

Value Addition of Fishery Resources

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Introduction

The popularity of fish and fishery products in the domestic, as well as the international markets, is increasing day by day at a greater pace. Fish is considered as a superfood for humans because of its high-quality protein content, n-3 polyunsaturated fatty acids (PUFAs), minerals, vitamins, and other trace elements. **It is recommended to consume fish at least two times per week as part of a healthy diet. Apart from the nutritional and health benefits it offers, it plays an important role in building the economy as it is** one of the most traded commodities and a regular food item in the diet of a large population. To reach customers around the world, product diversification and adoption of international flavours preferably ethnic are of great importance. Better utilization of the available fishery resources especially underutilized catches can be attained by adding value which increases the utilization in an improved way by modifying the products in a convenient manner as demanded by the consumers.

Value addition is the enhancement added to a product before it is offered to the customers. It can be defined as “any additional activity that changes the nature of the product which leads to an increase in price at the time of sale”. The category of value-added products includes ‘Ready to Eat’, ‘Ready to Cook’, ‘Ready to Fry’, ‘Thaw and Eat’, ‘Heat and Serve’, retail raw branded products, fishery pharmaceutical, and cosmetic products of high unit value in the export market. These products are gaining wide acceptance as modern customers prefer convenience products mostly ready-to-cook foods and of course due to the increasing trend of fast food gastronomy. Adding value to a product can be achieved through improving the existing market forms of the products, processing convenience food, and developing functional foods. Innovative products with multiple formats or shapes or dimensions, flavours, texture profiles, and new packages will attract customers without any difficulty. The process of value addition is of greater use because it increases the production and productivity, enhances the shelf life of the products, improves the safety of the food, reduces wastage and discards of the fishery resources, increases the utilization of all kinds of available fishery resources, satisfying the changing customer needs and demands, product and market diversification and better income through the sale of the products. Different categories of such value added products from fishery resources are discussed in this chapter.

Different product styles of fish

Raw and processed fish are marketed in different appearances, shapes, dimensions, and formats for attracting customers, convenience, and for the intended use. Chilled, frozen, and cooked fishes are available in a variety of such product styles in the modern market. A few examples of such product styles of finfishes are cleaned whole fish, drawn fish (only the entrails removed), dressed or pan-dressed fish (fins, head, and tail removed), steaks, fillets, sticks, butterfly style (dorso-ventral cut), chunks, cubes, etc. A few examples of the product styles of shellfishes are peeled and deveined shrimp, peeled, cooked and tail-on shrimp, headless

shrimp, shrimp head on (centre peeled), shrimp head on cooked (centre peeled), barbecue shrimp (beheaded, deveined, peeled with a bamboo stick pierced into the meat from head to tail portion), sushi (cooked butterfly shrimp), skewered shrimp (4-5 shrimps are arranged in a skewer in an inverted “U” shape), squid tubes, squid rings, live lobster, frozen lobster tails, whole lobster frozen or chilled, whole cooked and frozen lobster meat, whole or shucked molluscs, etc.

Chilled fish products

Chilled fish is an important value-added product that dominates the market in terms of revenue. Chilling is the most widespread and effective primary preservation method used for the short-term preservation of fish. The ice and fish are packed in alternative layers in the ratio of 1:1 (fish: ice, w/w) or the temperature is lowered by keeping the fish in slurry ice. The temperature is lowered near to 1 to 4⁰ C which aids in preservation by arresting all enzymatic changes that take place inside the fish, killing mesophilic bacteria and inhibiting the growth of all spoilage bacteria. Chilling should be done quickly as possible after the harvest of the fish to get high-quality end products. The most common type of ice used is flake ice or crushed block ice. Prime quality chilled fishes usually fetch more price than frozen fish. The shelf life of the fish stored in a chilled condition depends on the shape, size, fat content, skin characteristics, etc. Round, small fatty fishes with thin skin will spoil faster compared to large, flat, lean fishes with thick skin. Generally, lean fishes will have a shelf life of 12-16 days, fatty fishes 5-8 days, prawns 8-10 days, and cephalopods 4-8 days. The application of modern packaging techniques such as vacuum packaging, modified atmospheric packaging, and active packaging considerably increases the shelf life of chilled fish products. Chilled sashimi grade tuna from bluefin, bigeye, and yellowfin tuna is a major delicacy in the international market. Other than raw fish, chilled processed fish products like smoked and marinated fishes are also available in the market.

Frozen fish products

Freezing is known as a modern method of preservation intended for the long-term preservation of fish at low temperatures. It is considered as a gentle method as the organoleptic qualities of the properly stored frozen fish are as good as fresh fish. During the process, the water in the fish is separated out from other food components and converted into ice. The water in fish flesh begins to freeze at about -1 °C. As the temperature drops below -1 °C, more water is frozen out and the concentration of salts in the remaining water rises so that its freezing point is lowered further. The ideal condition for fish to be frozen is -30 °C for 2 hours. Frozen fish fillets and steaks are popular in domestic markets whereas block frozen fish and individually quick frozen (IQF) fish play a major role in the international markets. In IQF technology, the fish is frozen individually in the highest quality possible. Moisture-proof thermoform moulded trays are best for such products to store at -30 °C. IQF Head on/Headless/Butterfly cooked/Blanched shrimp, IQF tray packed shrimp, IQF peeled Tail-on cooked shrimp, IQF marinated shrimp, Skinless and boneless fish fillets, IQF cooked/blanched squid/cuttlefish, Stuffed squid IQF tray packed, IQF tray packed lobster meat, whole cooked lobster, lobster tails, lobster meat, squid tubes, squid rings, fan tail, and round tail-on shrimp, stretched shrimp (Nobashi), skewered shrimp, boiled clam meat, etc. are few examples of frozen fish products popular in the market. The expected shelf life of frozen fish is 9 months to 2 years. Plate

freezing, air blast freezing, and cryogenic freezing are the other methods of freezing widely accepted by the industry.

Ethnic Fish Products

As fish is a highly perishable commodity preservation by various means is of utmost importance to extend its shelf life. A major portion of fish is consumed as fresh but still, a considerable portion is preserved. This will help to make the availability of fish in lean periods. Preservation helps to keep the fresh fish edible for a longer period of time. There are many age-old, region-specific practices to preserve the fish that include drying, salting, smoking, marination, and fermentation. All these traditional fish preservation techniques follow centuries-old indigenous knowledge of processing together known as curing methods. The customer demand for ethnic flavours and cuisines is ever increasing due to market expansion, globalization and hence they are upgraded as specialty food products.

Dry fish products

Drying is one of the widely used, oldest, and cheapest method of fish preservation in which the moisture content of fish is removed by evaporation to arrest microbial and enzymatic spoilage. Dried fishes with and without salt are popular in domestic markets as well as in overseas markets. In India, around 17-20 % of the total fish catch is converted to dried products. Fish drying can be done by natural and artificial means. Natural drying or sun drying is the process in which fishes are dried under sunlight. Here solar energy is used to evaporate the water in fish. Generally, fishes are suspended in bamboo poles or any other support or laid out flat on the open ground for getting dried. In artificial drying or dehydration, the fish is dried mechanically in an enclosed atmosphere under a controlled condition, unlike natural drying where we have no control over the environmental condition. At present, solar drying is of great demand, in which energy of the sun is collected and concentrated to produce optimum temperature for drying the fishes. The fish can be dried hygienically in solar driers without any energy cost even when the relative humidity is high. One simplest model is a solar tent drier. Solar driers with electrical backup, LPG backup, etc. are available in markets. The ideal temperature for fish drying is 44-55 °C. There is high demand for spiced and dried products, flavour incorporated products, coated and dried products in the modern market. Entrepreneurs are attracted to this business as it is highly profitable that requires less sophisticated machinery and storage facilities. The dried products can be stored in dry conditions at ambient temperature for a minimum of six months if properly dried and packed.

Salted fish products

Salting is a method in which common salt (sodium chloride) is used to preserve the fish. Salting is practiced as such or in combination with drying or smoking. The penetration of salt into the fish tissue removes the water inside, thus reducing the water activity which will help to inhibit spoilage by bacteria. Along with this, enzymes also get inactivated which further delays the spoilage. Generally, small-sized fishes are salted directly without removing head, fins, and entrails, unlike large and medium-sized fishes. For attaining proper salting and drying, the fish can be cut to butterfly-style, small pieces or scoring can be done to increase the surface area. Layer salting is preferred for medium and large-sized fishes whereas small-sized fishes can be salted by dip treatment for uniform penetration of salt through flesh. Fish to salt ratio for layer salting is in the range of 2:1 to 10:1 for big to small-sized fishes. Dip treatment can be done for 5-10 min in a 5 % brine solution.

Smoked fish products

Smoking is a very popular method of fish preservation, especially in the North-eastern states of India. Smoked fishes are known for their unique aroma, texture and its golden yellow colour imparted by wood smoke. The characteristic colour and flavour are imparted by the phenolic compounds present in the smoke. Heavily salted fishes were used to smoke for a longer period of time to get 'Hard cures'. This method combines salting, drying, and preservation by smoke components produced during the thermal breakdown of wood. Smoking of fish is usually done as an intermediate step in fish canning also. There are two categories of smoked products available, cold smoked and hot smoked products. Cold smoked products are usually made in traditional chimney kilns by smoking the fish for 36-72 hours at a temperature maximum of 40 °C. The fish is smoked and dried at 75 °C -80 ° C in case of hot smoking, unlike cold smoking this high temperature gives cooking partial sterilization effect on fish flesh. More conveniently, commercially available liquid smokes can be used to impart the aroma to fish products. Masmin of Lakshadweep is a very popular smoked fish product.

Marinated fish products

The value of fresh, frozen, salted, and dried fish can be increased by the process of marinating it with spices, sugar solutions, oil, plant extracts, acids like vinegar, fruit juice, and wine to enhance the flavour, tenderness, juiciness and also to extend the shelf life. These products are attracting customers because of their typical flavour and textural properties. Traditionally, acetic acid and salt were used for the marination process. Marinades are semi preserves, in which acetic acid inhibits microorganisms, giving characteristics succulence and tenderness. The addition of acid will favour the action of proteolytic enzymes and partial breakdown of protein into amino acids. The addition of salt aids in the extraction of salt out from the fish tissues and helps in coagulation of protein. The addition of plant extracts, spices, sauce, cream, oil, mayonnaise, etc. can increase the flavour and shelf life of marinades further. There are three types of marinades. Cold marinades or 'marinade proper', as the name indicates the process does not involve any heat treatment of fish or ingredients used. The entire processing and further storage take place at a temperature of 10-12°C. The product is having a shelf life of several months at chill storage. Cooked marinades or 'jellied products' are generally packed in a jelly. Here acid-salt treated fish is further heat treated for better preservation. Low pH is maintained to avoid harmful bacteria, especially *Clostridium botulinum*. The shelf life of such products is 6 months. In the case of fried marinades, the pre-treated fish with acid and salt is baked or broiled in oil with or without breading. Then this can be immersed in acetic acid or sauce. Higher temperature inhibits the growth of most bacteria. The shelf life can be up to one year if properly stored at 0-8 °C.

Fermented fish products

Fermented fish products are mainly popular in north-eastern states in India. They are upgraded as specialty fish products because of their unique aroma usually described as umami. Fermented products have a meaty flavour and they are rich in nutrients. The process of fermentation is an age-old practice of fish preservation in which complex protein molecules in the fish are broken down into simpler molecules by the action of organic catalysts, enzymes, or ferments which are stable at normal temperatures of storage. The method is suitable for both freshwater and marine fishes. Fermented products are of three distinct types, products in which

fish retains its original form e.g. cured fish, products in the form of paste, and products in the form of liquid that is fish sauce.

Fish pickle

Fish pickle is a widely accepted ethnic product commercially and a common product in households. Pickling is also a curing method in which edible products are preserved through anaerobic fermentation in brine or immersion in acid with spices. People relish this spicy adjunct with sour flavour as a food accompaniment to make the food palatable and appetizing. Vinegar is the preservative and flavouring agent used in fish pickles. Acetic acid aids in preservation by restricting the growth of spoiling microorganisms. Vinegar pickles are known as fresh pickles or quick pickles. The added salt in the pickle can actually add flavour to it, helps in extracting the excess water from fish, unlocking the flavourful juices, concentrating the juices, and ultimately gives a firm texture to the fish meat. The oil content in the pickle seals off the air from the pickle which helps to enhance the shelf life. The flavour can be improved by adding seasonings. The process of pickling enhances the shelf life to six months and more. Any fleshy fish can be used for preparing fish pickles like tuna and seer fish. It is important to maintain the pH of fish pickles below 4.5 to reduce microbial activity.

Mince based products

Mince is the edible fish meat that is separated from the inedible portions like the scale, skin, fins, and bones. It can be prepared by manual hand picking or by mechanical deboning technique. The fish mince serves as an intermediate stage for the preparation of a variety of value-added products. The fish mince devoid of inedible portions is consumer friendly in usage. Low value fishes with white meat are mainly preferred for the preparation to increase the utilization and demand of such resources by adding value to it. Fish mince-based products available in the market include fish sausage, fish sandwich spread, fish wafers/crackers, fish cookies, momos, papad, spring roll, samosa, fish flakes, fish spirals, etc.

Extruded products

The process of extrusion is one of the popular methods of processing wherein soft mixed ingredients are forced through a perforated die designed to produce products of the required shape, size, and texture. There is a greater demand for snacks and ready to prepare products in the market. In the process, small granular food or powdered particles are reinforced into large pieces. The process of Extrusion cooking or thermoplastic extrusion is considered as a High-Temperature, Short-Time (HTST) process, used mainly for developing cereal-based products rich in calories. The nutritional value of such products can be further increased by the addition of protein rich fishes. During the process material fed into the extruder gets compacted, softens, gelatinized, and/or melts to form a plasticized material. The combined effect of high temperature and mechanical shear causes gelatinization of starch and denaturation of protein. The technology is used to develop pasta, crackers, baby food, snack foods, dried soups, dry beverage mixes, etc. The utilization of low-value fishes can be enhanced through this technology to develop products stable at ambient temperature like fish kure.

Battered and Breaded Products

Battered and breaded products are convenient products of greater demand in which meat protein component is covered by a cereal-based coating. These products are also called as enrobed products or coated products as one food material is coated with another stuff. A coating is referred to as the batter and/or breading adhering to food after cooking. The external

coating forms a stable crispy layer retaining most of the sensory and nutritional quality of the fish product. Coating by battering and breading enhances the appearance, colour, flavour, texture, and nutritional value of the product. It also acts as a moisture barrier by minimizing moisture loss during frozen storage and microwave reheating. It seals the flavour in the product by acting as a sealant that prevents natural juices from flowing out. Wet coatings are referred to as batter. The batter is basically made from wheat flour or corn flour. Coating ingredients generally include polysaccharide, proteins, fats and hydrogenated oil, seasonings and water. A typical ratio of the batter mix to water is 1:2. There are three types of batter. Adhesion batters are mainly starch based that designed to adhere to the product whereas cohesion batters are mainly flour based which forms a shell around the product. Tempura batter is starch/flour based with a raising agent (sodium bicarbonate) for a puffy appearance, usually not followed by breading. Wide variety of bread crumbs are also available in the market like reclaimed and industrial bread crumbs. Deep fried coated products are ready to eat products, it can be par-fried/flash fried for storage (30 second at 190 °C) to cement the breading. The shelf life of stored products under frozen storage is 9-24 months. Fish finger, cutlets, balls, nuggets, coated shrimp, coated squid rings, coated bivalve products, coated fish fillets etc. are the most commonly available form of battered and breaded products. Coated Nobashi is a high value specialty product made from shrimp, literally means stretched shrimp. Nobashi is peeled, deveined tail on shrimp stretched by mechanical means. The length can be increased by about 1-2 cm depending on the size of the shrimp by making parallel cuttings at the bottom and applying pressure using simple mechanical devices. During the coating process, the product will have more pick up due to increased surface area and attract customers because of the aesthetic appearance.

Surimi based products

Surimi is a Japanese term for water washed fish mince. The fish mince devoid of any pigments or blood stains has excellent keeping quality with the added cryoprotectants. It is defined as mechanically deboned fish mince from white fleshed fish that has been washed, refined, and mixed with cryoprotectants for better frozen shelf life. The washed mince will be white in color and have a unique texture that often provides a viscoelastic nature to the end product. Surimi- based products form an important dish in Japanese cuisine. Due to its high gel strength, it is used as an intermediate product used for the preparation of a wide variety of value-added products. Most commonly white fleshed fish with very less fat content is chosen for the product preparation. Analogue products or “imitation products” or “fiberized products” and moulded products like fish ball form an important category under surimi-based products. These products are prepared to mimic the texture, flavor, and appearance of shrimp, crab or scallop even when they are prepared from the commonly available fish from the market. This involves the use of sophisticated technology for preparation and has not gained much popularity in the Indian market. Surimi-based products are popular in developed countries. Kamaboko is a traditional Japanese product prepared from surimi. It is a steamed cake made out of surimi. This product it is known by different names according to the regions of production, ingredients used, cooking method, and shape of the product. Chikuwa is broiled kamaboko in the shape of bamboo. Steamed Kamaboko is called Sumaki or Mushiita. Fried kamaboko is called Tempura or Satsuma Age. Hampen is boiled kamaboko in a square shape.

Canned fish products

The growing popularity of safe packed seafood with enhanced shelf life has fueled the demand for canned fish globally. Canned fish products are ready to eat products. The process of canning or retorting is high temperature long term preservation method in which the food is preserved by the application of heat in a hermetically sealed container to obtain commercial sterility. The filling medium usually used in cans is oil or light brine. The double sealed robust cans maintain sterility throughout the storage period at ambient temperature. Canned tuna, herring, mackerel, and sardines are popular in the markets. Instead of metal cans, now canned products are more common in retort pouches. 3-ply laminated flexible pouches consist of polyester/aluminium/cast polypropylene is widely in use. Canned sardine in oil, tuna chunks in oil and brine, tuna flakes in oil, fish curry, etc. are a few examples of products available in the markets. The expected shelf life of canned fish is minimum one to two years.

Accelerated freeze dried products

Accelerated freeze drying is a novel technology of food preservation in which water from the frozen product is removed by the process of sublimation under vacuum. The method is expensive and finds easy acceptance in the case of high value food products. Properly processed freeze-dried products are comparable with the fresh material in case of flavour, colour, and nutritive value as there will not be product shrinkage, case hardening, thermal degradation of proteins, deteriorative changes in color or flavor and products will get rehydrated rapidly. Further, freeze dried products can be stored under ambient storage conditions without any additional cost for storage and it is convenient to use. The reported shelf life of freeze-dried products is more than two years. Instant fish soup mixes, prawn cakes, pre-cooked ready to serve salads are some products prepared using this technique having consumer acceptance. In India, freeze drying is employed for processing shrimp, squid rings, etc.

Seaweed incorporated products

India aspires to expand seaweed production to at least one million tonnes by 2050 considering the enormous potential of seaweed farming that can contribute to the blue revolution. Seaweeds getting more attention because of their nutrient reserves such as protein, essential amino acids, fibre, iodine, vitamin K and compounds having antioxidant and anti-inflammatory properties, such as polyphenols. Seaweeds are healthy, nutritious, and low-caloric food with low lipid content, rich in ω -3 and ω -6 polyunsaturated fatty acids making them an important food component in the diet at the present time. They are considered as an important part of food, animal feed, and fertilizers. Seaweed based snacks, cookies, biscuits, burgers, nutridrinks, fish soup enriched with seaweed bioactive compounds are novel products with high market potential. Sulphated polysaccharides with bioactive properties can also be extracted from seaweed.

Live Fish

There is a greater demand for live fish for food purposes and it usually fetches a high price as the freshness is ensured in the marketing. Consumers often demand smaller and medium-sized fishes in live form. Grouper, snapper, seabreams, seabass, red tilapia, reef fishes, air-breathing fishes, shrimps, lobster, crabs, clams, oysters, and mussels are examples of candidate fishes for live fish transport. Live fish trade of high-value fish is a lucrative business nowadays as it gives huge profit to the business. But the high rate of mortality of fish during

transport is a big challenge in the trade. The ways to improve the survivability of fish to be standardized for a continuous supply of fresh live fish to the consumers.

Speciality products from secondary raw materials

The term “fish wastes” in general indicates the non-edible portion of fish which includes the head, skin, bone, scale, visceral mass, and trimmings. Besides, fish species having mere or no market value, under-sized fishes as well as spoiled or physically damaged fishes will also be added to this category. By considering the potential for recycling, the term “fish wastes” has been replaced now as “rest raw material” and “secondary raw material”. These waste materials are having potential for recycling as they are good sources of high-quality protein, minerals, fat, etc. and thus they are important sources of different secondary products. The technology has a huge scope, as developed products can be used for human consumption, animal nutrition, and agricultural applications. Different secondary products such as fish meal, fish oil, squalene, collagen, gelatin, chitosan, hydroxyapatite, proteolytic enzymes, pigments, calcium, fish protein concentrate, etc. are of high value having wide acceptance market including the food industry.

Conclusion

Owing to the rich nutritional and health benefits, the demand for fishery products is on an increasing trend globally. The flow of new entrepreneurs with novel value-added seafood products all over the world makes the seafood processing and marketing sector more competitive every day. Value addition of the fishery resources is the pressing priority to utilize the available potential resources sustainably to increase profit without losing it. The modern market demands healthy, nutritious, and tasty convenient products. The value addition of fishery products has immense potential to uplift the livelihood of the stakeholders involved by expanding the array of products available in the markets.