucent. Add 70% of the onion and keep the rest aside for final preparation. ➤ Now add the green chilies, curry leaves, and garlic. Stir and cook them for 2 minutes. ➤ Add the chopped potatoes. Mix and cook for 1 or 2 minutes. Stir occasionally. ➤ Now add the salt and little water. ➤ Mix everything well and cook covered under medium flame for 4 to 6 minutes. ➤ Now take off the lid and cook uncovered under medium flame until all the water disappears. You may have to stir constantly to avoid burn. ➤ Now add the curry powder and crushed fish flesh. ➤ Mix everything well and cook uncovered under low flame for 2 or 3 minutes. You may have to stir and mix occasionally. ➤ Switch off the flame. Add the rest of the 30% chopped onion and lime. ➤ Mix everything well and taste the curry. Adjust salt and spices if needed. ➤ Now take the prepared roti and cut them into three symmetric pieces. ➤ Make the samosas. ➤ Heat the oil in a deep fry pan and add samosas. Fry them until the outer layer gets light brown color. ➤ This is a simple way to make fish samosa recipes. Serve hot.
All-purpose flour for making 'roti' (like Spring roll paper)	As required	
Potato		
Onion	500g	
Green chili	150g	
Garlic clove	5 – 7	
Curry leaves	4 – 6	
Curry powder	Few	
Turmeric powder	1 tablespoon	
Mustard seeds	½ teaspoon	
Lime	½ teaspoon	
Salt	½	
Water	As you wish	
Cooking oil	As you wish	



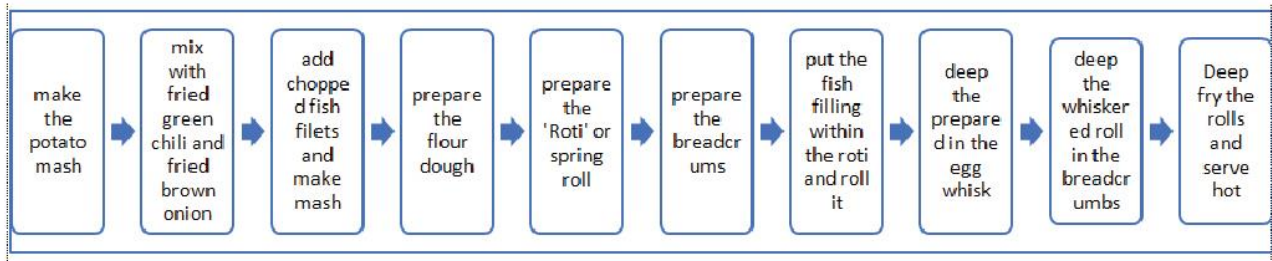
5. Fish Roll

This is a battered and breaded product. Fishes are deboned, fillets and mixed with preferred spices and marinated. Then thin roti or spring roll papers are made. Then the fish fillings are put on the roti (or spring roll paper) and rolled keeping the fillings inside. The two open edges of the roti are closed with the help of whisked eggs or water. Deep the rolls in the whisked eggs, shaking off any excess whisk and again deep in the breadcrumbs. Then deep-fry the rolls and serve hot with tomato sauces.



Figure 10: fish rolls
(<http://godavariaqua.com/html/fish-products.htm>).

Ingredients	Amount	Method (adopted from Dhanish 2020 ((Dhanish, 2020).
Fish Filling		To make the fish filling
Fish filets	150 g	➤ Boil the potatoes with 1 teaspoon of salt in a saucepan for 10 minutes or cook until tender.
Potatoes	300 g	➤ Peel off the skin and set aside.
Cumin seeds	½ TSP	➤ Heat oil in a wok and add cumin seeds and ginger garlic paste. Fry for 1 minute.
Ginger Garlic paste	1 TBP	➤ Add green chilies and onion, cook, until the onions start to brown.
Onions (chopped)	2	➤ Add chopped fish filets, red chili powder, turmeric powder, black pepper powder, salt and curry leaves. Stir until well combined.
Green Chilies (chopped)	2	➤ Add boiled potatoes and mash until smooth.
Curry Leaves (Chopped)	1 spring	➤ Check the seasoning and set aside.
Red chili powder	1 TSP	
Turmeric powder	½ TSP	To make the roti or spring roll
Black pepper powder	½ TBS	➤ In a blender add the flour, turmeric, salt, oil and water.
Salt	½ TSP	➤ Blend until smooth and lump-free. If the mixture is too thick add a bit of water and blend again. Set aside for 10 minutes.
Oil	3 TBS	➤ Heat a nonstick frying pan over high heat.
Roti or thin spring roll		➤ Add a spoon of ladleful of the batter into the pan and swirl to coat the base.
Plain Flour	150 g	➤ Once the pancake is loose enough to come away from the pan remove from the pan and set aside.
Turmeric powder	¼ TSP	➤ It should be soft enough to fold without tearing.
Salt	½ TSP	➤ Repeat with the remaining batter.
Oil	1 TSP	To make the crumbing mixture
water as needed	As needed	➤ Whisk the egg in a large bowl and set aside.
Crumbing mixture		➤ Place the bread crumbs in a shallow bowl and set aside.
Dried fine bread crumbs	250 g	To assemble the fish roll
Eggs	2	➤ Lay a pancake on a work surface and place a small amount of the fish filling in the center.
		➤ Fold two opposite sides of the pancake over the filling and roll up like a spring roll to enclose the filling completely.
		➤ Use some water/beaten egg to help the edges stick if necessary.
		➤ Repeat with the remaining pancakes and filling.
		➤ Dip each roll in the beaten egg, shaking off any excess, then coat in the bread crumb, and place on a tray.
		➤ Fill a deep wok one-third full of oil and heat until a cube of bread turns golden brown
		➤ Once the oil is heated, deep fry the rolls in batches, until crisp and golden all over.
		➤ Remove with a slotted spoon and drain on a paper towel.
		➤ Serve hot with the tomato ketchup



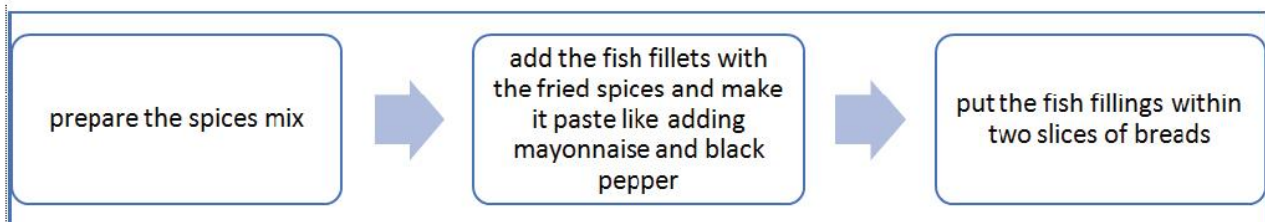
6. Fish sandwich

Fish filets are chopped and mixed with different types of seasonings. Then it is boiled with spices and make sticky. Then the cooked fish fillings are put within two pieces of bread or a bun. salad creams and other vegetables are given according to the customer's preference. Sometimes the whole fish fillet is bread-crumbed and fried and put it within the pieces of bread.



Figure 11: fish sandwich
(<https://www.bonappetit.com/recipe/fried-fish-sandwiches-with-cucumbers-and-tartar-sauce>).

Recipe: Ingredients (for four sandwiches)	Amount	The method adopted from(TNN, 2019)
fish fillets	250 g	<p>Step 1</p> <ul style="list-style-type: none"> ➤ Fry the chopped spring onion, garlic, ginger and green chili in a pan with required oil. Add salt according to your preference. Stir fry the ingredients for a while. <p>Step 2</p> <p>Mix the dried boneless fish fillets with the fried onion, ginger and chili mixture and again fry them. Stir fry for about 5 minutes. After this, remove the fish fillings from the pan and let them cool down for a while. Add salt as per your taste. Mix them well with mayonnaise and black pepper.</p> <p>Step 3</p> <ul style="list-style-type: none"> ➤ Take two bread slices and coat with margarine on both sides. Add the fish mixture on the first bread with margarine base and place the other slice of bread on the mixture. Grill the sandwich for about 3-5 minutes. ➤ Serve hot....
tablespoon garlic	½ TSP	
teaspoon green chilli	1 TSP	
tablespoon mayonnaise	3 TBS	
salt	As required	
margarine	As required	
spring onions	100 g	
tablespoon ginger	½ TBS	
tablespoon virgin olive oil	3 TBS	
crushed black pepper	½ TSP	
brown bread	8 slices	
water	2 cups	

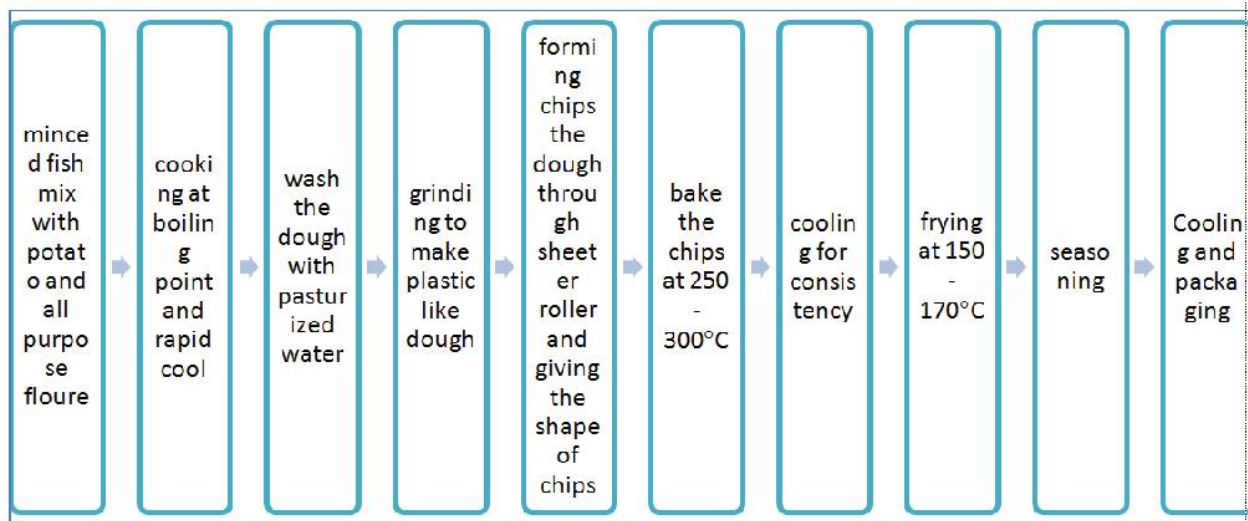


7. Fish chips

i. Thin fish chips

This is like thin potato chips. Minced fish are mixed with potato and allpurpose flour and dough are made. Afterwards, the dough is kneaded and fed to sheeter rolls and is sheeted into a thin layer which is then cut into slices with a specific shape. The thickness of the sheet determines the final product weight. The sheeting starts when the dough is fed into a pair of smooth rollers (coated with Teflon); one rotating counter-clockwise and the other clockwise. The gap between the rollers is

adjustable so that products of different thicknesses can be produced. The slices then flow into troughs which are filled with oil to fry. Paddles gently push the slices along (Anon, 2020). As the slices tumble, salt is sprinkled above the trough. At the end of the trough, a wire mesh belt pulls out the hot chips. As the chips move along the mesh conveyer belt, excess oil is drained off and the chips begin to cool. These then move under an optical sorter that picks out any burnt slices and removes them with puffs of air. Finally, they are packed and stored.

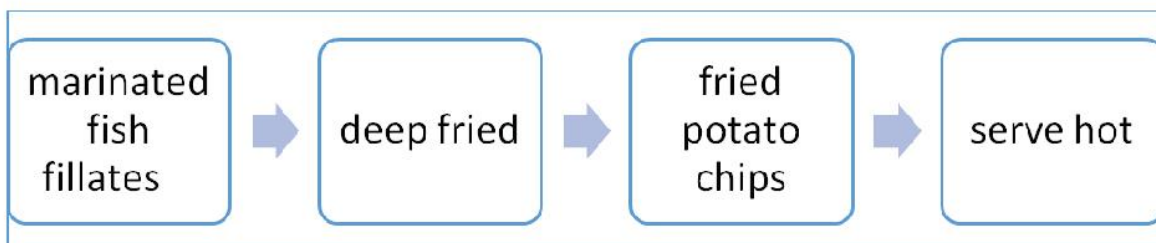


ii. Fish and chips

It is a egg battered product. Fish fillets are marinated with preferred spices and the deep fried at 150 - 170°C. at the same time, potato chips are also prepared and served both in the same plate with sauce.



Figure 12: Fish and chips
(<https://www.delonghi.com/Global/recipes/multifry/173.jpg>)



8. Fish pickle

This is not a very popular item in Bangladesh. However, recently it is marketed by some super shops in Bangladesh, mostly imported from countries like Thailand, India, and countries from the east. This product is very popular in south Indian states (like Kerela). The process of making fish pickles is very simple. Fish are fried, mixed with pickle spices, cooked again and preserved with preservatives like vinegar.



Figure 11: Fish pickle
(<https://food.manoramaonline.com/food/kerala-kitchen/2019/02/18/fish-pickle-recipe-kerala-style.html>)

Recipe: Ingredients (for four sandwiches)	Amount	The method adopted from (TNN, 2019)
250 gm of cubed (any firm-fleshed) fish	250 g	➤ Wash and clean the fish pieces.
Turmeric powder	½ TSP	➤ Place the fish pieces in a bowl and add the turmeric powder and red chili powder along with some salt
Red chili powder	½ TSP	➤ Mix well and set aside
Salt (adjust to taste)	½ TSP	➤ Pound or grind the ginger and garlic together. Making it fresh is key to get a yummy fish pickle so don't skimp on this step
Oil	½ CUP	➤ Now in the ½ cup oil, fry the fish until it's crispy on the outside
Black mustard seeds	½ TSP	➤ Drain oil and set aside
Fenugreek seeds (uluva)	½ TSP	➤ In the remaining oil, add mustard seeds and fenugreek seeds
Fresh ginger garlic paste	2 – 3 TSP	➤ As soon as the mustard seeds start to pop, add the ginger garlic paste
Green chillies	2 – 3	➤ lower the heat
Garlic cloves, sliced	4 – 5	➤ Then add the curry leaves, green chillies, garlic pieces, and Kashmiri chilli powder. Mix well
Curry leaves	A few	➤ Add the fried fish, mix well, and add more salt as needed
Kashmiri chilli powder	2.5 TBS	➤ When the fish pieces are well mixed with the spices, add the vinegar
White vinegar	3 TBS	➤ If you want more gravy in your pickle, add some water at this stage and bring to the boil
Salt	As needed	➤ Remove from heat and set aside
		➤ Cool completely and then store in airtight glass jars in the refrigerator
		➤ This pickle stays fresh if refrigerated for about 2 weeks. If you want to keep it longer, freeze a portion and take out as needed

CONCLUSION :

Bangladesh is a country where people preferred fish than anything else in their daily meal. The Bangladeshi phrase “Mache Vate Bangali” proves this fact that fish and rice are staples of our daily diet. However, these days, the use of fish is not only limited to the main meal. It becomes a part of the sweet and salty moments of daily life, particularly for younger generations. Along with local consumption, a notable amount of fishes and shellfishes are also being exported in foreign countries. Thus, it shows an increasing contribution to the economy of Bangladesh. The economy is

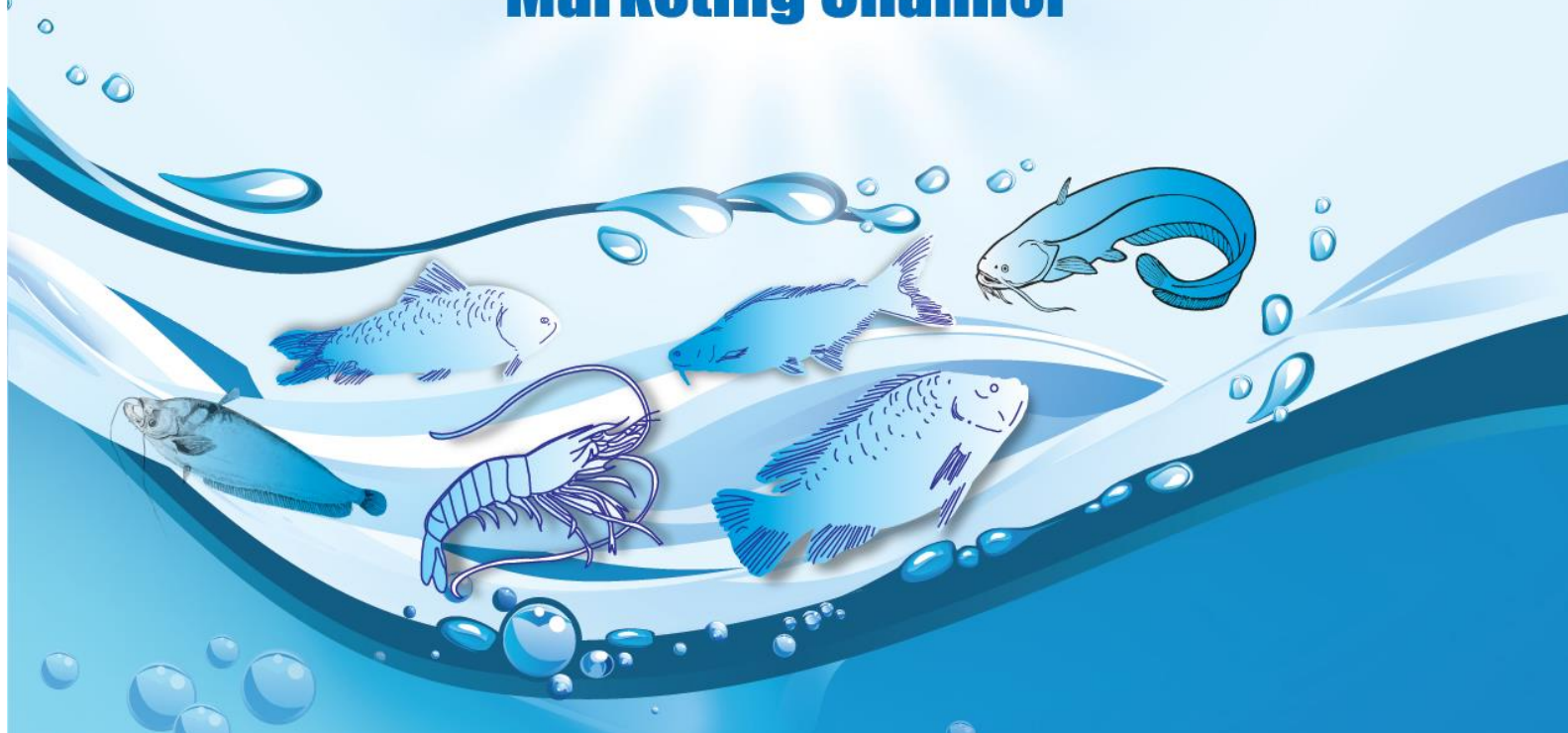
getting a further boost by exporting processed fish and shrimps’ products which are usually beheaded, degutted and washed, glazed and stored before shipping out. This study suggests a potential industry that can be further explored both for the local and international market. If necessary, steps are taken and appropriate investment made, it can significantly contribute to the country’s economy and simultaneously creates employment opportunities for millions of people in Bangladesh.

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