Value addition of seafoods

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Abstract

A large number of value added and diversified fish products both for export and internal market based on shrimp, lobster, squid, cuttlefish, bivalves, farmed fish and minced meat from low priced fish have been identified. A brief description of a few of such products, the technology for their production is readily available, is presented. The need to adhere to upgraded international quality yardsticks such as the EU Standards, requirements of HACCP and ISO-9000 series in fish processing establishments is stressed.

Keywords: *Value addition, Seafood, EU Standards, HACCP, ISO-9000, IQF*

1. Introduction

The health benefits associated with fish consumption have resulted in a favourable consumer image for fish products. As the nation changes gear into a high state of development, new requirements and needs in life, especially in the food style are emerging. Inevitably, there occurs a higher demand in quality and nutrition and obviously people look forward to 'freshness' in processed foods. Upgraded international quality yardsticks such as the EU Standards, requirements of HACCP and ISO-9000 series are internationally being adopted in fish processing establishments. Therefore, it becomes apparent that care in processing has to start right from the point of catch and continue through each step of subsequent handling and processing.

The world seafood-processing scenario is undergoing rapid changes. One particular phenomenon observed in the consumer market is gradual disappearance of the conventionally processed products and their emergence in new styles and forms. The sophisticated consumer abroad and the urban consumer at home demand a new type of hygienically prepared, nutritious and attractively packed ready-to-eat or ready -to-cook convenience products. There are several factors, which influence this demand. The increasing affluence and the consequent changes reflecting in the eating habits, particularly in the west have resulted in the demand for diversely processed value added 'convenience' fish based products. There is also an increasing trend of eating away from home and this has triggered the growth of fast food trade serving value added fish based products. There appears to be a good potential for India to increase its share in international fish trade by exporting value added fish products.

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It is a recognized principle that the development of export market should have the backing and support of a strong domestic market. The rapid industrialization and the consequent urbanization of rural India provide ample scope for development of such markets. Increasing number of workingwomen, shrinking family size, education and general consciousness about hygiene and health are other favourable factors. A large number of value added and diversified fish products both for export and internal market based on shrimp, lobster, squid, cuttlefish, bivalves, farmed fish and minced meat from low priced fish have been identified. The technology for their production is readily available. A brief description of a few of such products is given below

2. Battered and Breaded Products

Food technologists all over the world are focusing much attention on the development of products that are convenient to the consumer while maintaining high standards of quality. Battered and breaded products are included in this developmental effort because of their diversity and appeal. Battered and breaded products offer a convenient food valued widely by the consumer. Meats, fish, vegetables, fruits and cheese are coatable materials, which are commercially prepared on various forms. Many products are coated and immediately frozen, or they may be pre-fried, and then frozen for distribution and sales to consumers and food service establishments. They can be quickly reconstituted by conventional heating methods. Some products are designed for reheating in microwave ovens.

Battering and breading enhance food product's appearance and organoleptic characteristics in addition to improving its nutritional value. Coating acts as a moisture barrier, minimizing moisture losses during frozen storage and microwave re-heating. The most important function of coating is value addition by increasing the bulk of the substrate thereby reducing the cost element of the finished product.

There are several ingredients used in the formulation of coatings. Each ingredient performs its functions to contribute to the unique characteristics and functionality of coatings. The commonly used ingredients fall under five categories. They are polysaccharides, proteins, fats, seasonings and water. Besides small quantities of leavening agents, gums, spices, colour etc. may be added to provide specific functional effects.

There have been a number of interesting developments in coating technology during the past decade, many of which have originated from the USA although the Japanese industry is said to be more innovative than its US or UK counterparts. Probably one of the best-

known coatings to come from Japan is the 'tempura' or puff type specialty batter. These batters provide coatings of exceptionally high volume, which are also light in texture.

Another innovative coating to originate in Japan, but which was subsequently developed in the USA is the aptly named 'Japanese crumb'. Japanese-style breadcrumbs are manufactured in a variety of different flavours and colours.

Most coated products are now available with a three-way cook option. They can be baked in a conventional oven, prepared under the grill or fried. The hunt is now on for coatings, which are suitable for use in a microwave oven.

A coated food product is one, which is coated with another foodstuff .Two types of coatings are in common use. They are batter and breadcrumbs.

Batter is a fluid mixture of water, flour, starch and seasonings. Batters are of two types: adhesive and tempura.

Adhesive batter acts as a bond or interface between the substrate and subsequent coating. The primary purpose of batter is to increase crumb adhesion to the product. The formulation and viscosity of adhesive batters determine the amount of coating pick up. The thicker the batter (higher viscosity) the more crumbs will be picked up by the products. Consistent batter viscosity is required to produce uniform coated products. These batters are pumpable, and are suitable for continuous mixing. The batter should be kept cool to avoid the growth of microorganisms. Pre-chilled water should be used for mixing the batter where automatic temperature control is not available. When the batter temperature increases the viscosity falls and the batter will not stick to the substrate. However, if the batter temperature is very low and the fish to be coated is at a very low temperature, then the batter freezes on the conveyor belt. Tempering the frozen fish prior to battering will help to overcome this problem.

Tempura batters are referred to as puff or leavened batters. Wheat and corn flours play an important role in this system chemically leavened the batter itself can serve as the outside coating of the food and thus requires visual and structural qualities more complex than those of the interface/adhesive batter. Because of the leavening action of these batters they cannot be pumped with out substantial loss of the leavening gas (carbon dioxide). The wider use of tempura batter in conjunction with coarse crumbs represents a new coating process evolving into a major product line arrangement.

The term 'breading' is a general or descriptive term that covers a wide range of cereal based food coating. A breading is defined as a dry mixture of flours, starch and seasonings, coarse in nature and applied to a moistened or battered food product prior to cooking. The main ingredients used for batter mix and breadcrumbs are more or less same but the manufacturing techniques employed are different. Most breadings are developed using certain variations of established baking techniques.

Breadings may be identified by their functional characteristics when applied to a substrate. The major functional characteristics of breading are mesh size, area to volume relationship, browning rate, moisture absorption, oil absorption, colour and texture.

Breading types: A wide variety of breading materials is available in different size grades and colours. They can be used alone or in combination with other types of crumbs. Important crumbs are Cracker meal/Traditional breading, Home-style breadcrumbs, Japanese style crumb, Extruded crumbs *etc.*

Frying medium: Fat is the frying medium. Some fats may have specific flavour, which may be carried over to the product. Fat, besides being the heat transfer medium, is also a food ingredient and will influence the eating quality. Usually bleached and refined vegetable oils are used for frying.

The fat, because of the high temperature it is exposed to, may become degraded due to oxidation, polymerization and contamination by food particles. Therefore, the fat used should be tested for evaluation of quality by determination of its free fatty acids, smoke point, peroxide value as well as colour for all of which there are prescribed standard limits.

The production of battered and breaded fish products involves several stages. The method varies with the type of products and pickup desired. In most cases it involves seven steps. They are portioning/forming, pre-dusting, battering, breading, pre-frying, freezing and, packaging and cold storage.

2.1 Processing of some coated fish and fishery products

• Fish finger or fish portion

Fish fingers, or portions or sticks are regular sized portions cut from rectangular frozen blocks of fish flesh. They are normally coated with batter, and then crumbed before being flash fried and frozen. They may be packed in retail or catering - size packs.

The typical British fish finger normally weighs about 1 oz (28 g) of which up to about 50 of the total weight may be batter and crumbs. Food Advisory Committee of the UK government has recommended a minimum fish content of 55 % for battered and 60 % for the fingers coated with breadcrumbs.

Fish blocks are the most common starting material for battered or breaded fish portions and sticks. The use of fish blocks has risen dramatically over the last 10 - 20 years. Fish blocks are boneless fillets placed together into a frame, compressed slightly and frozen to form a solid block of fixed dimensions. The blocks are convenient to store, ship and handle. A very common $16^{1}/_{2}$ lbs fish block is $18^{7}/_{8}$ inches long, 10 inches wide and 2 $3/_{8}$ inches thick. On the production line, the blocks are subdivided by a series of band saws and a subsequent chopper. The band saws determine the portion thickness, while the chopper cuts the portions into the desired width and shape. The most common shapes are square, rectangular, wedge and French cut. As the industry expanded, mince or fish flesh recovered by means of a bone separator, was added back in to the block. Some blocks, particularly those used for catering products are made with high proportion of mince, even up to 100 %. Studies have indicated that fingers can be made from different white-fleshed varieties of low cost fish.

- **Shrimp products**

Battered and breaded shrimp can be prepared both from wild as well as from farmed shrimp in different styles and forms. The most important among them are butterfly, round tail-on, peeled and deveined (PD), nobashi (stretched shrimp) etc. The products from farmed shrimp have indicated longer shelf life, 16-18 months compared to those from wild variety 12-14 months at -20 °C.

- ***Squid products:*** Squid rings and stuffed squid are the popular coated products processed out of squid. Cleaned squid tubes are cut in the form of rings of uniform size, cooked in boiling brine (3 %) for 1-2 minutes followed by cooling, breading and battering. The coated rings are flash-fried, cooled, frozen and packed. Stuffed squid is generally processed out of small size animals. The cleaned tubes are filled with a stuffing mixture prepared using cooked squid tentacles, potato, fried onion, spices etc. It is then battered, breaded and flash-fried.
- ***Clam and other related products:*** Meat shucked out from depurated live clams after boiling is blanched in boiling brine, cooled, battered, breaded, flash-fried and packed Other bivalves such as oyster, mussels etc. can also be converted into coated products by the same method.

- ***Fish fillets:*** The brined fillets are battered and breaded. Fillets from freshwater fish are also used for the production of coated products. The only problem noticed in this case is the presence of fin bones; its complete removal is still a major hurdle.
- ***Mince based products:*** Fish mince from marine as well as freshwater fish can be used for processing a variety of coated products such as fish cutlets, burgers, balls etc.
- ***Fish cutlet:*** Cooked fish mince is mixed with cooked potato, fried onion, spices and other optional ingredients. This mass is then formed into the desired shape, each weighing approximately 30 g. The formed cutlets are battered and breaded.
- ***Fish burgers:*** More or less similar to fish cutlets, burgers are made using mince of lean white fish and are only mildly flavored. Cooked mince is mixed with cooked potato and mild spices and formed into burgers using forming machine. Burgers are battered, breaded and flash-fried before packing and freezing.
- ***Fish balls:*** Fish balls are generally prepared from mince of low cost fish. Balls can be prepared by different ways. The simplest method is by mixing the fish mince with starch, salt and spices. This mix is then made into balls, cooked in boiling 1 % brine. The cooked balls are then battered and breaded.
- ***Crab Claw Balls:*** Swimming legs of crab may be used for this purpose. Crab claws are severed from the body, washed in chilled portable water and the shell removed using a cracker. The leg meat is then removed and then mixed with 2 % starch based binder and this is stuffed on the exposed end of the claw. Alternatively the body meat mixed with the binder also can be used for stuffing. The stuffed claw is then frozen, battered and breaded and flash fried. The coated products are packed in thermoformed containers with built in cavities

3. Individually quick frozen products (IQF)

Radical changes have taken place in the freezing set up of fish and fishery products over the years. An important improvement in freezing prawns is the shift from the conventional block frozen to the individually quick frozen products. With advent and spread of aquaculture for shrimp, in particular, individual quick-freezing has become very popular. Farmed prawn has the advantage of harvesting at a predetermined period and hence can be frozen in the freshest possible condition. Because of this most of the farmed prawn is frozen as whole IQF. Lobsters, squid, cuttlefish, different varieties of finfish are also 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 needs 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. Thermoform moulded trays have become accepted containers for IQF products in western countries. Utmost care is needed during the transportation of IQF products, as rise in temperature may cause surface melting of the individual pieces causing them to stick together forming lumps. Desiccation leading to weight loss and surface dehydration are other serious problems met with during storage of IQF products.

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.

4. Accelerated freeze-dried products

Accelerated freeze-drying is now being increasingly used for the preservation of high value food products. In this process the product in frozen condition is subjected to very high vacuum causing the ice crystals to sublime. The product has the advantages like absence of shrinkage, quick re-hydration up to 95 %, minimum heat induced damage etc. In India this technique is now applied for processing shrimp, squid rings etc. The possibilities for various ready-to-eat products based on fish and shellfish employing this technique are immense.

5. Heat processed products

Tremendous development has taken place in canning industry especially in the design and development of containers, canning equipment and nature and type of the products. Some of the containers of recent origin are retortable pouches, rigid plastic containers, aluminium cans, drawn and wall ironed (DWI) as well as drawn and redrawn (DRD) cans made of tinplate, easy-open cans with ring or pull tabs. Heat processing of retortable pouches, heat sealed plastic containers as well as easy-open cans with pull/ring tabs is carried out in over pressure autoclaves of which many models are now available. Employment of hydrostatic cooker-sterilizer for high temperature heat processing, short time process etc. are other innovations in the field of equipment/machinery for heat processing seafood.

The product mix up in the heat-processed category of seafood includes several 'convenience' ready-to-serve products such as fish curry, fish-in-rice etc. These products can conveniently be processed in retort pouches using an over-pressure autoclave. Because of the smaller cross sectional profile of retort pouches such products need to be maintained only for a shorter time in the retort and hence temperature induced changes on the quality parameters of the product will be minimum.

6. Fish mince and mince based products

Minced meat is the meat separated from fish in comminuted form free of bones, skin etc. In principle, meat separation process can be applied to any species of fish, but when it is applied to low cost fishes significant value addition will accrue. Flesh can be separated from filleting waste also. Minced meat can be used as a base material for the preparation of a number of products of good demand. The properties of minced meat to a large extent are determined by the nature and quality of raw material. Meat-bone separators (meat picking machines) are generally used for the preparation of minced meat.

• Mince based products

Minced fish can be used for the preparation of a number of products like fish sausage, cakes, cutlets, patties, balls, pastes, surimi, texturised products etc. The processes for the production of most of these products are available and some of them are very much suitable for starting small-scale industries.

• *Surimi*

Surimi is a Japanese term for mechanically deboned fish flesh that has been washed with water and mixed with cryoprotectants for good frozen shelf life. 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.

• *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 includes 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 the greatest in 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 are 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.

7. Frozen fish fillets

Skinless and skin on fillets from lean/medium fat white meat fish have enormous market potential. Many varieties of deep sea fishes such as grouper, red snapper, reef-code, breams and jewfish are suitable for making fillets both for domestic market and export to developed countries in block frozen and IQF forms. In the importing countries these fillets are mainly used for conversion into coated products. Fish fillets can also be used for the production of ready to serve value added products such as fish in sauce and fish salads.

8. Chilled fish

Chilled fish is another important value added item of international trade. The most prominent among this group is sashimi grade tuna. Sashimi is a Japanese term for raw fish fillets mainly from tuna and it is a traditional delicacy in Japan. Two species, Blue fin and Big eye are mainly used for this purpose. The best quality sashimi tuna is that which is chilled at all stages from capture to final consumption. Other important products of this group are pomfret, shrimp, lobster and crabmeat.

9. Stretched shrimp (Nobashi)

Increasing the length of peeled and deveined shrimp and minimizing its curling by making parallel cuttings at the bottom and applying pressure using simple mechanical devices is a new technique adopted by the seafood processing industry in recent years. Increasing the length by about 1 - 2 cm depending on the size of the shrimp is possible by this method. The stretched shrimp will have better appearance compared to conventional PD shrimp and it also fetches

higher unit price. The stretched shrimp because of its increased surface area will have more pickup of coating during battering and breading and also good appearance.

Shrimp is washed in chilled water containing 5 ppm chlorine, beheaded, deveined, using bamboo stick and pealed keeping the last segment and tail intact. The tail is then trimmed and the shrimp is stretched using a metallic stretcher after making 2-3 parallel cuttings at the bottom side. Stretched shrimps are then packed in thermoformed trays under vacuum and frozen at –40 °C.

10. Barbecue

Shrimp is washed in chilled water containing 5-ppm chlorine, beheaded, deveined, peeled and again washed in chilled water. Bamboo stick is then pierced into the meat from head portion to tail. It is then packed in thermoformed trays under vacuum and frozen at –40 °C.

11. Sushi (Cooked butterfly shrimp)

Shrimp is washed in chilled water containing 5-ppm chlorine, beheaded, deveined and again washed in chilled water. Bamboo stick is then pierced between the shell and the meat from head portion to tail and then cooked in 1 % brine for two minutes at 100 °C. The cooked shrimp is then cooled in chilled water, bamboo stick removed and then peeled completely, including the tail fans. The ventral side is then gently cut down lengthwise completely using a sharp scalpel. The cut surface is then gently opened up to form the butterfly shape, packed in thermoformed trays under vacuum and frozen at –40 °C.

12. Skewered shrimp

The process is similar to that of barbecue, but piercing is carried out in such a way that 4 - 5 shrimps are arranged in a skewer in an inverted "U" shape. It is then packed in thermoformed trays under vacuum and frozen at –40 °C.

13. Shrimp head-on (Centre peeled)

Shrimp is washed in chilled water containing 5-ppm chlorine, peeled at the centre keeping the head and the last two segments intact, deveined, and the tail is trimmed. It is again washed in chilled water packed in thermoformed trays under vacuum and frozen at –40 °C.

14. Shrimp head-on cooked (centre peeled)

Shrimp is washed in chilled water containing 5-ppm chlorine, deveined and then cooked in 1 % brine for two minutes at 100 °C. It

is immediately cooled in chilled water and peeled keeping the head and the last two segments intact. The tail is trimmed and again washed in chilled water. It is then packed in thermoformed trays under vacuum and frozen at –40 °C.

15. Squalene

Squalene is an unsaturated hydrocarbon found in the unsaponifiable fraction of fish oils, especially of certain species of sharks. Liver oil containing high proportion of squalene is distilled in a stainless steel glass lined vessel under a vacuum of 2 mm bar. Fraction distilled between 240 and 245 °C is collected. All operations are to be carried out preferably in an inert atmosphere, as squalene is easily oxidisable. Squalene is widely used in pharmaceuticals and cosmetics

16. Tuna eyes

Tuna eyes are an item of commerce. Its high demand is attributed particularly to its content of polyunsaturated fatty acids like decosahexaenoic acid. This fatty acid is valued for its medicinal properties in combating atherosclerotic and thrombotic problems of chronic heart patients. Extraction and preservation of eyes of tuna and its marketing stand good prospects.

17. Shark cartilage

Shark cartilage assumes importance because of the presence of chondroitin sulphate, which is a mucopolysaccharide. Chondroitin sulphate has therapeutic uses and is effective in reducing cancer related tumours and inflammation, and pain associated with arthritis, psoriasis and enteritis. Oral intake of shark cartilage is reported to be effective in the above cases.

The bone separated from the shark is cleaned for removing the adhering meat, bloodstain etc. After washing well the bones are preserved by drying at a temperature not exceeding 70 °C to a moisture level below 6 %.

18. Chitin and Chitosan

The body peelings from shrimp processing plants are a major and economical source of chitin. Lobster and crab shell waste also contain sizeable quantities of chitin. The shells are deproteinised with alkali and demineralised with dilute hydrochloric acid. The fibrous portion obtained, after washing is chitin. Chitin can be deacetylated with caustic soda to give chitosan. The deacetylation is achieved by treatment of chitin with (40 % w/w) aqueous potassium or sodium hydroxide at about 100 °C. The product obtained is dried in hot air

dryer to a temperature not exceeding 60 °C. Chitosan finds extensive applications in many industries such as pharmaceutical, textiles, paper, water purification etc.

19. Fish maws/Isinglass

Air bladders of hake, sturgeon and carp are the main sources of isinglass. In India it is obtained from eel, catfish, carp catla etc. The dried bladders are softened by soaking in water for several hours. They are mechanically cut into small pieces and pressed between hollow iron rollers, then converting them into thin strips of 3-6 mm thickness and then dried. It is used mainly for clarifying beverages, as an adhesive base in confectionery products, glass, pottery and leather and also as an edible luxury. Its exports are mainly confined, at present, to Hong Kong, Singapore and Germany.

20. Shark fins/fin rays

Shark fin soup is considered as a great delicacy in Singapore and Hong Kong and hence our exports of shark fins are confined to these countries. The commercial value of the fins depends on their colour, size, variety and quality. Depending on the quality and quantity of rays present in the fins they are broadly classified into two varieties, generally known as black and white. The white fins usually fetch a better price compared to black fins. Fins are generally marketed in dried form. The preparation of shark fin does not require any elaborate treatment, but care is needed in cutting, trimming and drying operations. The dried fins are further processed, for the "rays". The price of fin rays depends mainly on colour, length and thickness of the individual strands, quantity of connective tissue, cartilage present and physical appearance.

21. Live stock feed from cephalopod processing waste

A simple environmental friendly process has been developed by CIFT to convert the squid and cuttlefish waste to live stock feed. The basic principle is lowering the pH by addition of formic acid and allowing it to liquefy by the action of proteolytic enzymes already present in the fish. The liquefaction will be over by 3 - 4 days, resulting in a product with a pleasant odor. During the liquefaction process protein undergoes partial hydrolysis thereby increasing its digestibility and feed efficiency. The silage formed in the liquid state is then converted into solid form by mixing with deoiled rice bran or wheat bran and sun drying to moisture content below 10 %, thereby easing the storage and transportation problems. The product after mixing with rice bran and drying contains 24 - 26 % protein along with calcium, phosphorous and vitamins etc. The product has very good shelf life because of its very low fat content.