# Technological options in fish processing for promoting entrepreneurship

Mohan, C. O.
ICAR-Central Institute of Fisheries Technology, Kochi-29
*Email: comohan@gmail.com*

Fish is highly nutritious and at it is also highly susceptible to spoilage, due to intrinsic and extrinsic factors. Proper processing and packaging help in maintaining the eating quality of fish for extended period. Worldwide, an array of processing and packaging methods are followed. This ranges from a simple chilled or ice storage, salted and drying to most recent and advanced high pressure and electromagnetic field applications, which attracts opportunities from both small scale and industrial level entrepreneurs. Fish products in live, fresh chilled, whole cleaned, fillets steaks, battered and breaded products, variety of dried products, smoked fish, fish sausage and traditional products are the range of low-cost processing methods which can be readily adopted by small-scale fishers. The processing methods like canning or heat processing, freezing, vacuum and modified atmosphere packaging, analogue products, high pressure processing, pulsed light processing, irradiation, electromagnetic field etc. are the processing methods which requires higher investments can be adopted by large scale entrepreneurs, apart from the above-mentioned processing methods. A brief description on these technologies are provided below.

## Live Fishery Products

There is a great demand for live fish and shellfishes, the world over. These products fetch maximum price compared to all the other forms of value-added products as it maintains the freshness. The candidate species for live transportation include high value species, cultured grouper, red snapper, seabreams, seabass, red tilapia, reef fish, air breathing fishes, shrimp, crabs, lobster, clams, oyster and mussels. These are normally transported in air cargo maintained at low temperature in order to lessen the metabolic activities of the animals.

## Chilled Fishery Products

Chilling is an effective method of maintaining the freshness of fish products. This normally involves keeping fishes in melting ice or slurry ice to maintain the fish temperature around 1- 4 ºC, which delays the enzymatic action and microbial activity, thereby extending the shelf life of the

products. Traditionally, chilling is carried out using melting ice, either flake ice or crushed block ice. Of late, slurry ice has been introduced for chilling. A wide range of fish and shellfish products varying from whole, headless, peeled gutted, headless gutted fish, fillets, steaks, loins, cubes can be preserved by chilling. Shelf life of fishes from different environment has been studied by the Division extensively. Shelf life of 12-15 days has been achieved for seerfish and black pomfret. Indian Mackerel and Indian oil sardine had very short shelf life in ice (3-7 days), due to rancidity and belly bursting. Tilapia from freshwater and brackish water showed significant difference in shelf life when stored in ice. The former kept longer (14-15 days) than latter (8-10 days).

### Vacuum packaging:

Vacuum packaging involves the removal of air from the package and the application of a hermetic seal. The air removal creates a vacuum inside the packs and lack of $O_2$ in packages may minimize the oxidative deteriorative reactions and aerobic bacterial growth. Vacuum packaging can considerably extend the viable shelf life of many cooked foods. The use of vacuum packaging, in gas impermeable and heat stable materials, has many advantages, which include; no or low risks of post pasteurization contamination, ease of handling, Inhibition of growth of aerobic spoilage organisms and inhibition or slowing of deleterious oxidative reactions in the food during storage due to oxygen barrier properties of the packaging material.

### Modified Atmospheric packaging:

In modified atmosphere packaging air is replaced with different gas mixtures to regulate microbial activity and /or retard discoloration of the products. The proportion of each component gas is fixed when the mixture is introduced into the package; however, no control is exercised during storage. The composition of the gas mixture changes from its initial composition as a result of chemical, enzymatic and microbial activity of the product during storage. It is primarily the enrichment of Carbon dioxide in the storage atmosphere as a means of controlling microbial growth, which results in the extension of shelf life of products. Carbon dioxide lowers the intra and extracellular pH of tissues and possibly that of microorganisms. Further it may affect the membrane potential of microorganisms and influence on the equilibrium of decarboxylating enzymes of microorganisms. The gases normally employed are carbon dioxide, mixtures of carbon dioxide and nitrogen, carbon dioxide and oxygen and carbon dioxide, oxygen & nitrogen with the sole objective to extend the shelf life of the product beyond that obtained in conventional refrigerated storages.

The composition of the gas mixtures used for MAP of fresh fish varies, depending upon whether the fish in the package is lean or oily fish. For lean fish, a ratio of 30 % Oxygen, 40% Carbon dioxide, 30% Nitrogen is recommended.

### Smart Packaging

Active and intelligent packaging techniques are the advanced Smart packaging techniques to preserve and monitor the quality of food products. These techniques offer new opportunities to the ever-expanding food industry to cope up with the consumer's expectations. The major active and intelligent packaging systems includes $O_2$ scavengers, $CO_2$ emitter/absorbers, moisture absorbers, antioxidant packaging, antimicrobial packaging, ethylene absorbers, flavor releasing/absorbing systems, time-temperature indicators, leakage indicators and freshness indicators.

### Frozen Fishery Products

Freezing is an age-old practice to retain the quality and freshness of fishery products for a long time. This involves the conversion of water present in fishery products to ice i.e., a phase change from liquid to solid phase takes place in freezing. This retards the microbial and enzymatic action by reducing the water available for their action. This involves exposing fish products to very low temperature (<-35$^0$C) to enable freezing of free water and maintained at -18$^0$C till it is consumed. Plate freezing, air blast freezing, cryogenic freezing and individual quick freezing are the methods adopted by the industry to preserve food products. Both raw frozen as whole, whole cleaned, headless gutted, steaks, fillet, cubes etc. or in the form of value-added products viz coated fish ball, cutlet, fillet, portion, nuggets, patties and other forms as well as marinated products can be preserved in frozen form. The shelf life of these products ranges from 6 month to 24 months depending on the products.

### Dried and Salted Fishery Products

Drying is probably one of the oldest methods of food preservation. It consists of removal of water to a final desired concentration, which in turn reduces the water activity of the product, thereby assuring microbial stability and extended shelf-life of the product. In some cases, common table salt (Sodium chloride) is also used to prolong the shelf life of fish. Salt absorbs much of the water in the food and makes it difficult for micro-organisms to survive.

### Thermal processing for Ready to eat fish products

It is also known as heat processing and is normally carried out in metal cans, retortable pouches, glass bottles and rigid containers. Normally it involves packing the prepared fish product in different forms in a container followed by adding filling medium, exhausting, sealing and heat processing at high temperature in the range of 110 to 135°C depending on the food product to achieve desired lethality. In retortable pouches, the product is processed in an over pressure retort. The time and temperature will be standardized depending on the product. With the availability of retort pouches it can function as an excellent import substitute for metallic cans. Besides, cost reduction retort pouch packages have unique advantages like boil in bag facility, ease of opening, reduced weight and do not require refrigeration for storage. Processed food products can be kept for long periods at ambient temperature. The energy saving is more in processing in flexible pouches compared to cans. On a comparison of total costs, including energy, warehousing and shipping, the pouch looks even more favorable. There is 30 to 40% reduction in processing time compared to cans, solids fill is greater per unit, empty warehousing is 85% smaller and weight of the empty package is substantially smaller.

### Extrusion:

Extrusion cooking is used in the manufacture of food products such as ready-to-eat breakfast cereals, expanded snacks, pasta, fat-bread, soup and drink bases. The raw material in the form of powder at ambient temperature is fed into extruder at a known feeding rate. The material first gets compacted and then softens and gelatinizes and/or melts to form a plasticized material, which flows downstream into extruder channel. Basically, an extruder is a pump, heat exchanger and bio-reactor that simultaneously transfer, mixes, heats, shears, stretches, shapes and transforms chemically and physically at elevated pressure and temperature in a short time. At times, the extrusion cooking process is also referred as High Temperature Short Time process. In extrusion process gelatinization of starch and denaturation of protein ingredient is achieved by combined effect of temperature and mechanical shear.

### Irradiation:

Irradiation is a physical treatment that consists of exposing foods to the direct action of electronic, electromagnetic rays to assure the innocuity of foods and to prolong the shelf life. Irradiation of food can control insect infestation, reduce the numbers of pathogenic or spoilage

microorganisms, and delay or eliminate natural biological processes such as ripening, germination, or sprouting in fresh food. Like all preservation methods, irradiation should supplement rather than replace good food hygiene, handling, and preparation practices.

### Microwave processing:

The applications of microwave heating on fish processing include drying, pasteurization, sterilization, thawing, tempering, baking etc. Microwaves are electromagnetic waves whose frequency varies within 300 MHz to 300 GHz. Microwave heating is caused by the ability of the materials to absorb microwave energy and convert it into heat. Microwave heating of food materials mainly occurs due to dipolar and ionic mechanisms. Water content in the food material causes dielectric heating due to the dipolar nature of water. Microwave blanching can be carried out for color retention and enzyme inactivation which is carried out by immersing food materials in hot water, steam or boiling solutions containing acids or salts. Microwave drying is used to remove moisture from fish and fishery products. Microwave drying has advantage of fast drying rates and improving the quality of product.

### Ohmic heating:

Ohmic heating is an emerging technology with large number of actual and future applications. Ohmic heating technology is considered a major advance in the continuous processing of particulate food products. Ohmic heating is direct resistance heating by the flow of an electrical current through foods, so that heating is by internal heat generation. Ohmic heating have a large number of actual and potential future applications, including its use in blanching, evaporation, dehydration, fermentation, extraction, sterilization, pasteurization and heating of foods.

### High pressure processing:

High pressure processing (HPP) is an emerging and innovative technology that has a great potential for extending the shelf-life with minimal or no heat treatment. It is also effective in preserving the organoleptic attributes of many foods. High pressure Processing is a non-thermal technology in which the food product to be treated is placed in a pressure vessel capable of sustaining the required pressure and the product is submerged in a liquid, which acts as the pressure transmitting medium. Water, castor oil, silicone oil, sodium benzoate, ethanol or glycol may be used as the pressure transmitting medium.

## High value products from fishery waste

Huge quantity of waste is generated while handling and processing of fish and fishery products, which is threatening environment and public health. This can be used for producing high value compounds of importance to agriculture, animal feed, nutraceutical and pharmaceutical products. These include fishmeal and oil, fish silage, fish feed, chitin, chitosan, glucosamine hydrochloride, squalene, foliar spray, fish calcium, animal feed from cephalopod waste, gelatin etc. All these technologies offer entrepreneurship and industrial development opportunities.