Ministry of Food Processing Industries
Government of India

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Reading Manual for Marine Products

Under PMFME Scheme

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ABBREVIATIONS & ACRONYMS

Sr: No.	Abbreviations &Acronyms	Full Forms
1.	APEDA	Agricultural and Processed Food Products Export Development Authority
2.	FAO	Food and Agriculture Organization
3.	FBO	Food Business Operator
4.	FLRS	Food Licensing and Registration System
5.	FPOs	Farmer Producer Organizations
6.	FSSAI	Food Safety and Standards Authority of India
7.	Kcal	Kilocalorie
8.	MoFPI	Ministry of Food Processing Industries
9.	PA	Polyamide
10.	PET	Polyesters
11.	PFA	Prevention of Food Adulteration
12.	SHGs	Self Help Groups
13.	UK	United Kingdom
14.	US	United States
15.	WVTR	Water Vapour Transmission Rate

CHAPTER- 1

INTRODUCTION

Coastal India comprising of nine maritime States and two Union territories supports 30% of 1.30 billion populations. The Indian coastal system comprises estuaries, lagoons, mangroves coral reefs, marshes, seagrass beds, and rocky and sandy beaches that extend to 40,808 sq ft. They are known for high biological productivity providing a range of habitats for much aquatic flora and fauna. The marine ecosystem apart from providing food also offers many non-food uses and pharmaceuticals. The inventory of the marine ecosystem is extensive but not exhaustive. Human society is reaping many economic benefits without assessing the actual value. The coastal and marine ecosystems are among the most productive ecosystems in the world and greater economic value to human society. Hence it is important to assess both the nutritional and economic value of the marine system for better understanding and sustainable exploitation.

1.1 Importance of Fish in Nutritional Security In Indian Context

Nutritional security is the physical and economic access by all people to the nutritionally adequate food they need. Therefore, it embodies a stable, sustainable, and predictable supply of nutritionally adequate food for life functions and equity through access for all regarding the means of production and/or purchasing power. Ensuring sustainable nutritional security is the major challenge confronting all developing countries. In India, 16% of the world population has to be sustained on 2.4 % of the global land area. It is imperative to look for alternate sources of nutritious food to feed the increasing population. The rich bio-diversity from the marine environment offers protein-rich food and other products of use to mankind. Fisheries are emerging as one of the fastest-growing food production systems all over the world. The potential for fisheries development in India is highly promising given the physical and biological resources available in the country coupled with technological developments.

Fish is a highly perishable commodity and supply of acceptable quality is a challenging task to all concerned in the fisheries sector. This is compounded further with the world fish production from capture fisheries is not showing a significant increase in catches. As the human population is ever-increasing, the stagnation in fish production implies that less and less fish will be available every year. Nevertheless, a large fraction of this valuable commodity is wasted due to discarding at sea and deterioration after landing and this post-

harvest loss is estimated to be 20-25% of total catches landed (FAO, 1995). Better utilization of aquatic resources should therefore aim primarily at reducing this enormous loss by improving the preservation of fish and fishery products and upgrading the discarded low-value fish to high-value fishery products. An International Convention of 100 maritime nations at Tokyo in 1996 discussed plans on 'Sustainable contribution of fisheries to food security and adopted a set of immediate actions for conservation and management of fishery resources. These included minimizing post-harvest losses and optimal use of the resources to increase the available supply of fish and fishery products for human consumption.

India has an extensive coastline of 8129 Km and an exclusive economic zone of 2.02 million Km $^{2.}$ The Indian marine ecosystem has been identified as one of the rich sources of major flora and fauna. In India, the total fish production has crossed 10 million mt. during the year 2016-2017. The present annual yield from marine fisheries is about 4 million mt and the only additional products that can be expected in the future is about 0.9 million mt from un-fished shore waters The diversity of fish species is varied and if exploited optimally, the resources from the sea will add a new dimension to the nutritional security of the country. The projected requirements of fish by 2020 are 15 million mt. This huge deficit has to be made by some other sources. In the present circumstances the only available source of mooting national, as well as global requirements is the reduction in wastage of fish caught and rapid expansion of aquatic farming.

There are several unique features about fish that inhibit or plague trade and development. The major one is that it is very perishable and requires special attention and facilities if the quality is to be maintained. This remains a major problem in the marketing of fish even today and results in major losses throughout the industry in both developed and developing countries. Another handicap is that fish, unlike agricultural produce, must be transported from the place of harvest to distant places. It is recognized that protein from aquatic sources could drastically reduce famine in the world today if a distribution system could be set up to transport available fish resources to where they are most needed.

1.2 Marine Fish Processing

The principal aim of fish preservation is to delay, reduce or inhibit microbial spoilage. In the case of fatty fish, the preservation may also aim at reducing or inhibiting oxidation and other undesirable changes in the fish lipids, which are highly unsaturated and capable of going rancid at various stages of processing. Among different methods of fish preservation, it is

short-term preservation by chilling which has attracted worldwide attention. Perhaps, this is mainly because of the preference for fresh fish by consumers. The other methods of fish preservation, which have commercial relevance, are freezing, canning, salting and drying, smoking, and mince production. These preservation techniques are basically for human food and the processing of fish into non-food items includes the production of fishmeal and oil, silage, and other industrial products.

The Indian seafood industry is mainly dependent on the export trade of frozen products. The export trade of frozen seafood started in 1953, with the first shipment of frozen shrimp to the USA by M/s. Cochin Company from the port of Cochin. Since then the growth of the frozen seafood industry is phenomenal. India's seafood exports have crossed Rs. 45,000/ crores during the year 2017-2018 (MPEDA 2018) Frozen shrimp, frozen finfish, frozen cuttlefish, and surimi contributing to more than 80% of the earnings. Among the various seafood processing, it is the freezing industry in India that has occupied a pre-eminent position. The scenario is no different in Karnataka, and it is the freezing industry that drives the export trade followed by fish meal and oil. The potential for the production of fish mince-based products like fish fingers, breaded and battered products, fish sausages, and other value-added products is very high. These value-added products can be prepared by small and medium entrepreneurs which will pave way for tremendous employment opportunities.

The fresh fish harvested from the marine ecosystem is used for human consumption immediately or processed to different products to extend the shelf life by value addition in the process. The processed fishery products realize higher value by several-fold compared to the value of fresh fish. The different value-added products from fish mince or surimi (water-washed fish mince with added cryoprotectants).

1.3 Surimi Preparation

The term Surimi is a Japanese word used for deboned, minced, and washed fish flesh, an intermediate product in the manufacture of imitation products such as crab legs. The surimi industry demands white fish mainly because of the importance of the whiteness and textural properties of the resulting products. Surimi is a traditional product of Japan consumed worldwide and production has reached about 830,000 MT during 2017 with the major contribution of 400,000 MT from South Asian and Southeast Asian countries. Alaska Pollack is the single major species contributing 21% of the total surimi production whereas tropical species like threadfin bream, croaker, lizard fish, ribbon fish, and bigeye snapper together

contributing about 60%. (www.future-seafood.com). Increasing consumption and demand of surimi-based products may be attributed to the wholesomeness, nutritious nature, and affordable price.

Surimi is prepared from fish by gutting, heading, filleting, mincing, water washing, and refining (Fig. 1). A major step in conventional surimi processing is repeated washing of fish mince with chilled water (5-10^{o}C) resulting in odorless and colorless products. Depending on the condition of fish upon processing and the fish species, the temperature of water used for washing, washing cycle, and volume of water may be varied. Washing cycles and meat to water ratio vary from 2 to 4 times and 5:1 to 10:1 respectively. The purpose of water washing is to remove the lipids, water-soluble sarcoplasmic proteins, blood, enzymes, and heme compounds. As a result, this process concentrates myofibrillar proteins. Washed fish mince is then pumped to a refiner to remove connective tissues and small pin bones. As a final dewatering step, washed meat is subjected to a screw press before mixing with cryoprotectants. Cryoprotectants commonly used in a commercial application for cold-water species are 4% sugar, 4-5% sorbitol, and 0.2-0.3% polyphosphate with moisture contents at 74-76%. However, for surimi from warm water species such as threadfin bream manufactured in SE Asia and India, only 6% sugar and 0.2-0.3% polyphosphates are used without sorbitol. Even though fish proteins from warm water are having better-frozen stability, the addition of an equal amount of cryoprotectants is desired to maintain the consistency in sweetness and longer shelf life. Finally, surimi is stuffed into 10 Kg plastic bags before subjecting to a plate freezer. After freezing blocks with their core temperature at -20^{o}C, two blocks are packed in a carton box for frozen storage (Park and Lin 2005).

Alternately fish mice can be prepared from different fishes following the same procedure except the water washing unit operation need not be included. However, only a few selected species can be made use of for fish mince preparation. Also, the frozen stability of fish mince is relatively lower as compared to surimi.

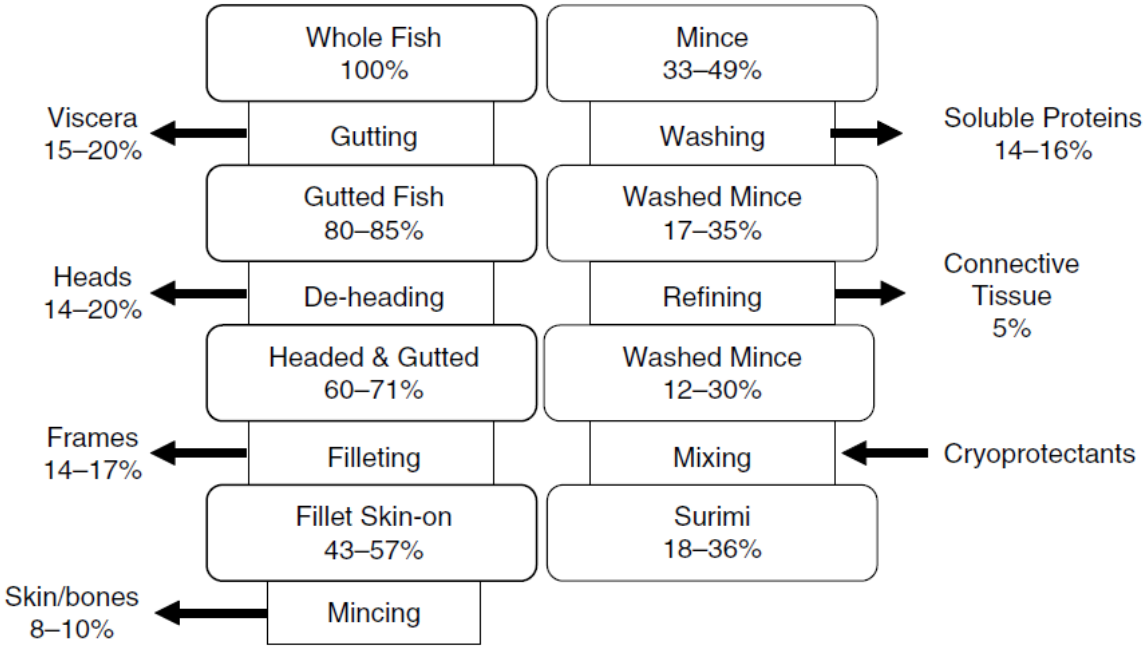

Fig 1: Flow Line for Surimi Production / Fish Mince Production. In the preparation of the Fish mine, water washing unit operation is excluded.

CHAPTER 2

PROCESS & MACHINERY REQUIREMENT

2.1. Raw Material Aspects

During some growth cycles and annual spawning or migration periods, the composition of fish can differ considerably, particularly in their fat content. Moreover, the composition of captive-bred fish (i.e. aquaculture fish) will vary based on their artificial diet. Fish freezing is a preservation process. In this process, fish tissue and fishery products are converted into ice within the water at a lower temperature. This technique boosts the shelf life of fish and fish products. This approach is used internationally to monitor the quality of fish and fish items at the time of conservation. There are many ways in which fish can be frozen, but both need specialized equipment to affect the necessary rapid temperature drop and adequately decrease the core temperature to ensure that the commodity can be safely stored in cold storage. If unfrozen fish are merely positioned in a cold store running at -300c, the temperature will decrease rapidly enough and the result will be frozen fish of poor quality; cold stores are built to keep fish already frozen at low temperatures.

2.2.Technologies

Direct and indirect systems

The refrigerant absorbs heat directly from the material to be cooled inside the direct expansion device. The refrigerant consumes the heat that the brine absorbs from the substance to be cooled inside the indirect or brine method. In industrial freezing practices, all of these devices are widely employed. Freezing strategies are grouped widely into:

- Air-Freezing is the most popular medium for freezing. There are two kinds of air freezing mechanisms - still air freezing and induced air freezing.
- Freezing in still air: The freezer consists of an enclosed space or a cabinet held at -28 to -45oC. Packaged or otherwise put in aluminum trays, fish is held on shelves consisting of pipes or coils from which the refrigerant is pumped. The time needed to freeze could be 12 hours or longer. The least expensive method of freezing is to freeze in still air; however, the slowest method is welding.
- Air Blast Freezer-The air blast freezer consists of a tunnel or insulated space. Air is cooled by blowing a ventilator into the cooling coil of the cooling system. Cold air flows

over the frozen fish and takes up the heat from the food, the freezer walls, etc. Hold the temperature at -35 to -40oC.

- Continuous air blast freezer-This is an enhancement to the air blast freezer where a conveyor belt is used to transfer the fish around the space or tunnel continuously. It is possible to change the speed of the conveyor to accommodate the type of fish to be frozen. Airflow may either be countercurrent to the material's movement or around the belt. The air velocity, sustained at 150-300 m/sec, makes intimate contact with the fish and easily freezes. Freezing is easier and, in shorter times, any form of fish can be frozen in large amounts. An example is spiral belt freezers.
- Fluidized Bed Freezing-Fluidized bed freezer is a continuous belt freezer improvement. Fluidization is a way of preserving partly assisted stable particles in an increasing column of cold air. In an outward stream of cold air at a velocity adequate to float the particles in the cold air, the particles kept on a mesh are independently suspended. Each molecule is surrounded by air and is isolated from the other and is left suspended. Freezing is quick, as between the cold air and the product, the best possible heat transfer is ensured. 120m/min air velocity. And for fluidized bed freezing, operating temperatures of -35 to -40 o are popular. This is most fitting for small and standardized items such as shrimp, small fish, etc.

Indirect Contact Freezing

By holding it in contact with a metal surface that is cooled by a refrigerant, indirect contact freezing can be described as freezing a substance. The horizontal plate freezers and the vertical plate freezers come in two styles.

- Horizontal plate Freezer: There are 15-20 plates in these freezers in total. The substance to be frozen, stored in metal freezing trays, is loaded between the freezing plates and held under low hydraulic pressure in near contact with the top and bottom plates to ensure optimum heat exchange. The freezing trays are often protected with closely fitted lids to help provide contact at the top with the freezing plates. Hold the temperature between -35 and -40oC. The fish will freeze within 2-2.5 hours.
- Vertical Plate Freezer: These are most widely used to freeze sea fish. They consist of various vertical freezing plates in a container called stations that shape partitions. When each station is completed, the fish are loaded between the plates, and the plates are then closed together to form fish blocks. Temperatures vary from -30 to -40oC.

- The process of the Contact plate freezer is very economical. The product's dehydration will be minimal and it will sit in uniform blocks without bulging.
- Freezer with Rotary Drum: This is a drum of refrigerated stainless steel which rotates at a pre-set speed. The frozen material is fed through a conveyor on the outside surface of the drum. By freezing the water on the material's back, it adheres directly to the surface of the drum. The frozen substance is scraped off at the end of one revolution and is passed into an electronic glazer before packaging. As there is no air circulation and freezing is rapid, there will be little to no weight loss during the freezing period.
- Immersion by Freezing: In this approach, freezing is done by immersion in a refrigerant that stays liquid during the process, or spraying with it. As a medium for freezing, refrigerated aqueous solutions of propylene glycol, glycerol, sodium chloride, calcium chloride, and sugar and salt mixtures can be used. Immersion freezing facilitates intimate interaction with the freezing medium of each surface of the material and thereby allows very effective heat transfer.
- Freezing in brine: At -21 o c, saturated brine freezes and this is the most prevalent medium used in immersion freezing. The freezing of brine is fast and can be optimized for continuous activity. However, any salt, which depends on certain aspects, such as the temperature of the brine, the length of immersion, the fat content of the fish, and the surface area, will be consumed by the fish. Through using a combination of glucose or corn syrup and salt as a fridge, the absorption of salt can be significantly decreased. The glucose-salt solution will lend the substance a safe glaze and it will thus not hold together. A significant downside of this method is the degradation of the medium and resulting cross-contamination of batches.
- Freezing by brine spray: The fish put in trays are sprayed with chilled brine. The heat from the fish is absorbed in 1-2 hours by the chilled brine.
- Cryogenic Freezing: Quite fast freezing is accomplished in cryogenic freezing by exposing the fish to an incredibly cold freezer undergoing a change of state, unpacked or with a very thin box. The significant distinction between cryogenic freezing and heating for liquid immersion is the change of state in the former as heat is extracted from the body. Boiling nitrogen and boiling or sublimating carbon dioxide are the most popular food-grade cryogenic freezers. Cryogenic freezing is much quicker than the freezing of the air blast or touch plate, but only marginally faster than the freezing of the fluidized bed or liquid immersion. For example, in a commercial liquid nitrogen freezer, shrimp

takes nine minutes to freeze, while it would be 12 minutes in a fluidized bed freezer and 1-2 hours in touch plate or air blast freezers.

- Using liquid nitrogen, freezing: When liquid nitrogen is used to freeze, liquefied nitrogen gas is poured over the substance as it goes along a conveyor belt in a tunnel. Before touching the liquid nitrogen spray, the nitrogen gas travels counter current to the action of the fish so that the fish gets pre-cooled. The substance is permitted to temper after the spray for a while when discharged from the tunnel.
- Freezing Using Liquid / Solid Carbon Dioxide: When it moves through a tube on a rotating conveyor, liquid carbon dioxide is poured over the fish. The carbon dioxide is pumped through the nozzles and the pressure is gradually lowered during spraying and about 50 percent of it instantly shifts to small particles that absorb the heat from the air and are turned to steam, resulting in the fish being easily cooled. By exposing the fish to powdered solid carbon dioxide, freezing may be carried out. Carbon dioxide freezing provides much of the benefits of liquid nitrogen freezing. However, to the point of causing undesirable swelling, unpacked foods may absorb or trap carbon dioxide.
- Freezing using refrigerant liquid: Dichlorodifluoromethane, the most popular liquid refrigerant used, is (Freon -12). Fish is conveyed to an enclosed chamber in a mesh belt. Fish is then frozen by spraying the stock with a strong Freon food grade or a mixture of initial immersion in Freon liquid accompanied by spraying with it. The vapors are obtained for re-use in both situations. The procedure has all the effects of the freezing of liquid nitrogen and the additional cost advantage. However, due to worries about the impact of Freon -12 on atmospheric ozone depletion, its use has reduced rapidly.
- Double Freezing: Protecting the fish by freezing onboard boats as the journey continues for a few weeks is a common procedure. The fish is thawed and reprocessed upon reaching the sea. Examples of double freezing are the use of fish frozen in bulk onboard for further finger processing and the reprocessing of bulk frozen shrimp into IQF shrimp. Quality-wise, fish re-freezing is regarded to be unacceptable. As a fillet, lean fish suffers a loss of consistency, particularly when the texture becomes rough.
- Partial Freezing: Partial freezing or supercooling means reducing the fish's temperature to between -2 and -3 C. Approximately half of the unbound water contained in the fish would be transferred to the solid stage by cooling the fish to the temperature level. The shelf life of partly frozen fish is almost double that of ice-storage fish. Some lack of sensory efficiency, however, is experienced when the storage time stretches to five days, primarily due to temperature variations. A 0.5 C shift can be instrumental in the periodic

melting and freezing of fish water and can have a significant effect on the denaturation of proteins. The shelf life of partly frozen fish would be very short if it is subsequently frozen. The preservation of a strictly constant storage temperature is very critical for avoiding loss of consistency in partially frozen fish.

2.3. Manufacturing Process:

Fish is a perishable raw material because of its chemical composition. After death, the taste and texture of fish change quickly during preservation. Thus, it is advisable to keep the fish alive as much as possible when handling freshwater fish. Quality improvement mechanisms also cover the transfer and storage/depuration of fish waiting for processing. To eliminate bacterial activities, to prevent undesirable enzymatic and microbiological processes, de-heading, gutting, washing, and chilling should be carried out immediately on dead fish. To preserve shelf life, processing techniques should be implemented when fish is not sold fresh. Freezing, smoking, heat treatment may be used in these (sterilization, pasteurization, etc.).

- Immediate cooling- Fast cooling and retention of fish at temperatures between 2 and -2 °C (36 and 28 °F) occurs shortly after processing. (See Treating Harvested Fish: Chilling above.)
- Rapid freezing- Rapid temperature drop to between -2 and -7 °C (28 and 20 °F) is the secret to freezing. This temperature range illustrates the highest ice crystal forming region in the cells of the animals. If water freezes rapidly in the cells, so the ice crystals can stay small and allow the cells to experience minor damage. Slow freezing, however, results in the development of large ice crystals, and the cell membranes are ruptured. The ruptured cells release water (called drip) and several compounds that provide some fish flavor characteristics when slow-frozen flesh is thawed, resulting in a dry, tasteless product. In general, fish going through the region of maximal ice crystal production in less than one hour would have minimal drip loss after thawing.
- Freezing- Among the various preservation processes used to preserve seafood, the taste and consistency of fresh fish can only be retained by freezing. The biochemical processes in fish flesh are significantly reduced or interrupted by freezing. For example, enzymes do not react to soften and degrade the flesh in the absence of free water. Immediate cooling and holding, quick freezing, and cold storage are the three stages for freezing fish. When fish are frozen poorly, leading to enzymatic deterioration, texture changes, and dehydration, structural integrity can be damaged.

- Freezer Chamber- To preserve long shelf life and ensure consistency, fish must be preserved at a steady temperature of -23 ° C (-10 ° F) or below when frozen. Water is a major part of fresh seafood (e.g., oysters are more than 80 percent water). Since water in fish contains several dissolved compounds, at the freezing point of pure water, it does not freeze evenly. The free water in fish instead freezes over a large range, starting at around -2 °C (28 °F). Until the substance exceeds a temperature of approximately -40 °C (-40 °F), the sum of residual free water declines. Fish kept below that temperature can be preserved for an infinite time and packed so as not to allow water depletion by sublimation. Unfortunately, because of the enormous variation in energy prices, there are comparatively few commercial freezers capable of keeping fish at -40 °. Therefore, fish are usually preserved at -18 to -29 °C (0 to -20 °F), resulting in the variable shelf life of only a few weeks and almost one year.

2.4.Flow Chart:

Steps	**Machine Name**	**Description**	**Machine Image.**
Packaging	Vacuum Packaging Machine	The Fish Vacuum Packing System extracts and seals air from the pouch in an airtight way. Vacuum packing increases the shelf-life and helps maintain the product's consistency.	
Freezing	Blast Freezer-	For deep freezing fillets of cod, air blast freezers are also used. On their travel into the tube, the fillets lie on a conveyor belt and freeze.	
Storage	Freezer/cold storage	A plant for the refrigeration, freezing, and cold handling of perishable foodstuffs and other perishables.	

2.5.Additional Machine & Equipment:

MACHINE AND EQUIPMENTS	USES	PICTURE
Gutting machines	Gutting machines reduce the amount of waste by basically gutting all forms of fish with extremely high accuracy, leading to a decline in the cost of processing. The guts are sucked out with the aid of a vacuum when the fish is gutted and sliced. Problems involving knife sharpening as a result of stones eaten by fish are thereby avoided.	
Wishmaster	For the initial cleaning, rinsing during processing, or final washing before packaging, a Wash master may be used. Wash master is available as a 2-chamber device, meaning that some of the water can be reused while the second chamber still has fresh water.	
Scale master	The Scale master unit is mounted on a rigid spring suspension frame to change the size of the fish. The fish is kept in place by tight connections during the decaling process-it is necessary to maintain the fish in place to ensure a successful decaling. The tightening of the ties is performed pneumatically and it is easy to seamlessly change the tightening process. The links can be cut for better cleaning of both the ties and the unit in a minute.	

2.6.General Failures & Remedies:

S. No.	General Failures	Remedies
1.	Ball-bearing failure of various machine	1. Proper periodic lubrication of all bearings in various machines. 2. Regular replacement of all bearing to prevent critical failures.

2.	Power Drive Overload	1. Ensure proper weighing & metering especially in the case of the semi-automatic plant. 2. Install warning sensor in the buffer region of loading capacity to ensure efficient operation.
3.	Mechanical Key Failure	1. Ensure that mechanical keys are replaced as per their pre-defined operational life. 2. Prevent Overloading.
4.	Loss of Interface	1. This problem is dominant in the newly established automatic plant, one must learn to maintain rules in the plant & ensure no employee goes near transmission lines unless authorized. 2. Provide proper physical shielding for the connections.

2.6 Fish Mince based products

Different fish mince-based products can be prepared and a few of them have been described.

2.6.1 Fish Fritters (Fish Balls)

Introduction: Fish fritter's or fish ball's composition of ingredients vary from one country to the other. Fish minced meat is mixed with various ingredients and then formed either by hand or by forming machines into balls. The balls are then battered and breaded and kept under frozen storage. Fish balls can also be flash-fried like fish fingers to be highly sterile. It is always sold as frozen material.

Materials required: Minced meat (*Priacanthus sp.*), all the ingredients listed in the table-1, mixing bowl, Pan, ladle, and a serving plate.

Table-1: List of ingredients

Sl. No.	Ingredient	Quantity (%)
1.	Minced meat	55
2.	Water	15
3.	Onions	4
4.	Garlic paste	1.5
5.	Salt	2.0
6.	Pepper powder	0.5

Procedure:

1. Minced meat is mixed with all the ingredients listed in the table-1
2. Mixed mass is made into a ball shape
3. Set it at an ambient temperature
4. Fry the fish balls in oil at 90-100ºC till it turns to golden brown color

2.6.2. Fish Balls

Introduction: Fish fritter's or fish ball's composition of ingredients vary from one country to the other. Fish surimi meat is mixed with various ingredients and then formed either by hand or by forming machines into balls. The balls are then battered and breaded and kept under frozen storage. Fish balls can also be flash-fried like fish fingers to be highly sterile. It is always sold as frozen material.

Materials required: Surimi, all the ingredients listed in the table-1, mixing bowl, Pan, ladle, and a serving plate.

Table-1: List of ingredients

Sl. No.	Ingredient	Quantity (%)
1.	Surimi meat	55
2.	Water	15
3.	Onions	4
4.	Ginger Garlic paste	1.5
5.	Salt	2.0
6.	Turmeric powder	0.5
7.	Chilli Powder	1
8.	Finely chopped coriander leaves	0.5
9.	Corn starch	0.5

Procedure:

1. Surimi meat is mixed with all the ingredients listed in the table-1
2. Mixed mass is made into a ball shape
3. Set it at an ambient temperature
4. Fry the fish balls in oil at 90º-100ºC till it turns to golden brown color

2.6.3 Battered and breaded product- fish fingers/fish stick

Introduction: The term fish finger is the first reported in a recipe given in a British popular magazine in 1900 and the dish is often considered emblematic of United Kingdom. The commercialization of fish fingers may be traced to 1953 when the American company

Gorton-Pew Fisheries, now known as Gorton's was the first company to introduce a frozen Ready –To- Cook (RTC) fish finger, the product named Gorton's fish sticks, won the parent's magazine seal of approval in 1953.

Materials required:

1. Egg (egg white) – 20
2. Salt-1 pack
3. Red chili powder- 250 g
4. Surimi meat -2 kg
5. Bread crumbs- 1 kg
6. Ginger garlic paste – 500g
7.

Procedure

1. **Preparation of batter** - add egg white, salt, red chili powder into a mixing bowl. Mix all the ingredients thoroughly and keep aside
2. Take 1kg of fish mince and add 2 % of salt and cook for a couple of minutes without the addition of water. Grind the cooked meat for a few minutes
3. Make the fish portions or sticks
4. Dip it in the batter and next to the bread crumbs
5. Fry the breaded and battered fish product.

2.6.4 Fish Spirals

Introduction: Spirals are one of the common and most popular snack items. Processed fish meat or fish protein concentrate shall be incorporated into the preparation of spirals without altering the original characteristics.

Materials required: Minced meat (*Priacanthus sp.*), all the ingredients listed in the table-1, mixing bowl, Pan, ladle, and a serving plate.

Table-1: List of ingredients

Sl. No.	Ingredient	Quantity (%)
1.	Minced meat	45.5
2.	Rice flour + Bengal gram flour in 3:1 ratio	45.5
3.	Jeera	1.0
4.	Niger	1.0

5.	Salt	2.0
6.	Chilli powder	2.0
7.	Oil	3.0

Procedure:

1. Minced meat, rice, and Bengal gram flours are mixed in the ratio as given in the table-1.
2. Kneaded to make a dough of required consistency (add water if necessary).
3. Oil and other spices are then added to the dough and mixed it again thoroughly.
4. The spirals are made using a stuffer with a suitable nozzle.
5. The spirals are then fried in oil maintained at 180-200ºC, fry till it turns golden brown color.
6. Then hot spirals are cooled at an ambient temperature and are stored in polythene bags or tin containers.

2.7.Nutritional Information:

The information below shows the composition of the nutrients of various fish species.

- Proteins- An outstanding source of high-quality protein is fish. Owing to their high water volume, mollusks are typically lower in protein compared with finfish and crustaceans. Sarcoplasmic proteins (e.g., enzymes and myoglobin), contractile or myofibrillary proteins (e.g., actin and myosin), and connective tissue proteins are the same proteins present in fish as those contained in meat derived from other species (i.e., collagen).
- Fat- Fat is mainly liquid (i.e. fish oil) in fish and it contains a comparatively low proportion of fatty acids that are saturated. Fish belong to a particular dietary class since they include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) omega-3 polyunsaturated fatty acids, which have been shown to safeguard against many diseases, including heart disease. The aquatic and freshwater plants on which fish feed are abundant in EPA and DHA, unlike land plants.
- Vitamins and mineral substances- Fish supplements the diet with a variety of essential vitamins and minerals. They are a healthy source of riboflavin, niacin, and thiamine in the fat-soluble vitamins A, D, E, and K, and the B vitamins. Calcium, magnesium, phosphorus, and iron are found in the mineral content.

- Microbiology- Fish are highly prone to microbial pollution due to their soft tissues and the marine climate. Fish bear a heavy microbial load on the surface of their skin, in their digestive tract, and their gills at the time of harvest. Depending on the season, the species, and the natural environment, the form and number of microorganisms found in fish vary. During the harvest, storage, or distribution of the fish, additional pollution may occur. Species of Pseudomonas, Moraxella, and Acinetobacter, found primarily in marine fish, and Bacillus and Micrococcus, found in freshwater fish, are typical spoilage microorganisms in fish. Pathogenic (disease-causing) microorganisms like Salmonella and Escherichia coli can also be found in fish. For mollusks, pathogenic infection is of great concern since they are often consumed raw and as whole organisms.

2.8. Export Potential & Sales Aspect:

Factors driving the global frozen seafood industry are growing the demand for frozen seafood products globally. Manufacturers concentrate on delivering healthy offerings of items. Frozen seafood products are frozen with cryogenic technology that aims to prevent the bacterial growth of frozen seafood products. Several frozen seafood companies worldwide use cryogenic freezing equipment to retain low temperatures of solid carbon dioxide or liquid nitrogen that is specifically added to frozen seafood products. Frozen seafood items can be preserved for a long period with the aid of advanced freezing technologies. Most customers change their choice to frozen foods over prepared foods because the nutrients are not destroyed in frozen foods and the food items are also eaten worldwide. The consistency of the products is preserved by these frozen seafood products and is therefore mainly eaten globally. Accordingly, robust growth over the projected timeframe is anticipated in the global Frozen Seafood industry.

Some of these major parameters are discussed below: Many parameters regulate the consistency of the final product:

- Appearance: The most significant aspect of the appearance of any food is its color, particularly when it is directly correlated with other features of food quality. Form, surface profile, and clear texture are additional attributes. The appearance of food is just as important as its flavor and color to the success of a food product.
- Taste: The sensory system, or sense of taste, is the sensory system that is partly responsible for taste sensing (flavor). Taste is the perception produced or induced when a material in the mouth, often on the tongue, chemically interacts with taste receptor cells located on taste buds in the oral cavity. Any divergence from them would result in deviation in the final dish of the different food items with their particular tastes, so it is important to preserve a uniform taste in refined food products.
- Content of Nutrition: A well-balanced ratio of the essential nutrients of carbohydrates, fats, proteins, minerals, and vitamins in food or dietary supplements is a measure of the nutritious content or nutritional value as part of the consistency of the food about the nutrient needs of the user. The higher the nutritional content of a food is its consistency, as appropriate ingredients have to be added to increase nutritional value along with the base ingredient.
- Shelf Life: Shelf life is the amount of time a substance can be processed without being unsafe for use, consumption, or sale. Provided a range of products with the same nutritious quality and flavor, it comes into play after presentation, taste, and nutrition, one appears to opt for the product with longer shelf life.
- The packaging: The quality of the product is often established, apart from the basics such as food-grade packaging material, the form of process and technology further increases the quality of the product, such as the incorporation of anti-microbial packaging to the value of the product and hence the quality.[i]

CHAPTER- 3

PACKAGING

3.1. Shelf Life of Product:

Fish freezing is a preservation process. In this process, fish tissue and fishery products are converted into ice within the water at a lower temperature. This technique boosts the shelf life of fish and fish products. This approach is used internationally to monitor the quality of fish and fish items at the time of conservation. There are many ways in which fish can be frozen, but both need specialized equipment to affect the necessary rapid temperature drop and adequately decrease the core temperature to ensure that the commodity can be safely stored in cold storage. If unfrozen fish are merely positioned in a cold store running at -300c, the temperature will decrease rapidly enough and the result will be frozen fish of poor quality; cold stores are built to keep fish already frozen at low temperatures. Any frozen fish or shellfish will be healthy indefinitely; after long storage, though, the taste and feel will fade. Freeze (0 °F / -17.8 °C or less) cooked fish for up to 3 months, for the highest consistency. Frozen raw fish is best used within 3 to 8 months; shellfish, 3 to 12 months.

The shelf life of food stored depends on these 4 main criteria:

- Temperature:
  Foods stored at room temperature or cooler (75°F/24°C or lower) will be nutritious and edible much longer than previously thought according to findings of recent scientific studies. Foods stored at 50°F to 60°F (which is optimal) will last longer than foods stored at higher temperatures. Heat destroys food and its nutritional value. Proteins break down and some vitamins will be destroyed. The taste, color, and smell of some foods may also change.
- Moisture:
  The reason long-term food storage is dehydrated or freeze-dried is to eliminate moisture. Too much moisture promotes an atmosphere where microorganisms can grow and chemical reactions in foods causing deterioration that ultimately can sicken us.
- Oxygen:
  Too much oxygen can deteriorate foods and promote the growth of microorganisms, especially in fats, vitamins, and food colors. That is the reason to use oxygen absorbers when dry packing your food products.
- Light:
  Exposure to too much light can cause deterioration of foods. In particular, it affects food colors, vitamin loss, fats and oils, and proteins. Keep long-term food storage in low-light areas for the longest shelf life.
  Most expiration dates on foods in can range from 1 to 4 years but keep the food in a cool, dark place and the cans undented and in good condition, and you can likely safely double that shelf life from 3 to up to 6 years. It shall also conform to the following standards.

3.2.Frozen Fish Packaging:

Packaging has two key purposes: enticing buyers and retaining materials. There is a wide array of packaging choices for food processing plants to pick from, but it mainly depends on the type of product they make. Many factors need to consider while selecting a suitable type of pack for the product:

- The product contents.
- The application of the product.
- Content stability.
- Protection from any environmental factors
- Acceptability of the pack to the customer.
- Regulatory, legal, and quality issues.
-

Characteristics of packaging material

- The material selected must have the following characteristics:
- Must meet tamper-resistance requirements
- Must not reactive with the product
- They must protect the preparation from environmental conditions
- Must be non-toxic
- Must not impart odor/taste to the product
- Must be FDA approved.

Classification of Freeze Food:

There are three basic classifications of canned foods based on their acidity, they are classified as low acid canned food, acidified canned food, and high acid canned food.

3.3.Types of Packaging:

Popular kinds of packaging include:

- Stand-up pouches: Attention-grabbing stand-pouches provide ease, reduce the cost of shipping, and keep items new.
- Vacuum skin packaging: To enhance its visual appeal and extend its lifespan, vacuum skin packaging (VSP) forms a tight, clear film over a product**.**
- Multi-layer films: To keep the fish fresh, multi-layer films create a tight seal. The product is shown clearly by this type of packaging, and the multiple layers help protect packages from punctures and abrasions.
- Individually fast-frozen (IQF) packaging: for frozen fish fillets and other frozen seafood items, IQF packaging is also used. In general, IQF is available in bag format and can come in a range of types, such as the shape of the pillow or flat bottom.
- Packaging is often an automated process involving advanced machines which fill and seal containers and bags of goods. This process reduces the need for manual labor and speeds up the packaging stage.

3.4.Material of Packaging:

- Polyethylene (PE)- The foundation of packaging films is known to be this. Since moisture is one of the main threats to the integrity of candy goods, polyethylene is of definite importance due to its low water vapor transmission. Polyethylene films are fairly free from plasticizers and other additives and are commonly used as a laminating component. Its heat seal capacity increases its worth.
- Low-Density Polyethylene (LDPE) is an inexpensive material with low WVTR but has high flavor/volatile permeability, poor fat tolerance, and limpness. High-density polyethylene (HDPE) is more robust, transparent, and has stronger barrier properties, but sealing requires higher temperatures. High molecular weight high-density polyethylene (HM HDPE) and linear low-density polyethylene (LLP) are later additions (LLDPE). HM HDPE is a film-like paper with high physical strength and barrier characteristics but is less translucent than standard polyethylene. In twist-wrap grades, HM HDPE is available. For making bags and pouches, polyethylene films are also appropriate. Polyethylene and polyvinyl alcohol copolymers and EVOH have outstanding gas barrier properties, especially when dry.
- POLYVINYL CHLORIDE (PVC)- PVC has a low gas transmission rate and is a stiff and transparent film. It is easy to use PVC as small wraps, sacks, and pouches. PVC as co-polymerized with polyvinylidene chloride is known as Saran. As it is an expensive material, it is only used to achieve barrier properties and heat saleability as a coating. For twist wraps, PVC film is also used, since it has twist retention characteristics and is excellent on high-speed machines.
- Polyesters and polyamide (PET) (PA)- The film of polyethylene terephthalate has high tensile strength, gloss, and rigidity, as well as resistance to puncture. It has mild WVTR, but for volatiles and gases, it is a strong buffer. PET is usually laminated to other substrates to have the heat seal property. Nylons or polyamides are similar to Cat but have high WVTR.

CHAPTER 4

FOOD SAFETY REGULATIONS AND STANDARDS OF FROZEN

4.1.Introduction to FSSAI:

The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards, 2006 which consolidates various acts & orders that have hitherto handled food-related issues in various Departments. The FSSAI is responsible for setting standards for food so that there is one body to deal with and no confusion in the minds of consumers, traders, manufacturers, and investors. The Act aims to establish a single reference point for all matters relating to food safety and standards, by moving from multi-level, multi-departmental control to a single line of command.

Highlights of the Food Safety and Standard Act, 2006-

Various central Acts like Prevention of Food Adulteration Act, 1954, Fruit Products Order, 1955, Meat Food Products Order, 1973, Vegetable Oil Products (Control) Order, 1947, Edible Oils Packaging (Regulation)Order 1988, Solvent Extracted Oil, De- Oiled Meal and Edible Flour (Control) Order, 1967, Milk and Milk Products Order, 1992, etc will be repealed after commencement of FSS Act, 2006.

The Act also aims to establish a single reference point for all matters relating to food safety and standards, by moving from multi-level, multi-departmental control to a single line of command. To this effect, the Act establishes an independent statutory Authority – the Food Safety and Standards Authority of India with head office at Delhi. Food Safety and Standards Authority of India (FSSAI) and the State Food Safety Authorities shall enforce various provisions of the Act.

Establishment of the Authority-

Ministry of Health & Family Welfare, Government of India is the Administrative Ministry for the implementation of FSSAI. The Chairperson and Chief Executive Officer of the Food Safety and Standards Authority of India (FSSAI) have already been appointed by the Government of India. The Chairperson is in the rank of Secretary to Government of India.

4.2 FSSAI Registration & Licensing Process:

According to Section 31(1) of the Food Safety and Standards (FSS) Act, 2006, Every Food Business Operator (FBO) in the country is required to be licensed under the Food Safety & Standards Authority of India (FSSAI).

As per FSS (Licensing & Registration) Regulations, 2011, Licenses and Registrations are granted to FBOs in a 3 tier system

- Registration - for petty FBOs with annual turnover less than Rs 12 lakhs
- State license - for medium-scale food manufacturers, processors, and transporters
- Central License - for large-scale food manufacturers, processors and transporters

FSSAI registration is done online on the FSSAI website through Food Safety Compliance System (FoSCoS)

- FoSCoS has replaced the Food Licensing and Registration System (FLRS).
- Petty food business operators are required to obtain FSSAI Registration Certificate
- "Petty Food Manufacturer" means any food manufacturer, who manufactures or sells any article of food himself or a petty retailer, hawker, itinerant vendor or temporary stallholder (or) distributes foods including in any religious or social gathering except a caterer;

Or

- Other food businesses including small scale or cottage or such other industries relating to food business or tiny food businesses with an annual turnover not exceeding Rs. 12lakhs and/or whose production capacity of food (other than milk and milk products and meat and meat products) does not exceed 100 kg/ltr per day

Any person or entity that does not classify as a petty food business operator is required to obtain an FSSAI license for operating a food business in India.

FSSAI License - two types - State FSSAI License and central FSSAI License

Based on the size and nature of the business, the licensing authority would change.

- Large food manufacturers/processors/transporters and importers of food products require a central FSSAI license
- Medium-sized food manufacturers, processors, and transporters require a state FSSAI license.
- License period: 1 to 5 years as requested by the FBO.
- A higher fee for obtaining an FSSAI license for more years.
- If an FBO has obtained the license for one or two years, renewal may be done, no later than 30 days before the expiry date of the license.

4.3 Food Safety & FSSAI Standards & Regulations:

2.6. Fish and Fish Products: 2.6.1 Fish and Fish Products- Frozen fish fillets or minced fish flesh or mixtures thereof are products obtained from fresh wholesome fish of any species or mixtures of species with similar-sensory properties. Fillets may be pieces of irregular size and shape with or without skin. Minced fish flesh consists of particles of skeletal muscle". and is free from bones, viscera, and skin. The product may be glazed with water. The products shall conform to the following requirement: -

Particular	Characteristics	Requirements
1.	Total Volatile Base	Not more than 30 mg/ 100gm

	(Nitrogen)	
2.	Histamine	Not more than 20 mg / 100gm

Note I: Products under articles 1, 2, 3, 4, and 5 shall be frozen in appropriate equipment quickly to minus (-) 18º C or colder in such a way that the range of temperature of maximum crystallization is passed quickly. The quick-freezing process shall not be regarded as complete unless the product temperature has reached minus (-) 18º C or colder at the thermal center after thermal stabilization. The product shall be kept deep frozen to maintain the quality during transportation, storage, and sale. The entire operation including processing and packaging shall ensure minimum dehydration and oxidation. The product may contain food additives permitted in Appendix A except for the listed product under regulation 2.6.1 (3). The product shall conform to the microbiological requirement given in Appendix B. The products shall be free from any foreign matter and objectionable odor/flavor[ii]

Food Safety

Part I - General Hygienic and Sanitary Practices to be followed by Petty Food Business Operators applying for Registration

Sanitary and hygienic requirements for food manufacturer/ processor/handler

The place where food is manufactured, processed, or handled shall comply with the following requirements:

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain an overall hygienic environment. All new units shall set up away from environmentally polluted areas.

2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain an overall hygienic environment.

3. The premises shall be clean, adequately lighted and ventilated, and sufficient free space for movement.

4. Floors, Ceilings, and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.

5. The floor and skirted walls shall be washed as per the requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead, fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors, and other openings shall be fitted with a net or screen, as appropriate to make the premise insect-free The water used in the manufacturing shall be potable, and if required chemical and bacteriological examination of the water shall be done at regular intervals at any recognized laboratory.

6. A continuous supply of potable water shall be ensured on the premises. In the case of intermittent water supply, adequate storage arrangements for water used in food or washing shall be made.

7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.

8. No vessel, container, or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing, or storage of food. (Copper or brass vessels shall have proper lining).

9. All Equipment shall be kept clean, washed, dried, and stacked at the close of business to ensure freedom from the growth of mold/ fungi and infestation.

10. All equipment shall be placed well away from the walls to allow proper inspection.

11. There should be an efficient drainage system and there shall be adequate provisions for disposal of refuse.

12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.

13. Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all times and the person should not be allowed to come in direct contact with food.

14. All food handlers shall keep their fingernails trimmed, clean, and wash their hands with soap, or detergent, and water before commencing work and every time after using the toilet. Scratching of body parts, hair shall be avoided during food handling processes.

15. All food handlers should avoid wearing, false nails or other items or loose jewelry that might fall into food and also avoid touching their face or hair.

16. Eating, chewing, smoking, spitting and nose blowing shall be prohibited within the premises especially while handling food.

17. All articles that are stored or are intended for sale shall be fit for consumption and have proper cover to avoid contamination.

18. The vehicles used to transport foods must be maintained in good repair and kept clean.

19. Foods while in transport in packaged form or containers shall maintain the required temperature.

20. Insecticides/disinfectants shall be kept and stored separately and `away from food manufacturing / storing/ handling areas.

4.4. Labelling Standards (Regulation 2.5 of FSS)

Labeling requirements for packaged food products as laid down in Part 2.4 of the Prevention of Food Adulteration (PFA) Rules, 1955, and the Standards of Weights and Measures (Packaged Commodities) Rules of 1977, require that the labels contain the following information:

1. Name, trade name, or description
2. Name of ingredients used in the product in descending order of their composition by weight or volume
3. Name and complete address of manufacturer/packer, importer, country of origin of the imported food (if the food article is manufactured outside India, but packed in India)
4. Nutritional Information
5. Information Relating to Food Additives, Colors, and Flavors
6. Instructions for Use
7. Veg or Non-Veg Symbol
8. Net weight, number, or volume of contents
9. Distinctive batch, lot, or code number
10. Month and year of manufacture and packaging
11. Month and year by which the product is best consumed
12. Maximum retail price

Provided that — (i) the nutritional information may not be necessary, in case of foods such as raw agricultural commodities, like, wheat, rice, cereals, flour, spice mixes, herbs, condiments, table salt, sugar, jaggery, or non –nutritive products, like, soluble tea, coffee, soluble coffee, coffee-chicory mixture, packaged drinking water, packaged mineral water, alcoholic beverages or flour and vegetables, processed and pre-packaged assorted vegetables, flours, vegetables and products that comprise of single-ingredient, pickles, papad, or foods served for immediate consumption such as served in hospitals, hotels or by food services vendors or halwais, or food shipped in bulk which is not for sale in that form to consumers.

Wherever applicable, the product label also must contain the following

The purpose of irradiation and license number in case of irradiated food. Extraneous addition of coloring material.

Non-vegetarian food – any food which contains whole or part of any animal including birds, freshwater or marine animals, eggs or product of any animal origin as an ingredient, not including milk or milk products – must have a symbol of a brown color-filled circle inside a brown square outline prominently displayed on the package, contrasting against the background on the display label near the name or brand name of the food.

Vegetarian food must have a similar symbol of the green color-filled circle inside a square with a green outline prominently displayed.

All declarations may be: Printed in English or Hindi on a label securely affixed to the package, or Made on an additional wrapper containing the imported package, or Printed on

the package itself, or Maybe made on a card or tape affixed firmly to the package and bearing the required information before customs clearance.

Exporters should review Chapter 2 of the “FSS (Packaging and Labelling) Regulation 2011” and the Compendium of Food Safety and Standards (Packaging and Labelling) Regulation before designing labels for products to be exported to India. FSSAI revised the labeling Regulation and a draft notification to that effect was published on April 11, 2018, inviting comments from WTO member countries and the comments received are under review and the publication date remains unknown.

According to the FSS Packaging and Labelling Regulation 2011, “pre-packaged” or “pre-packed food” including multi-piece packages, should carry mandatory information on the label.

Conclusion

Sheetal is a very popular fish product in northeast India. Irrespective of rich or poor, Sheetal is a daily requirement of all the tribal and majority of the non-tribal population of the region. Moreover, there is a great demand for this product amongst the NE-Indians residing in other states of the country or in abroad. If Sheetal could be produced following the method mentioned here, the product will be safe from a nutritional point of view. With the help of packaging technology, Sheetal could be made available in all grocery shops and malls. Moreover, due to similar food habits, Sheetal has the potential to be exported to neighboring as well as other Southeast Asian countries. In the present situation of unemployment, entrepreneurship development through Sheedal technology is a very promising field.

CHAPTER 5

OPPORTUNITIES FOR MICRO/UNORGANIZED ENTERPRISES

5.1. PM-FME Scheme:

Ministry of Food Processing Industries (MoFPI), in partnership with the States, has launched an all India centrally sponsored "PM Formalisation of Micro Food Processing Enterprises Scheme (PM FME Scheme)" for providing financial, technical, and business support for up-gradation of existing micro food processing enterprises. The objectives of the scheme are:

I. Support for capital investment for up-gradation and formalization with registration for GST, FSSAI hygiene standards, and Udyog Aadhar;
II. Capacity building through skill training, imparting technical knowledge on food safety, standards & hygiene, and quality improvement;
III. Handholding support for the preparation of DPR, availing bank loan and up-gradation;
IV. Support to Farmer Producer Organizations (FPOs), Self Help Groups (SHGs), producers cooperatives for capital investment, common infrastructure, and support branding and marketing.[iii]

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[i] https://www.doh.wa.gov/communityandenvironment/food/fish/healthbenefits#:~:text=Fish%20is%20filled%20with%20omega,part%20of%20a%20healthy%20diet.

[ii] https://www.fssai.gov.in/upload/uploadfiles/files/Food_Additives_Regulations.pdf

[iii] https://mofpi.nic.in/pmfme/docs/SchemeBrochureI.pdf