

## **Packaging of Seafood Products**

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### **Introduction**

Packaging is crucial to our modern food distribution and marketing systems. Without protective packaging, food spoilage and wastage would increase tremendously. The advent of modern packaging technologies and new methods of packaging materials made possible the era of convenience products. In the past, the packaging emphasized the expectations of the producers and distributors but has now shifted towards the consumer since they are becoming more demanding and aware of the choices available (Piergiovanni, 1991). A food package usually provides a number of functions in addition to protection.

Fish is one of the most perishable of all foods. The best package cannot improve the quality of the contents and so the fish must be of high quality prior to packaging (Fujita, 1990). Different products have different packaging requirements and it is important to choose suitable packaging material accordingly. It is important to know the intended storage conditions of the product, i.e., temperature, relative humidity and expected shelf life. This is why multilayered plastics are very popular since properties of different films can be effectively used (Mueller, 1991). The basic function of food packaging is to protect the product from physical damage and contaminants, to delay microbial spoilage, to allow greater handling and to improve presentation.

### **Packaging of fresh fish**

A suitable package for fresh fish should keep the fish moist and prevent dehydration, retard chemical and bacterial spoilage, provide a barrier against moisture and oxygen to reduce fat oxidation and prevent permeation of external odours.

In India baskets made of split bamboo, palmyrah leaf and similar plant materials were traditionally used for packing fresh iced fish. However, they do not possess adequate mechanical strength and get deformed under stacking. The porous surface of these containers tends to absorb water and accumulate slime, creating an ideal breeding ground for spoilage bacteria, which can contaminate the fish. Even though washing cleans the contaminated surfaces of the container it will be ineffective in reducing the bacterial load significantly. Sharp edges of bamboo also cause bruises on the skin of fish. Used tea chests provided with 2.5 cm thick foamed polystyrene (in polyethylene sleeving) slabs inside have been found extremely beneficial for transport of fish over long distances up to 60 hours duration. Modern insulated containers are made of HDPE or polypropylene with polyurethane insulation sandwiched between the inner and outer walls of the double walled containers. They are durable and in normal use have a life span of over 5 years. Materials such as aluminum, steel and fibreglass are also used in the construction of insulated containers. Insulation properties of these containers

depend on the integrity of the layer of insulation. Contamination of insulation layer with water drastically reduces insulation properties of the medium. A recent development is an insulated corrugated plastic container, which is the lightest of all packages available in the country for iced fish transport. It lasts for 5 trips with collapsible design and lightweight, return of empty container is very easy. For cycle hawkers U shaped box (100 kg capacity) made of high molecular weight high density polyethylene is found ideal. An insulated galvanized iron box (40 kg capacity) was introduced for multipurpose use on boats and processing centers. They did not become popular with the trade because of high tare weight (27 kg) and corrosion of metal parts in sea atmosphere. Some of the workers experimented the use of fibreboard containers for the transportation of iced marine and fresh water fish and frozen fish. They found that fish could be transported in good condition for 60 hours covering a distance of 1700 km in fibreboard container and wood wool used in between two walls of containers was found to provide effective insulation. Wooden boxes and used plywood boxes of 20–120 kg capacity is used in western parts of the country for transport of fish by rail and road. Generally, these boxes are again used for transport of fish at the receiving point to other places. The boxes lose their insulation property on becoming wet and tend to become heavy.

### **Packaging of frozen fish**

World trade in frozen fishery products has been increasing every year. In India, frozen fishery products form a major constituent of the export earnings. About 80 percent of the total

aquatic products exported from India to the European, USA, Japan and Middle East countries is frozen in different forms and packs. These products are processed and packed for export to the European, USA, Japan and Middle East countries. Fish being highly perishable transportation and storage of frozen fishery products requires a cold chain. Hence, these fishery products are stored at temperatures below  $-18^{\circ}\text{C}$ . They are transported by sea in refrigerated freight containers of the reefer type. The kind of packaging and the material used depends on the value of the product and the end user or customer. Both consumer and bulk packaging are used to facilitate trade. The retail pack of smaller quantity is used for household purposes whereas bulk packs with larger quantities are used in restaurants, catering services or for repacking into consumer packs.

The main items of export of frozen products are block-frozen shrimps, cephalopods and fishes. IQF and value added fish products form only a minor portion of the trade. Market research has indicated that there is need for standardization of current materials, styles and modes of packaging of frozen foods. At the same time, it is necessary to give attention to cost –effective packaging material.

Fishery products are frozen at  $-40^{\circ}\text{C}$ . However cold storage temperature where they are subsequently stored varies from  $-30$  to  $-18^{\circ}\text{C}$ . The enzymatic activities bring about deteriorative changes like rancidity in frozen fish products. Exposure to low temperatures for a long time may result in freezer burns. Hence for extending shelf life and further storage, packaging is of absolute importance. To get a quality frozen product in perfect condition the package must provide protection against

dehydration, oxidation, flavour and odour loss and physical changes. Evaporation of moisture from the surface of the fish may occur resulting in freezer burns. In order to overcome these problems suitable packaging is absolutely necessary.

The advantages of packaging frozen fish are

- Prevention of dehydration
- Prevention of rancidity in fatty fishes
- Protection against contamination and physical damages
- Convenience of handling the product
- Retention of flavour and colour
- Attractive appearance of the product
- Prevents leaching while thawing
- Convenience in handling and using a portion of the product.

### **Packaging for various frozen fish products**

The packaging used for frozen fish products should be of good quality. It should protect the product from transit and storage hazards as well as provide a barrier for retention of moisture. Packaging material used for frozen fresh fish is mainly polyethylene, either as premade bags or wraps which are then packed into waxed duplex cartons. Frozen fish are also over wrapped in polystyrene trays for display. Individual fillets are packed in cellophane or PVC. Vacuum packaging of fish fillets and steaks in laminate films, and PVDC copolymer system is also practiced. The corrugated fiberboards are usually waxed or provided with a liner. Sometimes an inner slab of polystyrene foam is

effective in providing increased insulation. Laminated packs are usually used for IQF products. The sequence of packing starts with the primary inner wrap and finishes at the master carton.

### **Packaging for block frozen products**

#### ***a. Primary wrap for block frozen products***

The material used as a primary wrap for contact with the food is mainly Low-density polyethylene (LDPE). This can be in the shape of a bag or a film. Usually 2 kgs or 5 pounds material is packed along with 10-20 % glaze. Glazing should be optimum at the recommended level, since this will add to packaging and transportation. Alternately, films of HM-HDPE, which is not as transparent as LDPE film can be used, being more cost effective. 100 gauge LDPE is used for wrap while 200 gauge is used for bag. The corresponding values for HDPE are 60 and 120 gauge. Polyethylene films should be of food grade conforming to IS: 9845 specifications, which are given below in Table 1.

#### ***b. Duplex carton/ Inner carton***

There are four types of cartons used for packaging of seafood products, which are top opening, end opening, end loading and tray type. In top opening carton system filling is done from the top. This is mainly for filling larger pieces of fish and cephalopods. End opening type cartons are used when the product is smaller and free flowing, like packaging of fish curry or soup. Here the carton is coated with polyethylene on both inside and outside. The end loading

system feeds the product from one end into a horizontal glued carton. End flaps are heat sealed or closed by tucks in flap. End loading is suitable for products packed in aluminum /carton trays. Tray type cartons consist of cartons systems/ polypropylene trays, which are sealed with a lid and used for production of frozen pre cooked food that will be heated and thawed in the package itself. To withstand heating, the board is coated with polypropylene.

The frozen blocks are wrapped in film and then packed in duplex cartons. A number of such blocks are packed in a master poly bag and then packed into master cartons. The carton should have details like net weight, type and size, name and address of the producer and the country of origin. Specifications for duplex cartons are given in Table 2.

**Table 1: Specifications for primary wrap for block frozen products**

Water vapour transmission rate	18 gm/ sqm / 90 ± 2 % RH / 24 hrs / 37 ° C
Tensile Strength	Not less than 120kg/cm <sup>2</sup> in machine direction
	85 kg/cm <sup>2</sup> in cross direction
Elongation at break	100 per cent in machine direction
	350 per cent in cross direction
Overall migration residue	60 mg/ litre or 10 mg/dm <sup>2</sup>

**Table 2. Specifications for duplex cartons**

Material	Duplex board
Style of carton	preferably one-piece staple fewer cartons
Grammage	300g/m <sup>2</sup> (minimum)
Bursting strength	4 kg/cm <sup>2</sup> (minimum)
Wax coating	inner& outer side. 10g/m <sup>2</sup> on each side (minimum)
Polyethylene coating	20 gsm on each side
Ring stiffness	270 N
Printing details	Brand name, product type, net content, size grade. Identification of packer, country of origin.

Source: *Fish Packaging Technology – Materials and Methods, Concept Publishing Company*

**c. Master carton**

In the case of frozen shrimps about 6 units of 2 kg each or 10 units of 2 kg each are packed into master cartons. Corrugated fiberboards are used for the packaging of frozen fish. They may be of virgin material and having three or five ply with liners. The cartons may be wax coated or supported with liner paper with higher wet strength to make it moisture resistant. The specifications (Table 3) for master carton vary depending upon the country or the type of pack.

**Table 3: Specifications for master carton (10 units' carton)**

Material	Corrugated fibreboard
Style of box	Constructed from one piece of board
Number of plies	3 or 5 ply corrugated paper board
Type of flute	B or C and combination of these
Position of flute	Vertical
Bursting strength	14 kg/cm <sup>2</sup> min
Puncture resistance	160 oz in. / tear in
Cobb value (30min)	120 g/m <sup>2</sup> max
Compression strength (kg)	350 (minimum)
Manufactures joint	Staples on the outside. Overlap not less than 3 cm. Staples not more than 6 cm apart and not further than 2.5 cm from beginning and end of joint
Type of glue	Water resistant, preferable starch based or any other neutral adhesive.
Wax coating	Inside and outside of 20 g/m <sup>2</sup> (min) on each side.
Printing details	Product details, country and packer/exporter details.

Source: *Fish Packaging Technology – Materials and Methods*, Concept Publishing Company

**d. Strapping and tying**

Boxes are now mainly closed at the top and bottom by using cellophane tapes. They are also stapled or strapped by using polypropylene / high density/ rayon extruded straps. The straps are clipped or heat-sealed. The tensile strength must be great enough to withstand the load. In the case of polypropylene, the fluctuations in the tensile strength and elongation at break (%) at -20°C are comparatively less. Hence this material is most suitable when compared to HDPE where the tensile strength and elongation at break vary. The specifications are given in Table 4.

**Table 4: Specification for straps**

Closure	Minimum of 2 straps to be tensioned and heat sealed
Type of strap	Polypropylene (pp)
Width of strap	12 mm
Tensile strength	1,500 kg/cm <sup>2</sup>
Elongation	20 % minimum
Breaking load	75 (minimum)

Source: *Fish Packaging Technology – Materials and Methods*, Concept Publishing Company

**e. Packing slip (Code slip)**

Two packing slips are usually used. One placed on each side of the block. The slips should record the type, quantity, batch number, producer code and packing details.

### **f. Printing**

- The printing should be in one colour. The exterior of the master carton should have the following information printed.
- Name of the Processor and exporter
- Country of origin and destination
- Gross and net weight
- Type of packing
- Name of the product and code of packing
- Name and address of the consignee
- Transit instructions (perishable, hold at -20°C)

### **g. Storage and ware housing**

The use of wooden pallets and racks to store the filled boxes is recommended throughout in- factory handling and storage to ensure that damage is avoided before the boxes leave the plant.

### **h. Containerization**

It is essential that the optimum use be made of the freight container. This means that boxes of suitable dimensions that fit closely in the container should be made. A large variety of sizes and dimensions of shrimp packaging has been used in India.

### **Packaging of Individually Quick Frozen (IQF) Products**

Packaging requirements of IQF shrimps are different from block frozen products. IQF shrimps are mainly packed for retail marketing in consumer

packs ranging from 100g to 5 kg. An IQF pack has a single glaze on its surface and because of the larger surface area, they are vulnerable to several risk. Essential characteristics required for packaging materials of IQF shrimps are

- Low water vapour transmission rate to reduce the risk of dehydration
- Low gas/oxygen permeability, thereby reducing the risk of oxidation and changes in colour, flavour and odour
- Flexibility to fix the contours of the food
- Resistance to puncture, brittleness and deterioration at low temp.
- Ease of filling

IQF shrimps are filled in primary containers along with code slip and weighed. Bar coding is nowadays adopted which will depict various product and inventory details through a series of bars. Bar coding is compulsory for products imported to the EEC and US markets. The product is filled into primary pack which is heat sealed and further packed in master cartons for storage and transportation. The primary pack may be plastic film pouches (monofilm co-extruded film or laminated pouches). The unit pouches may be provided with unit/intermediate cartons or directly packed into master cartons. The unit/intermediate cartons are made of duplex or three ply corrugated fibreboard laminated with plastic film on the inside and outside to improve the functional properties as well as aesthetic value of the pack. The most functional cost effective film has been identified as 10  $\mu$ biaxially oriented polypropylene (BOPP). Some duplex cartons are also wax-coated. One major requirement of the master carton is high compression

strength to bear weight without damage to the product. Compression strength of 500 kg is the minimum recommended specification, which might give reasonable safety to the product. The cartons made of 5 or 7 ply corrugated fibreboard satisfying the above requirement can be safely used.

### **Packaging of battered and breaded fish products**

These are value added products in convenience form. A number of value added marine products for export and also for internal markets are prepared from shrimps, cephalopods, fish and minced fish. Battering and breading process increases the bulk thus reducing the cost element.

Thermoform trays produced from food grade materials like PVC, HDPE are suitable for packaging of fishery products. These trays are unaffected by low temperature of frozen storage and provide protection to the contents against desiccation, discoloration and oxidation during prolonged storage.

### **Packaging of Accelerated Freeze dried products**

Accelerated freeze dried products demand a very high price in the export trade. The final moisture content of AFD products generally is about 2 %. Low moisture content and large surface area make these foods extremely hygroscopic. Most dried products deteriorate when exposed to oxygen. Changes in colour also may take place as a result of bleaching. Light accelerates oxidative reactions and hence contact with light should be prevented. If proper packaging materials are not used there is every chance that the materials may undergo

flavour changes due to the oxidation of the product and also migration of flavour from the packaging material. As fish contains fat there will be chances of taking up the taints from the packaging material. The particular structural properties of freeze-dried products lead to damage by mechanical means. The light porous nature causes them to be very fragile and easily prone to breakage during handling and transportation. Freeze dried products are also liable to damage caused by free movement within the package. Measures must be taken to fit the product compactly in the container, while leaving the minimum headspace for filling inert gas.

Rigid containers both glass and cans were used earlier for packaging of freeze dried products. However, it can now be seen that metalized polyester laminated with polyethylene or aluminum foil /paper/polyethylene are used since they have low oxygen transmission rate and water vapour transmission rate. Most of the packages are filled with an inert gas. The product can also be packed under vacuum to give better protection against damage.

### **Packaging of Surimi**

Surimi is a Japanese term for mechanically deboned fish mince from white-fleshed fish that has been washed, refined and mixed with cryoprotectants for good frozen shelf life. Surimi is used as an intermediate product / raw material for processing several value added products like fabricated foods, shrimp and crab analogues and a variety of other products. Surimi requires to be preserved frozen until used for processing different products. For this purpose, surimi is generally frozen as

rectangular blocks. In order to prevent probable deterioration during storage like oxidative rancidity and desiccation care has to be taken to ensure that the frozen block does not contain any voids and that the packaging materials used have low water vapour permeability and low permeability to gases and odours. The packaging materials employed should be sufficiently strong and durable to withstand stress during handling, storage and distribution. Packaging employed for block frozen shrimp are considered safe for surimi.

### **Packaging of Fish Sausage**

Fish sausage is a product identical to the popular pork sausage. Surimi is the base material, which is homogenized after mixing with several other ingredients. The homogenized mass is stuffed in synthetic casings like Ryphan (Rubber hydrochloride) or Krehalon (Vinylidene chloride) or polyamide. Other casing available are cellulose casing which are permeable and can help in the penetration of smoke during the process. The casing is closed using metal rings after which it is heated in water at 85-90°C and then slowly cooled. After drying the surface, the sausage is wrapped in cellophane laminated with polyethylene. Fish sausage is kept at refrigerator temperatures for retail; however, when prolonged storage is needed it is better kept frozen. Duplex cartons lined with a plastic film are ideal for short-term storage, but when stored frozen, packaging suggested for block frozen shrimp can be considered suitable.

### **Packaging of Fish Pickle**

Fish pickle is a value added item whose bulk is contributed by low value items like ginger, chilly, acetic acid etc. Generally low cost fish and shell fish components are used in fish pickles. Conventionally glass bottles are used as containers, which offer properties like inertness, non-toxicity, durability, non-permeability to gases, moisture etc. But they are heavy, prone to break, voluminous and expensive. New flexible packaging materials developed for fish pickle is based on plain polyester laminated with LDPE-HDPE co-extruded film or Nylon/Surlyn or LD/BA/Nylon/BA/Primacore. These are inert to the product, can be attractively fabricated as stand up packs and can be printed on the reverse side of the polyester film.

### **Packaging of Fish soup powder**

Fish soup powder is a specialty product containing partially hydrolysed fish, protein, carbohydrates, fat and several other seasonings including salt. The product is hygroscopic and hence the selection of the package assumes great significance. Appropriate package developed for such products are 12micron plain polyester laminated with LDPE-HDPE co-extruded film or 90-100 micron LD/BA/Nylon/BA/Primacore multilayer film which ensure a safe storage of the product up to 180 days

### **Packaging of Dry Fish Pickle**

Fish pickles generally have high content of liquid gravy and hence present some problems in its packaging. Dry fish pickle with no gravy will be more suitable for packaging, transportation



and distribution. Many small varieties of fishes are generally dried and marketed; however, these fishes offer a very good raw material for processing into dry pickle which is considered a value added product. Such products

have been found quite acceptable to the consumers. A packaging material which offers safe storage of the product up to 14 months at ambient temperature has been identified as nylon/surlyn or LD/BA/nylon/BA/prim core.