# Modern Trends in Seafood Packaging

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**Abstract :** Improved methods of packaging have helped not only in keeping food safe with longer shelf but also helped in enhancing its consumer acceptance. Aquatic food products have special packaging requirements as distinct from fruits and vegetables, meat and meat products, dairy products, etc.

## Packaging of Fresh Fish

Fresh fish is one of the most perishable of all foods. More than 20% of the fresh fish caught in many tropical and subtropical areas is wasted with the major loss in quality and value occuring between harvest and fresh sale. Chilling by mixing fish with ice is the cheapest and most efficient method of minimising such wastage (Lissac *et al.*, 1988).

The primary function of a fish container or box is to hold fresh fish in ice during transportation or storage. In most developing countries traditional countainers are made of timber, bamboo, rattan or reeds. The porous surface of these containers tend to absorb water and accumulate slime, creating an ideal breeding ground for spoilage bacteria, which can contaminate fish held in them. Even though washing cleans the contaminated surfaces of the box it has been shown to be inefffective in reducing the bacterial load significantly. In this context it is advisable to go for returnable plastic boxes made of high densitypolythene (HDPE) and Polypropylene (PP) which resist impact, moisture and chemicals. Plastic containers have several advantages over traditional boxes such as durability, ease of cleaning, improved drainage of melt water, light weight, stackability and ability to nest when empty. Containers are designed for stable stacking when full and maximum nesting to conserve space when empty. Containers should be so designed to prevent the weight of the containers on top coming onto the fish held in the container underneath. Recyclability and improved nesting are two aspects which have drawn much attention in designing modern containers.

Modern insulated containers are made of HDPE with Poly urathane insulation sandwitched 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 aluminium, steel and fibre glass 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 the use of reusable collapsible shipping container for transport of fresh fish in ice (Roel Schlemaker, 1990).

In India baskets made of split bamboo and similar plant materials are trditionally used for packing fresh iced fish. After packing they are wrapped in gunny outside and sewed (Gopakumar, 1993). However, they do not possess

adequate mechanical strength and get deformed under stacking. Sharp edges of bamboo also causes bruises on the skin of fish. Used tea chests provided with 2.5cm thick foamed Polystyrene (in polythene sleeving) slabs inside have been found extremely beneficial for transport of fish over long distances upto 60 hours duration. A recent development is the development of an insulated corrugated plastic container which is the lightest of all packages available in the country for iced fish transport. It last for 5 trips and being of collapsible design and light weight, return of empties is very easy (Rao and Antony, 1988). For cycle hawkers U shaped box (100 Kg capacity) made of high molecular weight high density polythene is found ideal (Anon 1992-93). An insulated galvanised iron box (40 kg capcity) was introduced for multipurpose use on boats and processing centres. They did not become popular with the trade because of high tare weight (27 kg) and corrosion of metal parts in sea atmosphere (Prabhu, 1993). Chattopadyay and Bose (1978) experimented the use of fibre board containers for the transportation of iced marine and fresh water fish and frozen fish. They found that the fish could be transported in good condition for 60 hours covering a distance of 1700 km in fibre board container and the woodwool used in between two walls of containers was found to provide effective insulation. Wooden boxes and used plywood boxes of 20-120 Kg. capacity are 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 receving point to other places. The boxes lose their insulation property on becoming wet and tend to become heavy.

No container has as yet been produced which will satisfy the diverse needs. It has been found exteremely difficult to introduce a container which is standard in either dimensions, capacity or material.

## Packaging of Processed Seafoods

### i Packaging of Frozen fish

A suitable package for frozen fish must be able to meet the following requirements:

1. Reduction in moisture loss, oxidation and change of odour and flavour
2. Retention of volatile flavours
3. Flexibility to fit the contour of the food
4. Resistance to puncture, brittleness and deterioration at low temperature
5. Ease of filling

Paper board (duplex board) carton is the most important primary package used for packaging of frozen seafoods. These cartons are given a wax coating to protect the contents from loss of moisture. Frozen blocks weighing 2 Kg (usually) are packed in such cartons lined inside with 100/125 guage low density polythene. Ten such cartons are in turn packed in 5 ply corrugated fibre box which serves as shipping container. They are strapped with 12 mm wide high density polythene or polypropylene or rayon straps.

Bureau of Indian Standards (BIS) has specified quality requirements of maste carton (IS: 6715, 1972). Based on these CIFT has recommended the specifications to be followed for the export of frozen shrimp for export (Gopakumar, 1993).

The present trend is processing individually quick frozen shrimps in consumer packs. IQF products are normally

packed in either single layer polythene bags or laminated bags and placed in master cartons (Sirlak Suwarangsi, 1989). For IQF packaging there are several limitations in the use of wax coating on the duplex board. In view of the relatively poor quality of duplex board, the use of plastic film laminated to the inside of the carton as well as the surface print can be of very great help functionally and to enhance the aesthetic value of the pack. When laminated to print surface it will brighten the colours appreciably and lift up the sales appeal of the package as a whole. Besides, there are many advantages in such a laminations as it prevents moisture from affecting the board, etc. The most functional cost effective film will be a 10 micron biaxially oriented polypropylene (BOPP). Care should be taken in selecting the right adhesive as well as curing process, otherwise there is a great risk of the laminate coming off, resulting in a poor pack. Some countries object to film lamination for ecological reasons, since the carton cannot be recycled into pulp without removing the film, in which case the only alternatives will be to use a moisture resistant varnish.

Two functional requirements of packing IQF shrimp are worth noting. IQF shrimps are less well protected than the glazed block frozen shrimp against dehydration in storage and oxidative rancidity. Therefore, good quality barrier material is needed in the form of sealed bag as the primary pack. The transit package must have good compression strength to bear weight without damage to the product. Adequate compression strength should therefore be an important quality for the transit package. A compression strength of 500 Kg has been recomended to give reasonable safety to the product.

CIFT has developed flexible packaging material for IQF shrimp based on 12 micron plain polyster laminated with 250 gauge low density polythene laminate for consumer packs to hold 100 to 200 gm of the product.

Frozen fish are subject to two principal oxidatative deteriorations, rancidity and rusting. This may temporarily be prevented by covering the fish with a glaze of ice or by vacuum packing in oxygen barrier film Almarker, (1963) surveyed the packaging material in UK used for frozen fish products. He mentioned that if storage of nine months at -20°C and at relative humidity of 75% is required water vapour permeability of the packaging material should not exceed 0.22 to 0.37 g/m$^2$ in 24 hours. Bramsnaes and Sorenson (1960) have demonstrated that rainbow trout which very quickly becomes rancid on the inside of belly flaps and particularly along the fine blood vessles will keep for 9 months when vaccum packaged in polythene laminated cellophane and stored at -20°C. Lindsay (1977) studied the effects of film packaging on oxidative quality of fish fillets made from lake trout, packaged and frozen at -18°C for 10 months. Results indicated that Vacum packaging in low oxygen permeable films such as Nylon/Suryln and Suryln PVDC/ Surylyn protected the fish from oxidation and desiccation during prolonged frozen storage. In USA, greater amount of fish is sold in the frozen form in the super markets. The package used is polythene, wax or hot melt coated carton with or without a waxed paper overwrap.

### ii Packaging of Dried Fishery Products

The special function required of a suitable dried fish/product package are inertness, leak proofness, impermeability to oxygen and moisture and less transparent (Gopakumar, 1993). Resistance to mechanical abrasion and puncture is another desired quality. In Britain only a small amount of fish is salt cured such as dried salted cod and pickled herrings. The products are not sterilised and therefore require refrigeration as packages used are glass jars or cans. In Malaysia dry fishes are packed in any type of container available such as hessain or gunny bags , card board cartons, wooden boxes, bamboo and rattan baskets. At the retail shop, dried fish is displayed in boxes, rolled down paper bags, LDPE baskets etc. (FAO, 1983).

One fifth of India's fish catch is salted and dried for internal consumption. The packaging employed is highly unsatisfactory leaving much to be desired from the scientific and hygienic points of view. Baskets improvised with braided coconut or palmirah leaves are the containers mainly used for packaging this product both for export and internal distribution. An overwrap with gunny fabric is given as reinforcement in the case of products meant for export and those which have to be transported over long distances. These packages are however prone to easy entry of insects, rodents and other pests. The product being highly sensitive to changes in relative humidity the packaging has to be sufficiently water vapour proof.

The commonly used packaging materials for consumer packs of dry fish are low density polythene or polypropylene. These materials are cheap, readily available and have good tearing and bursting strength. Disadvantages are high water vapour and gas transmission rate, proneness to puncture or damage from sharp spines and smell coming out. Shelf life is limited. Recent developments of cured fish packaging is the use of polyamide polythene laminate pouches for consumer packaging (Gopal, 1994).

The bulk packaging materials commonly used in tropics are waxed corrugated cartons, deal wood or plywood boxes, bamboo baskets or gunny bags, dried palmirah or coconut palm leaves and multiwall paper sacks. Among different packaging materials studied high density polythen woven gusseted bags laminated with 100 guage low density polythene are found quite suitable for dried fish packaging. From the hygienic points of view HDPE is impervious to microbial and insect attack.

Accelareted freeze dried (AFD) prawns are in good demand due to their superior quality inspite of higher cost of production. AFD fish weighs only 1/5th of fresh fish. The moisture content is generally below 2%. Hence such dried material has to be packed in inert gas so as to exclude air and oxygen. The packaging materials must have low oxygen and water vapour transmission rate in order to protect the materials from rancidity and absorption of water. Paper/ aluminium foil/polythene laminates or metallised polyster laminated with polythene are used as packaging materials for AFD products. In some cases metal containers like tin cans have to be used to protect from shock as the material is very brittle.

### iii Packaging of Canned Fish

A suitable canned fish package should be hermetically sealable, thermally conductive and inexpensive

which should not affect the odour, flavour, texture, colour and food value of the contents. Sulphur resistant lacquered cans are generally used for fish products. Cans made of aluminium are also used and these are less expensive than tin plate cans. Now there are several choices available such as standard tin plate, light weight tinplate, double reduced tinplate, tin free steel, vacuum deposited aluminium on steel and aluminium (Sacharow and Griffin, 1980). The most common material used for manufacturing containers for fish products the world over is tinplate, aluminium and laquered steel plate. Aluminium alloys are finding increasing use in can making in USA and UK. Shallow drawn aluminium cans are being used for canned tuna, sardines, crab meat, lobster, salmon and oysters (Lopez, 1975). Indigenously developed aluminium can has been found quite good for heat processing fish and fish based products (Balachandran *et al.*, 1994). In recent years a lot of new developments have taken place in the field of canning technology. Among them is the introduction of drawn and wall ironed (DWI), drawn and redrawn (DRD), easy open ends and alternative package materials such as tin free steel (TFS) and different types of rigid and flexible packaging materials (Mahadevaiah 1985). The development of welded side seam is a more recent innovation (Laad, 1985). Another new material Litewel-N (LTW-N) is being marketted by a Japanese company for use in food and beverage cans. It consists of a steel sheet thinly plated with tin and tin nickel alloy. It is claimed to have corrosion resisance, weldability and lacquer adhesion properties compared to tin plate despite containing less tin (Anon, 1989). Another development is the use of flexible packaging material as a substitute for cans. It is perhaps the most significant advancement in fish packaging since the development of the can and is made from a laminate of three or four materials viz. an outer layer of polyster or nylon layer for strength, a middle layer of aluminium foil as moisture, light and gas barrier and an inner layer of cast polypropylene as the heat seal and food contact material. It offers many advantages over conventional canned and frozen food package to the food processor, distributer, retailer and consumer. Commercial application has taken place in Japan, Europe and USA. Some advantages of retort pouch are rapid heat penetration resulting in the reduction of processing time by 35-50%, improved quality of products with significant reduction in loss of heat labile vitamins, lower packaging cost and saving in freight, less requirement of space, convenience to use and savings in energy (Lampi. 1977). Studies carried out at CIFT showed that fish packed in retortable pouches are highly acceptable to consumers.

**iv. Modified Atmosphere Packaging**

In recent years considerable interest has been envinced in many countries in research on storage of fresh fish in modified or controlled atmosphere packaging. It is primarily the enrichment of $CO_2$ in storage atmosphere as a means of controlling microbial growth. The gas gets absorbed on the moist surface of the product forming Carbonic acid thus lowering the surface pH and retarding the growth of spoilage bacteria. The gas has a higher solubility at refrigerated temperatures and hence a better protective role. Fey and Regenstein (1979) found that 60% $CO_2$ in

atmosphere is very advantageous in extending the shelflife of fresh red hake (*Orophycischess* species) packed in gas impermiable bags. Recent studies (Bank *et al.*, 1980, Brown *et al.*, 1980)on Vermillion rock (*Sebastes* species), Coho Salmon (*Oncornhynchus* species) Gulf trout (*Cynoscion* species) and Croaker (*Micropagon* species) have shown that while $CO_2$ is effective in inhibiting the growth of gram negative bacteria Pseudomonas which produces trimethyl amine and ammonia, growth of gram positive bacteria such as lactobacillus is stimulated. Packaging materials generally employed for the purpose are flexible films of Nylon/Surylyun laminates Plastics moulded trays overwrapped with 75 guage PVC strech film, Polyacrylonitrile/ polythene film laminate etc. In Norway Cod fillets are packed in PVC moulded tray laminated with 100 micron LDPE and sealed with 50 micron PVC laminated with 100 micron LDPE film with 50% $CO_2$ and 50% $O_2$ and has the shelf life of 19 days at 0-2°C compared to 11 days in air (Srinivasa gopal, 1985). Srinivasa - gopal *et al.* (1990) studied the modified atmosphere storage of fresh water fish fillets (*Catla catla*) using 12 micron plain Polyster laminated with 230 gauge LDPE. They found that at 80% $CO_2$ and 20% $O_2$ fish had a shelf life of 27 days, whereas the sample held in air the shelf life was only 12 days at 0-4°C.

## Packaging of Fish Based Convenience Foods

The seafood industry the world over is on the threshold of diversification both from the point of view of catching and processing. On the processing/ preservation side, technologies have been developed for preparing several fish based convenience foods. Different types of packaging materials developed at Central Institute of Fisheries Technology for such products are briefly discussed hereunder.

## Fish Pickles

Prawns, mussel, seer and tuna meat pickles are some of the pickles which are popular in India as also in other countries particularly where conglomerations of Indian population are present. The conventional packaging for pickle is glass bottle which possess several plus points like rigidity, inertness, non-toxicity, durability and non-permeability to gases and moisture. The main disadvantages are heaviness, breakages, voluminous nature and high cost. Losses due to breakage during transportaion are high. Glass containers with closures cost about 25-30% of the total cost of production of fish based pickles. CIFT has developed flexible packaging materials based on Plain Polyester laminated with LDPE-HDPE co-extruded film or metalised polyster laminated with LDPE-HDPE co-extruded film or Nylon/Surlyn or LD/ BA/Nylon/BA/ Primacore. In these flexible packaging materials pickles can be kept for a period of 7 to 8 months at ambient temperature. The above packaging materials do not have any deleterious effect on the product and can be attractively fabricated as stand up packs with all details printed and hence can advantageously replace the conventional glass bottles. Flexible packaging materials are found to be cheaper than glass.

## Frozen Fish Curry

One method of long term preservation of fish curry is to heat process in cans. However, the product develops slight metallic taste during storage and meat pieces become soft. An alternate is to preserve it by freezing. Fish curry

packed in Polystyrene or Polyvinyl chloride thermoformed containers and stored at 20 ± 2°C had a shelf life of 26 weeks.

## Fish Soup Powder

Fish soup powder contains partially hydrolysed proteins, carbohydrates, fat and several seasoning compounds including salt and is hygroscopic in nature. Proper packaging of this product assumes great importance in view of its hygroscopic character. Work in CIFT has revealed 12 micron plain polyster laminated with LDPE-HDPE co-extruded film or 90-100 micron LD/BA/Nylon /BA Primacore multilayer film to be suitable for storage of soup powder for long term storage upto 180 days.

## Value Added Marine Products

Value added shrimp consumption is heavily increasing in U.K., France, Germany while South European countries are lagging behind (Helsa Josalet and Luc de Franssu, 1992). One of the important classes of value added marine products is battered and breaded products. Battered and breaded shrimp in different styles, squid rings, stuffed squid etc. are prominent ones. Fish fingers, Fish cutlets, patties (burgers), etc are processed using fish mince. Conventional packaging materials like flexibile plastic films alone are not suitable for these products as they provide little mechnical protection to the products and as a result the products get damaged or broken during handling and transportation. Thermoformed trays produced from food grade materials like Polyvinyl chloride or high impact Polystyrene are suitable for the packaging of such products. For export, especially to European and U.S. markets where merchandising is mainly through super markets and departmental stores thermoformed trays will prove beneficial. The trays are required for self service merchandising systems and constitute unit packs and the buyers in these countries are used to them.

## Dry fish pickle

Fish pickles generally have high content of liquid gravy and so packing presents difficulty. Dry pickle having no liquid gravy will be more suitable for packing transport and distribution. Nylon/Surylyn or LD/BA/Nylon/BA/Primacore multilayer film ere found as ideal packages for dry pickles for long storage upto 13 months at ambient temperature.

## Environmental Legislation and Eco-Labelling

Environmental legislation on packaging are primarily aimed at reducing the level of discarded packaging in the waste stream. Relevant authorities in most countries have set targets for waste reduction and have enacted legislation to achieve such goals. In many developed countries legislation is based on the " 3Rs" : "source Reduction", "Reuse" and "Recycling". In Europe and North America, emphasis is mainly on Reuse and "Recycling" of packaging through financial incentives as well as through mandatory or voluntary restraints.

An important development in this direction is eco-labelling practices adopted by many countries. In eco-labelling an assessment is made on both the product and its packaging. New trends in eco-labelling will necessitate most industries and exporters to take serious note of the requirements in the export markets, since the criteria for award of eco-labels could be used to restrict imports. Hence it is important for exporters

to be fully aware of the total environmental impact of various operations required to produce the product and its packaging and to strive to reduce this impact to minimum.

## Conclusion

In recent years significant developments have taken place in the packaging industry with the availability of newer packaging materials and techniques which can be adopted by the fishing industry for improving the present standard of packagings so as to be on par with other developed nations. Better packaging ensures improved quality and presentation of the product and higher returns to the producer. By using appropriate packaging materials better shelf life can be ensured. However it is not possible to identify one specific packaging film or material for any particular product because of the many variables involved. Thus it has has to be tailor made to fit the specific requirement of the food and degree of protection needed, be it against the influence of moisture , oxygen, light, odours, microbes, etc. In view of the eco friendly packaging materials insisted by many importing countries, our fishing industry should gear up to the present need.

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