Ministry of Food Processing Industries
Government of India

सत्यमेव जयते

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Reading Manual for Fish Products

Under PMFME Scheme

National Institute of Food Technology Entrepreneurship and Management

Ministry of Food Processing Industries

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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

Fermentations offer a wealth of possibilities and the fermented foods have been found to possess therapeutic properties. The WHO food safety unit has given high priority for the research in food fermentation, as it will improve the food safety by controlling the growth and activity of pathogens in foods. Fermentation technology has adapted itself to social demands. Despite their popularity, research and development on fermented foods is meagre. Most of the traditional food fermentation industries are rural, seasonal, labour intensive, informal, and capital deficient. Commonly, fermented foods are sold and consumed in the areas where they are produced. The methods of processing were developed in homes and improvements were based on the observations of the practitioners. There is little interest in knowing the role of microorganisms and the physical and chemical changes that occur in the products. What is recognized are changes in colour, odour, and taste that result from modifications of the process or variations in the ingredients or conditions. Most processes are conducted on a trial-and-error basis with little quality control. Product quality primarily depends on the experience of the processor.

The Northeastern region of India extends between latitudes 21° 57′ and 29° 30′ North, and between longitudes 89° 46′ and 97° 30′ East, lie deep in the lap of easternmost Himalayan hills comprising of eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. It is one of the most thinly populated regions of India, with about 45.5 million people (as per 2011 census), representing about 4% of the whole population of the country with a population density of 14 – 340 Km^{-2}. The Northeast India is abode of varied number of tribal groups (approx. 166) and each tribe has their own distinct cultural and lifestyle identity. North East Indian tribes can be largely associated with the ethnic groups of Indo Mongoloids, Tibeto- Burmese and proto Austrioloids which represent the Asio-Austric culture on Indian hilly regions. The trends of these ethnic groups are visible in the looks as well as the traditions which are followed by these communities. They provide a cultural bridge between India on one side and South-East Asia, China and Inner Asia and Burma on the other by ethnic and linguistic angles. Their existence can be traced back to the pre-historic times.

Though Northeast India is very rich in its food culture, but it differs vastly from rest of the country in its taste as well as flavours. Normally, inhabitants of the region are non-vegetarian, and fond of spice. The region is a treasure of indigenous knowledge systems pertaining to agriculture, medicine, food and natural resources management. Different fermented and non-fermented foods are used in various combinations with traditional vegetables to meet the food and nutritional security. The fish fermentation technology in the Northeastern states evolved by compulsion of people. The Northeastern states of India, being the highest rainfall area of the world, do not provide a congenial environment for simple sun drying of fish. People used to preserve fish for use in lean period by drying under sun. Hence, such drying used to be prolonged due to high humid atmosphere and frequent rainfall

particularly during the peak fishing seasons (i.e. from May to September). Northeast, being abundant in low lying areas where accumulation of water during rainy season offers an ideal habitat for the breeding of weed fishes such as *Puntius* spp., 'Darkina' (*Esomus danricus*), 'Mola' (*Amblypharyngodon mola*). The clever fishermen, therefore, was in search of a method through which they could preserve the heavy catches of such less valued weed fishes for consumption and sale in the dry seasons (November to April) when there was scarcity of raw fresh fish in the market. Moreover, due to non-availability of ice and good road communications, these perishable produce could not have been transported to the distant markets where they could get a higher price which they never used to earn in the village markets. It is fact that the tastes and food habits of the rice-eater prefers to eat his rather tasteless rice mixed with little morsels of products bearing strong flavours. In this situation, the fermented fish could become ideal to cater their needs.

Northeast region is bestowed with many fermented fish products such as Sheedal, ngari, hentak, lonailish, tungtap, namsing etc. Fermented fish contributes a regular menu especially in the diets of tribal people. Most of the traditional fish processing units are rural, seasonal, labour intensive, informal, and capital deficient. Traditional processes are normally inherited from generation to generation. Preparation of such fermented fish products is simple but most of the critical steps are optimized by experiences for getting a yield of different qualities. In general, there exists a traditional belief that all such ethnic fish products improve the immunity against seasonal illness in forest dominated NE India.

1.1 Importance of Sheedal in Northeast India


Punti Sheedal

Out of all the available traditional fish products of Northeast India, the most popular and most commercial product is Sheedal, which has universal acceptance in the entire NE region, Bangladesh particular and amongst all NE Indian people residing elsewhere including other countries. Unlike salt fermented fish products of Southeast Asia, Sheedal is a salt-free fermented fish product, which indicates the fact that the technology of salt-free fermentation originated long before the men started using salt (sodium chloride). It has several local names. It is popularly called as 'Seedal', 'Sepaa', 'Hidal', 'Verma' and 'Sheedal' in different places of the NE region. In Manipur, it is known as Ngari. Especially Assam, Tripura and Manipur is the major producer of Sheedal amongst the Northeast states. The technology is very old and originated in the erstwhile undivided India (now Bangladesh) and believed to came into existence at least before the British Era in Northeastern states of India, i.e., before 1824. As it is revealed from the Indian history, that the people of this region did not know the use of salt before its introduction by the British. Even after the British Era, the salt used to be treated as a highly valued and scarce commodity and


Phasa Sheedal

as an alternative of salt people used to use a substance known as 'khar', made from banana or papaya plant. Thus, people could not afford spending salt in fish preservation and this may be one of the reason to preserve fish in an unique way without using salt. The plains of Bangladesh and adjoining Northeastern sector is famous for their 'beel fisheries', which is a kind of weed infested shallow water body and gets dried up fully or partially during winter. The 'beel fisheries' is an excellent habitat for weed fish such as *Puntius* sp. which propagate naturally with the beginning of rainy season and form a good fishery when the water level starts decreasing with the onset of winter. The reason for exclusive use of *Puntius* sp. for sheedal production possibly lies with the huge availability of this fish particularly in the post monsoon period and probably this necessitated the evolution of this cheaper technology of fish preservation for their use in lean period.

The popularity of Sheedal is due to its strong flavour. This product is usually prepared from *Puntius* sp. The appearance of the product is solid, bilaterally compressed and pasty and shape of the fish remains almost unchanged except little disintegration near belly and caudal portion. The colour of best quality product is dull white that gradually becomes slight brownish to deep brownish on continuous exposure to air. The strong odour permeates the air in and around the storage and gives the area a characteristic smell of sheedal. The quality deteriorates very fast after breaking of seal of the container and exposure to air. Presently, the production of sheedal is confined to particular districts of the states of Assam (Nagaon, Dhubri, Goalpara and Kachar districts), Manipur (Imphal city) and Tripura (West Tripura district).

Until few years back, Sheedal used to be prepared exclusively from *Puntius* sp. only (usually from *Puntius sophore*). Due to continuous reduction of beel fisheries and choking of water bodies due to man-made activities, availability of *Puntius* fish started decreasing with simultaneous increase of price. But the high retail price of '*Punti Sheedal*' (due to higher cost of dry or wet Punti fish) necessitated searching for alternative. After several trial and error method finally a estuarine fish called phasa fish (*Setipinna phasa*) was found to be suitable for production of Sheedal. Therefore, since last ten years Phasa fish has been used as raw material fish in place of *Puntius* spp. to produce low cost Sheedal (known as Phasa Sheedal, Telesch, Baspati Sheedal etc.). 'Phasa Sheedal' is popularly known as '*Sheedal for the poor'*, as its retail price is almost half of the price of best quality '*Punti Sheedal'*.

1.2 Nutritional value of Sheedal

Fermentation is not only a method of preservation; in addition, the fermented foods can also have the added benefits of enhancing flavour, increased digestibility, improving nutritional value and provide pharmaceuticals. Sheedal is a rich source of protein, essential amino and fatty acids. Moreover, Sheedal has high antioxidant capacity. There exist a traditional belief that regular consumption of

Table 1. Biochemical and microbial quality of Sheedal (n=5)

Parameters	Punti Sheedal	Phasa Sheedal
pH	5.86 ± 0.11	6.62 ± 0.07
TTA (g %)	0.115±0.01	0.092±0.01
Moisture (%)	38.26±0.89	43.48±1.58
Crude protein (%)	36.84±1.42	36.75±1.75
Total lipid (%)	14.30±2.24	7.85±1.26
TVBN (mg %)	62.53±1.61	120.27±1.24
TBA (mg mld/kg)	0.99±0.06	1.10±0.14

Sheedal improve the immunity against seasonal illness in forest dominated northeast India. Moreover, Sheedal is believed to improve immunity against malaria.

1.3 Sheedal technology

Right time of Sheedal production

Actually dry Puntius and phasa fish are available in the market from December. Therefore, December to February is the right time for production of Sheedal. This may be extended upto April, before onset of rainy season.

Source of raw materials

Raw materials of Sheedal, i.e., dry Puntius and phasa fish are available in the local market. But for large scale producers, it is profitable to buy from Jagiroad Dry fish Market of Assam or from the source of production. Usually, dry Puntius fish are imported from UP, MP, Gujarat, Maharashtra etc. and dry phasa fish from West Bengal.

Dried *Puntius*

Method of production of Sheedal

Production of Sheedal is not complex. But what essentially required is to maintain hygiene and sanitation in every step during its production. Different steps in Sheedal production is given below.

Containers used for fermentation

Matka or hundi are local names of earthen made pear shaped container used for fermentation of fish. Although matkas of different sizes are in use but most common size is having the dimension of neck diameter 8 inch, diameter of middle expanded part 24 inch and height 36 inch with capacity approx. 40 kg. Recently, a consumer friendly small sized matka with capacity 2-5 kg are also available for Sheedal production. Since matkas are earth made, they are breakable, can be used for several batches of fish until they break. The best quality matkas are made from very fine black soil, due to the fact that these matkas absorb very less amount of oil during oil processing and they also provide very less air permeability. Producers' believe that older the matkas better the product quality and lesser the cost of production, because of the fact that older matkas absorb very less amount of oil during oil processing and they also provide very good air sealability.

Matka

1.4 Processing of matka

Before use, matkas are smeared with oil in order to close the micropores present in its wall to make it almost non-permeable to air

and vapour. Scientific basis of oil processing of matka is to prevent loss of moisture from fish during fermentation and facilitate dissipation of heat generated during fermentation. Oil extracted from Puntius fish is generally preferred by fishers and commercial producers if it is available in plenty. In case of large scale production of sheedal, vegetable oil especially mustard oil is preferably used. Oil is smeared in both inner and outer walls of the matka followed by drying in the sun. The oil smearing and subsequent drying process is continued for 7 to 10 days in case of new matka, until they become fully saturated with oil and unable to absorb any more oil even after a fresh drying. Matka is now ready for filling of fish. In case of re-use of matka, 2 to 5 days of oil smearing and subsequent drying is required.

Preparation of fish for Sheedal

Usually dried Puntius or phasa fish are procured from the market. It is better to use fish of the current year. After procurement, dry fish need further drying under sun for 3-5 days. This is done to remove moisture from the fish to maximum possible extent and also to drive away the maggots, if any. The dry fish are then cleaned by sorting broken pieces and adhering dusts etc. Fish with already sign of infestation is not taken for Sheedal production. After cleaning, fish become ready for water washing-cum-soaking.

Cleaning of dry fish

Water washing-cum-soaking

Dried and cleaned fish are taken in porous bamboo baskets (locally called Jhuri/Tukri) of dia. approx. 18 inch and height approx. 9 inch for water washing-cum-soaking. Traditionally dried fish are water soaked while washing in running water, i.e., in river at shallow depth. But due to poor quality of water in the shallow zone of river, there remains chances of contamination of dry fish with pathogens and other dirt present in the river water. For hygienic production it is advisable to construct cement cisterns with inlet-outlet provision and use of drinking water for water washing-cum-soaking. This step is very crucial for Sheedal production and also to some extent depends on the total period of fermentation as desired by the producer. Usually, for fermenting fish for 3-4 months, the duration of washing is approx. 3-5 minutes. And for fermenting fish for less than 3 months, washing is done for approx. 5-7 minutes. However, the duration of water washing-cum-soaking depends on the producers experience and is determined by previous experience depending on the quality of dried fish, period of fermentation desired and shelf-life of the end product. In case of washing in cistern, it is advisable to change water frequently (after washing of 1-2 lots) to prevent adding of dirt removed from one lot of fish to other lots. Absorption of water becomes higher and quicker due to previous drying of fish.

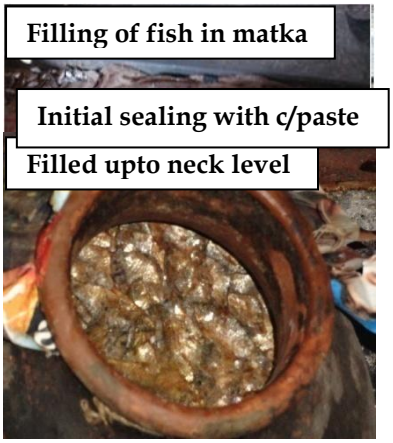
Washing of dry fish

Post-washing drying of fish


Drying of fish under shed

After water washing-cum-soaking, wet fish are spread over cleaned bamboo mattress (preferably) or in cemented floor under shade overnight for drying. Evening hours is the best time for water washing-cum-soaking, because the subsequent drying of water soaked fish for 10 to 12 hours passes without any nuisance activities from flies and birds.

Filling of matka


Filling of fish in matka

Initial sealing with c/paste

Filled upto neck level

Before filling, the oil processed matka is placed by digging a hole in the ground in such a way that one third of the belly portion of matka remains buried in the ground. This is done to ensure fixing of matka in vertical position and also to allow the matka to withstand the pressure during filling of fish with compaction. Clean gunny bags are spread surrounding the matka to avoid any spilled raw material getting contaminated with the soil underneath while filling. After fixing matka in the ground, the partially dried fish are spread in a layer of about 4-5 inches in height and uniform pressure is applied with bare hand or feet (in case of large mouth matka). Once the layer is tightly packed, subsequent layers are put in a similar manner till the layer reach near to neck. Sometimes wooden stick is also used along with hand or feet for almost air tight packing. About 35 to 37 kg of dried fish is required to fill one 40 kg capacity matka.

Cover paste

A cover paste with semi-solid consistency is made by grinding left over materials after sorting and cleaning of dried fish, with addition of little water.

Initial sealing of matka

Final sealing with clay soil

Once the matka is filled upto the neck portion, it is primarily sealed with a cover paste. After proper sealing with cover paste, seal is covered with broad leaves.

Final sealing of matka

The matka is finally sealed by a layer of wet mud made from clay soil. This soil is usually collected from the pond bottom. Care is taken that sealing is perfect. This mud layer is checked on and often for about a week for any crack and is repaired immediately by wet mud again. The

Matka after fermentation

final mud seal is then covered by a polythene sheet and tied, to prevent damage of the seal by rodents etc.

Fermentation shed

The filled matkas are lifted to the surface and left undisturbed under a shed for maturation/fermentation. The fermentation shed should be such that the matkas will get minimum sunrays and rain. In traditional practice, the ground of the fermentation shed is muddy and both roof and sides are made with bamboo fenches. Entry of dogs, rodents etc. in the fermentation shed should be prohibited. The usual period of maturation is 3-5 months. From third month onward 2-3 matkas of each lot is tested for checking the maturity or quality of Sheedal. About 40-42 kg Sheedal is obtained from each matka. The filled matkas can be sold during fermentation also after packing in gunny bags in erected position.

Matka for transport

Selling of Sheedal

Usually, the quality of Sheedal, both smell and texture, are lost rapidly after taking out from the matka. Therefore, while retailing Sheedal is instantly taken out and sold.

Economics of Sheedal production

Cost of production and profit for producing 10 matkas (40 kg) of punti Sheedal is given here.

Materials	**Quantity**	**Rate**	**Cost**
Dry fish (punti fish)	400 kg	350/-	1,40,000/-
Matka	10 nos.	100/-	1000/-
Labour cost	10 nos.	500/-	5000/-
Other misce. cost	-		4000/-
Total			**1,50,000/-**
Sale value (whole sale)	380 kg	500/-	1,90,000/-
Gross profit			**40,000/-**

Cost of production and profit for producing 10 matkas (40 kg) of phasa Sheedal is given here.

Materials	**Quantity**	**Rate**	**Cost**
Dry fish (phasa fish)	400 kg	150/-	60,000/-
Matka	10 nos.	100/-	1000/-

Labour cost	10 nos.	500/-	5000/-
Other misce. cost	-		4000/-
Total			**70,000/-**
Sale value (whole sale)	380 kg	275/-	1,04,500/-
Gross profit			**34,500/-**

1.5 Culinary and mode of consumption

Sheedal is consumed basically in three different ways by making three dishes, namely, Godhak, Sheedal Chutney and Sheedal Bharta.


Godhak

Godhak: Godhak is an oil-less preparation and very appetizing at the beginning of a meal. In earlier days, Godhak used to be prepared in bamboo cylinder (single internode of immature bamboo), but presently, it is prepared in small aluminium hundi (Dekchi). The recipe includes Sheedal, green chili, onion, any one or two vegetables such as bamboo shoot (most preferred), banana stem (actually the flower stalk of the banana plant), banana flower (mocha), bitter gourd (uchhe, karela), tree bean seed (*Parkia timoriana*) or any other seasonal ones including potato. All the vegetable ingredients are chopped and washed properly including Sheedal, boiled in a aluminium dekchi with addition of salt and water at moderate flame. When the vegetables are boiled then the mixture is stirred with spoon to break them for making a semi-solid liquid.


Sheedal chutney

Sheedal Chutney: Sheedal Chutney is a strong appetizer. The recipe includes Sheedal, oil, onion, garlic, green chili, turmeric power, red chili powder (optional), tomato (optional) and coriander leaves (optional). First Sheedal is lightly fried in hot oil and green spices are added with salt (up to taste) and tomato and/or coriander leaves and frying continued at moderate heat with constant stirring to make it a thick semi-solid paste.

Sheedal Bharta (paste): This preparation is made by burning Sheedal in flame followed by washing and making a hand-made paste with onion and green chili. This is for immediate consumption of Sheedal.

Socio-economic and ethnical or religious values

Sheedal is associated with the socio-economic life of the original inhabitants of the State (both tribals and non-tribals) as it serves as a main source of animal protein in their daily diet. Usually hill dwellers come down to the plane during two market days in a week and procure Sheedal for consumption throughout the week. Sheedal and other dried fish can be stored at ambient temperature in bamboo made cylinders which are hung over the traditional kitchen. Economically Sheedal is comparatively cheaper than fresh fish in respect of quantity required for its culinary preparation, as most of the poor men cannot afford for fresh fish.

In traditional custom of ethnic population of the State, Godhak is served in any social occasion irrespective of their economic and social status. It is strongly believed by the tribal population of the region that regular consumption of Sheedal protects them from malarial

infection and also boost up their immunity against seasonal illnesses. Godhak is believed to be useful for heart as it does not require any oil in its preparation. Moreover, Sheedal Chutney acts as an appetizer and also believed as a remedy for seasonal mild illnesses.

Scope of scientific intervention

A great deal of malpractices has been observed in the production of Sheedal due to its huge demand in all the rural and urban markets of the northeast India. The principal intension behind such malpractices are to utilize unsold dry fish for Sheedal production and early fermentation. Some of the malpractices are as follows:

- Use of insect infested/old raw material, i.e., dried *Puntius* spp. and *S. phasa*
- Mixing of old and insect infested and cheap variety of dried marine fish (cutting as the size of Puntius fish) along with dried *Puntius* spp. and *S. phasa*
- Use of colour during fermentation
- Use of vegetable oil during fermentation

1.6 Good Manufacturing Practices (GMPs) in Sheedal production

- Quality raw material (properly dried and stored)
- Re-drying of fish before fermentation (optional, depending on the dryness of the fish)
- Proper screening and sorting to remove insect infested fish and broken pieces
- Proper oil processing of 'matka' till it do not absorb oil anymore
- In controlled system, washing/water soaking of fish should be done in cement tank with spraying of chlorinated water
- Wash water of each batch of fish should be allowed to move out of the tank
- Sanitization of the floor of the matka filling room with antimicrobial sanitizer
- Drying of water soaked fish in clean and adequately dried bamboo mat or sanitized floor
- Filling of matka in closed room
- Persons involved in filling operation should not have any scours/lesions in body especially in hands or legs
- Spitting, smoking, chewing tobacco etc. are not allowed in matka filling room
- Paste seal is to be covered with clean leaf or polythene sheet before putting final seal of clay soil
- Clay used for final sealing should be clean
- After redressing the clay seal for a week for crack, seal should be covered with polythene sheet to prevent insect infestation
- The fermentation room should be cleaned, well ventilated, mud floor, lightly roofed and fenced with bamboo
- Entry of rodents, dogs, cats etc. in the fermentation room should be protected

1.7 Required hygiene and sanitation

It is absolutely required to maintain hygiene and sanitation in the production unit. This can be achieved by observing the norms as given below.

- Entire sheedal production area must be protected by erecting boundary wall or by GCI sheet or by strong bamboo fenching to prevent entry of rodents, cats and dogs.
- Persons involved in sheedal production especially filling of matkas should not have any scours/lesions in body especially in hands or legs.
- Spitting, smoking, chewing tobacco etc. are not allowed in sheedal production area.
- The fermentation shed should be cleaned, well ventilated, mud floor, lightly roofed and fenced with bamboo.
- A drain should be there in the periphery of the fermentation shed and bleaching powder should be used frequently in it.
- Water used for washing of fish must be of drinking water quality.

1.8 Quality control

Following must be maintained for safe and quality sheedal.

- Quality raw material (properly dried and stored).
- Re-drying of fish before fermentation (optional, depending on the dryness of the fish).
- Proper screening and sorting to remove insect infested fish and broken pieces.
- Proper oil processing of 'matka' till it do not absorb oil anymore.
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- Drying of water soaked fish in clean and adequately dried bamboo mat or sanitized floor.
- Filling of matka in closed room.
- Paste seal is to be covered with clean leaf before putting final seal of clay soil.
- Clay used for final sealing should be free from debris.
- After redressing the clay seal for a week for crack, seal should be covered with polythene sheet to prevent insect infestation.
- The fermentation room should be cleaned, well ventilated, mud floor, lightly roofed and fenced with bamboo.
- Entry of rodents, dogs, cats etc. in the fermentation room should be protected.

1.9 Coated Fish Products

- Also called as enrobed product
- If a food material is coated with another foodstuff
- A coating will be referred to as the batter and/or breading

Coating Ingredients

1. Polysaccharides -wheat ,corn flour, starch, farinaceous material, modified derivatives of cellulose and gums
2. Proteins – milk powder, milk protein fractions, egg albumin, cereal flours & seed proteins

3. Fats and hydrogenated oil
4. Seasonings – sugar, salt, pepper, other spice extractives
5. Water

Non-Wheat Starch

- Rice, corn, soy and barely
- Corn starch- is a source of natural yellow carotene pigment and hence it can supplement browning agents like reducing sugars and milk powder to impart a golden brown colour to the coatings
- Cornstarch is also used as a carrier of spices
- Helps to improve the crispiness of the coatings
- Helps to reduce the brittleness of the gluten protein
- Helps to form wide range of viscosities

Modified Starches

The simplest & common modification —pre-gelatinsation

- Starch +water -→heated➔ gelitnize ---dried to a powder

Extensive modification

---changes in the degree of branching (variation in amylose & amylopectin content)

----change in average chain length

----the extent of cross-linking

Extensively modified starch➔ known to increase the adhesion of breading with the product.

Leavening Agents

- Sodium carbonte ➔used to produce CO2, the leavening gas, in puff or tempura batter
- Mixture of acid/ salt—controls the release of CO2
- Some produce gas at an ambient temperature and other at high temperature
- Neutralising value: D'n ➔as the parts of leavening acid required to react completely with 100 parts of sod. Carbonate
- Eg: Tartaric acid, potassium hydrogen tartrate, monocalcium phosphate monohydrate, monocalcium phosphate anhydrous, sodium acid phosphate, dicalcium phospahte dihydrate and sodium aluminium sulphate.

Egg

- Egg contains albumin → heat coagulable protein that is useful in binding both breading and batter to the product and to itself
- Yolk protein contains lecithin→ an emulsifier ---batter stability
- Addition of egg to batter will tend to darken the product
- Also add characteristic eggy falvour

Milk And Whey

- Added as liquid or dry powders
- Milk and whey protein provides lactose-reducing sugar==involved in browning reactions
- Structural ability

Spices

- Many species –particularly pepper (3-5%)
- Paprika – added—colour- flavouring

Salt And Sugar

- Salt

1º →as a flavouring agent

→salt compete with flour proteins—slow the rate of protein hydration

- Sugar

  -compete for water

  -flavouring agent

Gums

- Many of the **hydrocolloidal** substances known as **gums**
- Gum controls viscosity
- water holding capacity (WHC)
- Participate in a gel or film formation (strengthens coating)
- <2% (0.5% -often)
- Eg: Xanthan

Shortenings and Oil

- Tenderizes the coating
- Moisture barriers
- Emulsifiers
- Anti-staling agent
- Breading is often encapsulated with fat to produce a "fried-like" flavour to oven or microwave reconstituted coatings.

Prepared Breadings

- Prepared breadings are material applied to battered food products
- Enhances the appearance
- Improves organoleptic qualities
- Maintain the integrity of batter
- Size, colour, flavour & compatibility with the existing processing system

Eg: Bread crumbs & corn flakes.

Batter

Adhesive batter

- Always associated with a supplemental breading or bread crumb
- 1º Purpose: *to increase the adhesion*
- By acting as an interface b/n the food & the subsequent coating
- uniformity & thickness ➔acceptability of the finished product
- The formulation & viscosity of the batter determine the amount of coating pickup
- Consistent batter➔ produce uniformly coated products
- Batter viscosity→ depends on the ratio of the flour to water
  → the temperature of mixing
- Typical ratio of batter mix to water is 1:2
- Quick set
- Batter→ stored at cool temperature –microorganism
  --viscosity (fall)

Tempura batter

- Purpose: to provide aerated crisp coating with or without the application of any other coating , a combination of wheat & corn flour are used along with a chemical raising agent
- Tempura batters →used at very high viscosity levels and containing raising agents
- Batter mix- powder-reconstituted with water--desired viscosity
- Final texture –frying the coated product in oil at 180º-220ºC
- Mixing – agitation
- Disadvantage: flesh will flash off as steam & blow off the batter surrounding the void
- Submersion is used rather than overflow batter application.

Breadings

- The secondary coating is referred to as 'breadings' (not be derived from bread always)
- Original crumbs –ground dry bread— major secondary coating
- Variety of breading materials----in different sizes & colours
- Used –alone or combined with various crumbs, fours, starches & flavouring materials (herbs, spices and seeds)
- Breadings are: thermally processed cereal based product though non-cereal products like potato are also used to provide different textures and appearance to the end product
- Particle size important : in terms of appearance, texture and pickup

Breading Types

A wide variety of breading material– different sizes & colours

Used –alone or combination with other types crumbs, flavours, starches & flavouring materials

Breading types:

1. Reclaimed bread crumbs
2. Industrial crumbs
3. Japanese style crumbs
4. Extruded crumbs
5. Cracker meal

1.10 Reclaimed Crumbs

These are prepared from ordinary

The drying process ---carried out deliberately at a high temperature ➔ to give an effect of toasting and to reduce the bacterial load.


1.11 Industrial Crumbs

This are factory- baked in large volumes

Used as crumb coatings in fish fingers/sticks and other products

→as a raising agent

→uses lower qt of water

→natural colouring agents like paprika or turmeric ---to impart an appetising appearance

→Industrial crumbs have harder texture & higher density than the 1st

→During baking a crust develops on the surface of the loaf

This is darker & harder than the rest of the crumbs

1.12 Japanese Crumbs

- Also called as '**oriental or panko crumb**'
- Has characteristic flake-like elongates structure → excellent visual & provides unique surface structure when fried
- It has an open & porous texture→imparts a light tender crispiness
- **Baked**→ Electrical induction heating process

  → one half the time taken for conventional baking

  →results in a loaf –crust-free & of low density

  → loaves are cooled, shredded through specially designer mills and dried to low final moisture level

1.13 Extruded Crumbs

- Extruded crumbs are produced by a **continuous process** where high starch ingredients are cooked under high pressure
- When the pressure is suddenly released, the moisture expands rapidly as steam and the extradate expands
- In the **extrusion cooking process** the heated dough exists from the extruder die as a fully cooked glassy material is quickly flashes off and, in effect, there is no drying system required
- Because of its lighter density the extruded crumbs have a tendency to float in oil, potentially **leading to contaminating black spots** in the fryer and rapid deterioration of oil quality

1.14 Cracker Meal

- The flour is made into dough with water and is rolled into thin sheet and baked
- The amount of effective cooking is adjusted not only by the baking time and temperature, but also by the dough thickness and the water to solid ratio in the dough itself
- The baked sheets are then crumbled through a **granulating mill** or a **slow speed grinder –appropriate granulation specifications then dried** (M-8%)

  →used for deep fat fried for longer periods--fish

1.15 Steps involved in the production of a Coated Fish Products

1. Pre-dusting

— to create a surface more conducive to the physical adhesion of a wet batter

---also provide a rough surface which helps the batter to coat the product evenly and obtain the desired pickup

--- usually composed of a cereal flour or flour mixture, spices & seasonings for both functional and flavouring purposes

2. Application of the batter

-- Total submersion or overflow batter application

-- Low viscosity batters →applied in an overflow batter application

-- Medium viscosity batters →total submersion system

Application of the batter

- The pre-dusted product is conveyed to the batter applicator and transferred to the next conveyor
- The fish portion is totally submitted in the batter as it is drawn through it
- Other applicators may use a pour –on application in addition to the submission method. Irregular shaped products should be placed on the line with any concave surface offered to prevent air pockets from inhibiting batter pickup
- Line speed is a very critical factor affecting better pickup
- An exclusively fast line speed will reduce the batter pickup. The battering may become incomplete. There may not be enough time for the excess batter to drip off, and this excess batter will be blown off during pre-frying. The blown off batter will get deposited in the fryer.

- Too low a line speed also can result in excessive better adherence the better weight in the pre-fried product is adjusted to be equivalent to fish flesh weight in most seafood products

2. Application of the batter (contin....)

- Excess batter is carried over the breading section will cause formation of lumps and can cause blockages in the breading machine. This will also cause formation of shoulders and tails on the edges of the product and contaminate subsequent breading application
- Therefore to overcome these problems the excess batter is removed after coating by blowing air over the product. The position of the air blower should be as close to the product as possible to control the air flow across the product
- Carry over from the pre-dusting operation also is critical where pre-dust is carried over the viscosity of subsequent batter will increase leading to an increase in pickup

Application of breadings

- There are many types of breading applicators available and the appropriate machine depends on the ingredients used
- The speed of the breading machine is so adjusted to closely match the belt speed of the batter applicator
- For soft products the crumb depth should be maintained as thin as possible to avoid product damage when leaving the breading machine however frozen or hard products should have a deep bed of crumb
- Pressure rollers are used to apply sufficient force to press crumbs onto the battered products. But the *pressure should not be high* to distort the product shape or push the product through the crumb bed causing marks in marks on the underside when the product may contact the breading conveyor.
- Floor buildings have a tendency to **compact and build up on the conveyors**. They also tend to bridge and cake causing uneven flow through the breading machine which can result in **inconsistent product quality**. Due to their fine particle size floor breadings tend to contaminate the frying oil with a residue so fine that it cannot be removed by normal filter system
- Japanese style comes with their low bulk density and large granule size make the crumb pickup difficult by the normal batter systems
- Special batter formulations, sometimes containing raising agents, may have to be used at medium viscosities for a desired level of pickup of crumbs

4. Prefrying:

- *Purpose*:
- Sets the batter coating on the fish portions so that it can be further processed by freezing
- Develops the product colour
- Forms a characteristics crust typical of fried foods
- Provide the product a fried (oily appearance)➔inhibits freeze dehydration and contribute to taste

5. Frying : 180-190ºC for 30 sec

- **Excess batter➔** called "tags", "crumbs" or "crunchies"

6. Freezing:

--stabilises coating

--resistant to physical abuse

--Prefried fish portions are generally frozen ---two steps

1. Initial quick freezing- using liquid nitrogen or carbon dioxide
2. Freezing -using mechanical freezer

Freezing is continued until the internal temperature attained is around -12 to -15ºC

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.Source of Raw Material

Indian rivers are the primary source of food for the irrigation scheme, drinking water and fish. There is a list of freshwater fish present in Indian rivers, with Rohu, Katla, Mahseer, Magur and Vaam being some of India's most common names for freshwater fish. As the primary target species for culture, a mixture of Indian main carps, including catla (Labeo catla), rohu (Labeo rohita) and mrigala (Cirrhinus mrigala) were used, as well as a few Chinese carp species such as silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella) and sometimes common carp species (Cyprinus carpio). The very high degree of technologies developed for induced carp breeding and the surplus of agri-based by-products used as supplementary feed have resulted in the country's rapid growth of freshwater aquaculture.

- Katla or Catla, also referred to as the big Indian carp, is widely found in Indian rivers and lakes and is one of the most popular freshwater fish species. The most important aquacultural freshwater fish in India are catla, roho labeo and mrigal carp.
- Mrigal carp is another common food fish and an important freshwater aquaculture species, only surviving in the Cauvery River wild population.
- A significant game fish, popular freshwater sport, and food fish, Tor tor is commonly referred to as the mahseer and Golden mahseer. Mahseer was located in Wayanad, the River Kali, the River Sarda, and the Rivers of the Himalayas.
- Ilish or hilsa shad, common in India, particularly West Bengal, Odisha, Tripura, Assam and Andhra Pradesh, is a freshwater and brackish water fish. In Andhra Pradesh and Bengal, fish is a common snack.
- Of all the varieties of common fish found in India, the Godavari River Pulasa fish in Andhra Pradesh is the tastiest and most expensive. The name of this fish genus is also known as hilsa, Ilish, and hilsa shad. In Andhra Pradesh, there is a saying that Pustelu

ammi ayina Pulasa tinocchu suggests, by even selling the Mangalsutra, it is worth eating Pulasa Fish.

- Often known as the Gangetic Ailia, Kajuli is mainly found in large rivers and associated water bodies. This is an important species for local commercial fish.
- Tengra or Tengna is a small catfish and one of the tasty fishes in Tangra Macher Jhal's Bengali recipes. Tengra fish are primarily found in the Bihar, Odisha, Chhattisgarh and Bengal rivers of the Indian state.

Total fish production in India is estimated at 6.24 million metric tons (MMT) in 2018, which is equivalent to two-thirds of the country's total fish production from both sources of catch and cultivation. As marine finfish production is rarely performed on a wide scale, development in the fish farming sector is mainly due to the freshwater aquaculture sector. Of the total animal protein eaten in India, approximately 12.8 percent comes from freshwater fish.

2.3.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. Air flow 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 each other and 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 c 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 which 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: This 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 prior to 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 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 freezing of the air blast or touch plate; but only marginally faster than 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 vapours 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 on-board 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 on board 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 super cooling 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.

2.4. 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, in order to prevent undesirable enzymatic and microbiological processes, de-heading, gutting, washing and chilling should be carried out immediately on dead fish. In order 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 flavour 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- In order to preserve a 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 a variable shelf life of only a few weeks and almost one year.

2.5.Flow Chart:

Steps	**Machine Name**	**Description**	**Machine Image.**
Packaging	Vaccum 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.	

2.6.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.	
Washmaster	For initial cleaning, rinsing during processing or final washing before packaging, 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.	
Scalemaster	The Scale master unit is mounted on a rigid spring suspension frame in order 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.	

2.7.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 specially in case of semi-automatic plant. 2. Install warning sensor in buffer region of loading capacity to ensure efficient operation.
3.	Mechanical Key Failure	1. Ensure that mechanical keys are replaced as per there pre-defined operational life. 2. Prevent Overloading.
4.	Loss of Interface	1. This problem is dominant in newly established automatic plant, one must learn to maintain rules in plant & ensure

		no employee goes near transmission lines, unless authorised. 2. Provide proper physical shielding for the connections.

2.8.Nutritional Information:

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

- The Proteins- An outstanding source of high-quality protein is fish. Owing to their high-water volume, mollusks are typically lower in protein compared with fin fish and crustaceans. Sarcoplasmic proteins (e.g., enzymes and myoglobin), contractile or myofibrillary proteins (e.g., actin and myosin), and connective tissue proteins are exactly 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 in 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 varies. 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.

2.9. 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 of time 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: There are many parameters that regulate the consistency of the final product:

- Appearance: The most significant aspect of the appearance of any food is its colour, 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 colour 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 in relation to 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]

CHAPTER3

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 absolutely destroys food and its nutritional value. Proteins break down and some vitamins will be destroyed. 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 reaction 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 own food products.
- Light:
  Exposure to too much light can cause deterioration of foods. In particular if affects food colors, vitamin loss, fats and oils, and proteins. Keep long term food storage in low light areas for longest shelf life.
  Most expiration dates on foods in cans 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. There are many factors that 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 odour/taste to the product
- Must be FDA approved.

Classification of Freeze Food:

There are three basic classification 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.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 labour 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 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.
- POLY VINYL 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-polymerised 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 in order 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 Food Safety and Standards Authority of India (FSSAI) have already been appointed by 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 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, processor and transporters
- Central License - for large-scale food manufacturers, processor 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 stall holder (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 manufacturer/processors/transporters and importers of food products require central FSSAI license
- Medium-sized food manufacturers, processor and transporters requires state FSSAI license.
- License period: 1 to 5 years as requested by the FBO.
- A higher fee for obtaining FSSAI license for more years.
- If a FBO has obtained the license for one or two years, renewal may be done, no later than 30 days prior to 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 article 1, 2, 3, 4 AND 5 shall be frozen in an 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 centre after thermal stabilization. The product shall be kept deep frozen so as 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 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 odour/flavour[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 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 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 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 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. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement 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's shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.

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

11. There should be 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 time and the person should not be allowed to come in direct contact with food.

14. All food handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work and every time after using 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 jewellery 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 in 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)

Labelling requirements for packaged food products as laid down in the 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 colouring material.

Non-vegetarian food – any food which contains whole or part of any animal including birds, fresh water 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 in close proximity to the name or brand name of the food.

Vegetarian food must have a similar symbol of 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 May be made on a card or tape affixed firmly to the package and bearing the required information prior to customs clearance.

Exporters should review the 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 labelling 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

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