INTRODUCTION TO FISH PRESERVATION TECHNIQUES

Zynudheen A.A.
ICAR-Central Institute of Fisheries Technology, Cochin
Email: zynucift@gmail.com

Fish is one of the healthiest foods available to man and there is an ever-increasing demand for fish and fishery products. Being a highly perishable commodity, fish require immediate processing and various options are available for the value addition of fish. Fish processing, particularly seafood processing and marketing have become highly complex and competitive and exporters are trying to process more value-added products to increase their profitability. Value can be added to fish and fishery products according to the requirements of different markets. These products range from live fish and shellfish to ready to serve convenience products. In general, value-added food products are raw or pre-processed commodities whose value has been increased through the addition of ingredients or processes that make them more attractive to the buyer and/or more readily usable by the consumer. It is a production/marketing strategy driven by customer needs and perceptions.

Technology developments in fish processing offer scope for innovation, increase in productivity, increase in shelf life, improve food safety and reduce waste during processing operations. A large number of value added and diversified products both for export and internal market based on fish, shrimp, lobster, squid, cuttlefish, bivalves etc. have been identified. This paper gives an overview of the processing techniques, emerging technologies and the value added products from fish and shell fish.

Chilling

Chilling is an effective way of reducing spoilage by cooling the fish as quickly as possible without freezing. Immediate chilling of fish ensures high quality products (Connell, 1995: Huss, 1995). Chilling by use of ice is the most important method employed commercially. The storage life of fish kept in ice depends on a number factors which include species, size, method of capture, fat content, breeding conditions, feeding regime and the method of killing. In general, the keeping quality of non-fatty fish is better than fatty fish in ice storage. The quality and

quantity of ice used are important factors in determining the shelf life of iced fish. In tropical countries, a 1:1 fish to ice ratio is ideal for ice storage. It is recommended to add about 12-20% extra ice to the fish in order to compensate for water loss from melting and bad handling (Zugarramurdi *et al*., 1995). It is generally accepted that some tropical fish species can keep for longer periods in comparison to fish from temperate or colder waters.

Transportation of live fish and shellfish

Transportation of fish, crustaceans and molluscs in live condition is the best method to ensure that the consumer is supplied with fresh product. In India, traditional mode of live transport in open earthen containers and metal containers was practiced (Jhingran, 1975). In terms of the range of species and the distance shipped, tropical fishes stand first in live fish transport. Waterless transportation of live fish is also practised for many species where the animals are kept in moist conditions under optimal cold temperatures.

Freezing

Freezing is one of the better methods to preserve fresh fish. It may be either slow freezing or quick freezing. Slow freezing is accomplished by placing the product at a low temperature and allowing it to freeze slowly usually in still air. Quick freezing is accomplished in any one or combination of the following four methods:

1. Immersion freezing
2. Indirect contact freezing
3. Air blast freezing and
4. Cryogenic freezing

Air freezing

Air blast freezing

Circulating cold air at high speed enables freezing to proceed at a moderately rapid rate and this method is referred to as air-blast freezing. Air-blast freezing is usually accomplished by placing the products on a mesh belt and passing it slowly through an insulated tunnel containing air at-18 to -34°C or lower, moving counter current to the product at a speed of I to 20 meter/sec. Air at -

29°C and at a speed of 10-12 meter/sec, is often satisfactory, although lower temperatures are preferred. Air blast freezing is economical and is capable of accommodating products of different sizes and shapes. It can result in (1) excessive dehydration of unpackaged products if conditions are not carefully controlled, and this in turn necessitates frequent defrosting of equipment and (2) undesirable bulging of packaged products which are not confined between flat rigid plates during freezing. Spiral Belt Freezer and Fluidized Bed Freezing are some of the commonly used methods in the industry.

Contact Plate Freezing

Fish products can be frozen by placing them in contact with a metal surface cooled by expanding refrigerants. Double contact plate freezers are commonly used for freezing fish/prawn blocks. This equipment consists of a stack of horizontal cold plates with intervening spaces to accommodate single layers of packaged product. The filled unit appears like a multi layered sandwich containing cold plates and products in alternating layers. When closed, the plates make firm contact with the two major surfaces of the packages, thereby facilitating heat transfer and assuring that the major surfaces of the packages do not bulge during freezing. Vertical plate freezers are also in use especially onboard fishing vessels. Contact plate freezing is an economical method that minimises problems of product dehydration, defrosting of equipment and package bulging. In this method the packages must be of uniform thickness. A packaged product of 3 to 4 cm thickness can be frozen in I to 1.5 hour when cooled by plates at -35°C. Freezing times are extended considerably when the package contains a significant volume of void spaces.

Liquid Immersion Freezing

Liquid immersion freezing or direct immersion freezing is accomplished when a product is frozen by immersing or by spraying with a freezant that remains liquid throughout the process. This technique is occasionally used for fish and prawns. Liquid immersion freezing can result in moderately rapid freezing. Freezants used for liquid immersion freezing should be non-toxic, inexpensive, stable, reasonably inert, and should have a low viscosity, low vapour pressure and freezing point and reasonably high values for thermal conductivity. Freezants should have a low tendency to penetrate the product, little or no undesirable effects on organoleptic properties and

require little effort to maintain desired standards for sanitation and composition. Aqueous solutions of propylene glycol, glycerol, sodium chloride, calcium chloride and mixtures of sugars and salt have been used as freezant.

Cryogenic Freezing

Cryogenic freezing refers to very rapid freezing by exposing food products to an extremely cold freezant undergoing change of state. The fact that heat removal is accomplished during a change of state by the freezant is used to distinguish cryogenic freezing from liquid immersion freezing. The most common food grade cryogenic freezants are boiling nitrogen and boiling or subliming carbon dioxide.

Individually Quick Frozen Products (IQF)

Lobster, squid, cuttlefish, different varieties of finfish etc. are processed in the individually quick frozen style. IQF products fetch better price than conventional block frozen products. However, for the production of IQF products raw-materials of very high quality need to be used, as also the processing has to be carried out under strict hygienic conditions. The products have to be packed in attractive moisture-proof containers and stored at –30°C or below without fluctuation in storage temperature. Some of the IQF products in demand are prawn in different forms such as whole, peeled and de-veined, cooked, headless shell-on, butterfly fan tail and round tail-on, whole cooked lobster, lobster tails, lobster meat, cuttlefish fillets, squid tubes, squid rings, boiled clam meat and skinless and boneless fillets of white lean fish. IQF products can be easily marketed as consumer packs, which is not possible with block frozen products. This is a distinct advantage in marketing.

Canning

Canning is a method of food preservation in which preservation is achieved by the destruction of micro-organisms by the application of heat of food packed in a sealed container. Since the canned foods are sufficiently cooked products and free from micro-organisms they offer consumer safety besides being ready to consume. Canning has the unique distinction of being an invention in the field of food processing/ preservation whereas all other methods can be considered as adaptation of natural processes or their modifications. Because of their very long

shelf life and ready to consume feature canned products have become very popular and a variety of food stuffs, both plant and animal origin and their combinations are produced and distributed.

Unit Operations in a canning process are:

1. Selection and preparation of raw material.
2. Pre-cooking / blanching
3. Filling in to containers.
4. Addition of liquid medium
5. Exhausting
6. Seaming
7. Heat Processing / Retorting
8. Cooling
9. Drying, warehousing, labelling and casing

Retort Pouch Processing is an improvement over the conventional canning process. Reportable flexible containers are laminate structures that are thermally processed like a can, are shelf stable and have the convenience of keeping at room temperature for a period of more than one year without refrigeration. The most common form of pouch consists of a 3 ply laminated material. Generally it is polyester / aluminium foil / cast polypropylene. See-through pouches made of polyester/aluminium oxide or silicon dioxide/nylon/cast polypropylene is also available. The manufacture of retort pouch packs involves a series of lengthy operations viz., filling, air removal, sealing, traying and heat processing in an over pressure autoclave

Curing

The traditional methods of processing fish by salting, drying, smoking and pickling are collectively known as curing. Cured fish consumption is more in areas where the availability of fresh fish is comparatively limited, namely interior markets and hilly areas. This is also the cheapest method of preservation, since no expensive technology is used. In India roughly 20 % of the fish caught is preserved by curing. Considerable quantities of cured fish are also exported, mainly to Singapore, Sri Lanka and to the Middle East. Simple sun drying was the

widely practised traditional method of fish preservation. By this, preservation was achieved by lowering of water content in the fish, thereby retarding the activity of bacteria and fungi. The heat was able to destroy the bacteria to a certain extent. Later on, a combination of salting and drying or salting, smoking and then drying were developed.

Salting

This is one of the oldest methods of preservation of fish. Salting is usually done as such or in combination with drying or as a pretreatment to smoking. During salting osmotic transfer of water out of the fish and salt into the fish takes place, which effect fish preservation. It is based on different factors like diffusion and biochemical changes in various constituents of the fish. Salting amounts to a process of salt penetration into the fish flesh. Penetration ends when the salt concentration of the fish equals that of the surrounding medium. Loss of water during salting limits bacterial growth and enzyme activity, thus preserving the fish. The high salt content prevents the growth of normal spoilage microflora in the fish; but halophiles, which can survive 12-15% of salt, will survive.

Smoking

Smoke curing is another traditional method of preservation of fish. It is generally a combination of salting, smoking and drying. Smoking is usually done in a specially designed kiln or a room. The source of smoke is wood, sawdust or coconut husk, depending on the particular flavour required. The fish that is salted and partially dried is used for smoking. Smoking can be done at temperatures below 35 ^{0} C (cold smoking) or at higher temperature (hot smoking). Liquid smoking by immersion in smoke liquor and electrostatic smoking is also practised in different countries. Masmin, Dried Squid, Dried Jelly Fish, Dried Bombay duck etc are Some commercially important dried aquatic products

Irradiation

Irradiation treatment involves controlled exposure of the food to radiation sources such as isotopes of cobalt (^{60}Co) or cesium (^{137}Cs), which emit gamma rays, and also X-rays and electron beams (Lagunas-Solar, 1995). Radiation processes that can be applied to fishery products include radurization (pasteurization of chilled fish), radicidation (sanitization of fresh and frozen

products including fish mince by elimination of non-spore forming pathogenic bacteria) and disinfestation.

Radurization of fresh fish at 1 to 3 kGy reduces initial microbial loads by 1 to 3 log cycle, essentially reducing spoilage causing bacteria and extends their chilled storage life 2-3 fold. The treatment is effective for the extension of shelf life of most of the marine and freshwater fish species.

Battered and Breaded Products

The most prominent among the group of value added products is the battered and breaded products processed out of a variety of fish and shellfish. Battered and breaded products offer a 'convenience' food widely valued by the consumer. These are products, which receive a coat or two each of a batter followed by coating with breadcrumbs, thus increasing the bulk and reducing the cost element. The pick-up of coating can be increased by adjusting the consistency of the batter or by repeating the coating process. By convention, such products should have a minimum fish component of 50%. Coated products viz., fish fingers, squid rings, cuttlefish balls, fish balls and prawn burgers form one of the major fish and shellfish based items of trade by the ASEAN countries.

The first commercially successful coated product is 'fish finger; or 'fish stick'. Later several other products particularly the coated fish fillet, fish portions, fish cakes, fish medallions, fish nuggets, breaded oysters and scallops, crab balls, fish balls, coated shrimp products, coated squid rings etc. became prominent in most of the developed countries with the advent of the fast food trade. The present day production of coated seafood items involve fully automated batter and breading lines which start from portioning and end with appropriate packaging of the product

Fish Mince and Mince Based Products

Mechanically deboned fish meat is termed as fish mince. Fish mince is more susceptible to quality deterioration than the intact muscle tissue since mincing operation cause disruption of tissue and exposure of flesh to air, which accelerates lipid oxidation and autolysis. The quality of the mince is dependent on the species, season, handling and processing methods. Also, low bone content in the mince (01-0.4%) is desirable for better functional and sensory properties. Fish mince is a major source of raw material for the preparation traditional products such as patties,

balls, wafers, loaves, burgers, fish fingers, dehydrated fish minces , cutlets and pickled products The mince from different species could be combined to prepare composite fillets

Surimi

Surimi is stabilized myofibrillar protein obtained from mechanically deboned flesh that is washed with water and blended with cryoprotectants (Park, 2005). Washing not only removes fat and undesirable matters such as blood, pigments and odoriferous substances but also increases the concentration of myofibrillar protein, the content of which improves the gel strength and elasticity of the product. This property can be made use of in developing a variety of fabricated products like shellfish analogues. India produces about 40.000 MT of surimi per annum, 70% of which comes from thread fin bream.

Kneaded products

Several kneaded products like kamaboko, chikuwa, hampen, fish ham and sausage are processed using surimi incorporating other ingredients. The ingredients used in most of these preparations are identical; however, the classification is principally based on the manufacturing process involved. The ingredients employed other than surimi include salt, monosodium glutamate, sugar, starch, egg white, polyphosphate and water. The method of processing all these products involves grinding together of the various ingredients to a fine paste and some sort of heat treatment at some stage.

Fibreized products

Fibreized products are in great demand among the surimi based imitation shellfish products. The ingredients used in the formulation of fibreized products includes, besides surimi, salt, starch, egg white, shellfish flavour, flavour enhancers and water. All the ingredients are thoroughly mixed and ground to a paste. The paste is extruded in sheet on the conveyor belt and is heat treated using gas and steam for partial setting. A strip cutter subdivides the cooled sheet into strings and is passed through a rope corner. The rope is coloured and shaped. The final product is formed by steam cooking the coloured and shaped material.

Fish sausage

Fish sausages are surimi or fish mince mixed with additives, stuffed in suitable casings and heat processed. The surimi or fish mince is mixed with salt (3-4%), sugar (2-3%), sodium glutamate (0.3%) starch and soy protein in a silent cutter and stuffed in casings by an automatic screw stuffer. The stuffed sausage is heated in hot water at 85-90°C for 40-60 min. After heating, it is cooled slowly to avoid shrinking of the tube and then stored at refrigerated temperature. The production of fish sausage in India is rather insignificant, although market potential for this product is good (Hassan & Mathew, 1999). Sausages prepared from rohu mince treated with potassium sorbate had a shelf life of 16 days at refrigerated temperatures (Sini *et. al*., 2008).

Accelerated Freeze Drying, High Pressure processing, Enzyme treatment, Extrusion technology, Pulsed light technology, Hurdle technology etc. are some of the emerging technologies for value addition of fish which are being practices by the industry to certain extent.

Fish processing and value addition has evolved over the years as an important sector in Indian Agriculture. Fish and fishery products earn maximum foreign exchange in the category of agricultural produce exported from India. This sector has immense scope for development through diversification and generation of employment for the skilled and unskilled workforce of the country.

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