New Vistas in the Value Addition of Marine Fishery Products

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1. Introduction

The importance of fish in human diet is increasing day by day owing to the health benefits associated with its consumption. However, fish landings in the marine sector have almost come to a stagnant level in spite of stepped up fishing effort. This underlines the importance of judicious and scientific exploitation and utilization of the available resources to cater to the increasing demands for fish. Rapid macro-economic developments in the economies of the developed and developing countries and changes in the expectations of consumers all over the world have led to diversification and value addition of product forms even in the domestic markets. Changing consumer preferences, in favour of easy-to-prepare processed fishery products, brought about by changing lifestyles as well as a general increase in consumer purchasing power, have increased the demand for such value-added fishery products.

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.

Development of value added products from under-utilized or low value

species would contribute towards a more sustainable use of scarce fishery resources. There appears to be a good potential for India to increase its share in international fish trade by exporting value added fish products. Indian exports today derive their competitive advantage on the basis of cheap labour and abundance of natural resources. This situation needs to change and the emphasis would be on the export of high-tech products. For this, a greater coordination and cooperation between industry and the R&D institutions are needed.

It is a recognised principle that the development of export market should have the backing and support of a strong domestic market. The rapid industrialisation and the consequent urbanisation 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 and process are 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. Meat, 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. 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. 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 Portioning/Forming

Portioning is an important stage in the production of coated fishery products. Cutting loss and surface area of the portions are the two important points, which determine the economics of coated products. Cutting loss is negligible when manually done with a band saw, whereas with automatic block cutting machines it is in the range of 5-10 %. Key factors in the production of fish portions are the speed and accuracy with which the frozen fish blocks can be processed at minimum cost. A recent innovation for the catering sector is forming of skinless and boneless fish fillets into a predetermined shape and size using specially designed forming machines. The shapes vary from conventional fillet shapes to several other imaginative ones.

2.2 Pre-dusting

Before a fish portion is battered it usually undergoes a pre-dusting step. The purpose of pre-dusting is to prepare the surface of the portion so that batter can adhere uniformly. Pre-dusting also improves the adhesion of batters to frozen or greasy food surfaces. Pre-dust normally consists of a very fine raw flour type material. A more sophisticated and expensive pre-dust may contain spices and seasonings for both functional and flavouring purposes.

2.3 Application of Batter

Conventional batters are of low to medium viscosity and hence can be applied with total submersion or overflow batter applicators. Low

viscosity batters are normally applied in an overflow configuration. Medium viscosity batters may require a total submersion system depending on the product requirements. The pre-dusted product is conveyed to the batter applicator and transferred to the next conveyor, which will draw it through the batter. The fish portion is totally submersed in the batter as it is drawn through it. Other applicators may use a pour-on application in addition to the submersion method. Irregular shaped products should be placed on the line with any concave surface upward to prevent air pockets from inhibiting batter pickup. Line speed is a very critical factor affecting batter pickup. An excessively fast line speed will reduce the batter pickup. Too low a line speed also can result in excessive batter adherence. Excess batter, if carried over to the breading section, will cause formation of lumps and this can cause blockages in the breading machine. This will also cause formation of shoulders and tails on the edges of the product and contaminate subsequent breading application. Therefore, to overcome the problems the excess batter is removed by blowing air over the product. The position of the air blower should be as close to the product as possible to control the airflow across the product. Carry over from the pre-dusting operation also is critical. Where pre-dust is carried over, the viscosity of subsequent batter will increase leading to an increase in pickup.

2.4 Application of Breadings

There are many types of breading applicators available and the appropriate machine depends on the ingredients used. The speed of the breading machine is so adjusted to closely match the belt speed of the batter applicator. For soft products the crumb depth should be maintained as thin as possible to avoid product damage when leaving the breading machine; however, frozen or hard products should have a deep bed of crumbs. Pressure rollers are used to apply sufficient force to press crumbs onto the battered product. Japanese style crumbs with their low bulk density and larger granule sizes make the crumb pickup difficult by the normal batter systems. Special batter formulations, sometimes containing raising agents, may have to be used at medium viscosity for a desired level of pickup of crumbs. Specially designed breading machines are used to apply uniform particle size distribution or granulation to both top and bottom of the product with minimum crumb breakdown. Air blowers are used to remove excess crumb from the product after breading. Excess crumb carried into the fryer can cause unsightly black specks on the product. Filters are used to remove small particles from the oil to prevent this phenomenon.

2.5 Pre-frying or flash frying

After coating with batter/bread crumbs many products are often flash fried prior to freezing. The purpose of pre-frying is primarily to set the batter/bread coating on the fish portion. Flash frying develops a characteristic crust and gives the product a characteristic fried (oily) appearance and taste. Therefore, the temperature of frying oil and the time of frying are critical. The normal frying temperature is between 180–200°C and the frying time 20-30 seconds. The term pre-frying is used because the final product frying is completed by the consumer for duration of 4-6 minutes depending on the portion size and thickness. The battered/breaded fish portions enter the frying medium through a conveyor system, the speed of which is adjusted so as to keep the fish portion in the hot vegetable oil for the required time.

2.6 Freezing

The fish portion leaves the frying oil with a coating temperature equivalent to that of the oil but still frozen in its center. Although the fish flesh center is frozen the surface flesh may be partially thawed. Therefore a quick and efficient freezing method is very essential to keep the quality of the coated product. The first step in preparing the fried fish portion for freezing is air-cooling. This is usually accomplished by the use of a fan or a series of fans. This allows the coating temperature to drop, while at the same time allowing the batter coating to recover from the frying shock and also to stabilise itself. The coated fish portions are then fed to the freezer through conveyor belts. Freezing is usually carried out in spiral freezers. Freezing is completed when the internal and external temperature of the fish portion drop to about –10°C.

2.7 Packing and Storage

The coated product may undergo desiccation, discolouration and become rancid during storage. Use of proper packaging can prevent/retard these changes and enhance shelf life. Thermoformed containers are most commonly used for packing coated products. The packaged products are usually stored at -20°C.

2.8 Processing of Coated Fish and Fishery Products

2.8.1 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.

2.8.2 Fish blocks

They 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, is 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.

2.8.3 Shrimp products

Battered and breaded shrimp can be prepared 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. As a first step, shrimp is converted into the desired form followed by pre-dusting, battering and breading. The breaded shrimp is then frozen in IQF form, packed in thermoformed trays and stored in cold storage.

2.8.4 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.

2.8.5 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.

2.8.6 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.

2.9 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.

2.9.1 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 30g. The formed cutlets are battered and breaded.

2.9.2 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 pre-dusted, battered and breaded.

2.9.3 Crab claw balls

Swimming legs of crab may be used for this purpose. Crab claws are severed from the body, washed in chilled potable water and the shell removed using a cracker. The leg meat is then removed and mixed with 2 % starch based binder. This is then 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 the 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 and 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 and other high value products 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-steriliser for heat processing high temperature short time process etc. are other innovations in the field of equipment/machinery for heat processing of 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 be conveniently 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 product

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.

6.1 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.

6.2 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.

6.2.1 Method of production

Meat is separated using a meat-bone separator. The diameter of perforations in the drum should not be larger than 3-4 mm to prevent the skin and scales from passing through the holes. The minced fish is washed repeatedly with chilled water (5-10°C) until most of the water-soluble protein is removed. Usually 5-10 times water is used and three washings employed. In the final washing, 0.01-0.3% sodium chloride is used to ease the removal of water and pressed using a screw press to a moisture level of 78-80%. Using a silent cutter, cryoprotectants like sugar, sorbitol and polyphosphates are mixed into the dewatered fish meat at levels 4.4 and 0.2%, respectively. During the process the temperature is not allowed to exceed 10°C above which the protein functionally could be damaged. The total protein lost during the washing process is approximately 30% of the minced meat and depends on the amount of water used and number of washing cycles employed.

6.3 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.

6.4 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 include, 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 crab meat.

9. Speciality Products from Shrimp

9.1 Stretched shrimp (Nobashi)

Increasing the length of peeled and deveined shrimp and minimising 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.

9.2 Barbacu

Shrimp is washed in chilled water containing 5 ppm chlorine, beheaded, deveined, pealed 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.

9.3 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 pealed keeping the last segment and the tail intact. The tail is then trimmed and the shrimp is split opened from the dorsal side without breaking the belly. It is then packed in thermoformed trays under vacuum and frozen at -40°C.

9.4 Skewered shrimp

The process is similar to that of barbacu, but piercing of shrimp is carried out in such a way that the shrimp is made a semi-circle, piercing both the head and tail portions with one bamboo stick. It is then packed in thermoformed trays under vacuum and frozen at -40°C.

9.5 Shrimp head-on (centre pealed)

Shrimp is washed in chilled water containing 5 ppm chlorine, pealed 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.

9.6 Shrimp head-on cooked (centre pealed)

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 pealed 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.

10. High Value By-Products from Processing Wastes

10.1 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

10.2 Tuna eyes

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

10.3 Fish calcium

Calcium powder processed from the backbone of tuna can be used to combat calcium deficiency in the diet of children, which otherwise can lead to bone failure and spine curvature. The method of production of calcium involves mainly removing the gelatin from the crushed bones and pulverizing the remaining portion. A process recommended for processing calcium powder from the backbone of skipjack tuna involves the following steps. The bone frame is crushed and washed in clean water a number of times. A 10% solution of calcium carbonate is added to the residue and is left for an hour. After draining the solution, washing and treatment with

calcium carbonate are repeated a number of times. Finally, washed bone residue is washed and dried and pulverised to the required mesh size.

10.4 Shark cartilage

Shark cartilage assumes importance because of the presence of chondriotin sulphate, which is a mucopolysaccharide. Chondriotin 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 bones separated from the shark is cleaned for removing the adhering meat, blood stain etc. After washing well the bones are preserved by drying at a temperature not exceeding 70°C to a moisture level below 6%.

10.5 Chitin and Chitosan

The body peelings from shrimp processing plants are a major and economical source of chitin. Lobster and crab shell wastes 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.

10.6 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.

10.7 Shark fins/fin rays

Shark fin soup is considered as a great delicacy in Singapore and Hongkong 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.

10.8 Absorbable surgical sutures

Another breakthrough in the utilization of fish waste is the development of technology to produce absorbable surgical sutures from fish guts. This has been found quite useful in ophthalmic and other microsurgeries. Currently, sutures for such surgical applications are met by import at high cost. The processing procedure now developed should be scaled up to pilot plant level production so that the economics of the processes can be made available to the probable entrepreneurs.

10.9 Live stock feed from fish processing waste

A simple environmental friendly process has been developed by CIFT to convert the fishery waste to live stock feed. The basic principle is lowering the pH by addition of formic acid and liquefying the waste 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 odour. 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 a moisture content below 10%, thereby easing the storage and transportation problems. The product after mixing with rice bran and drying contains 24 -26% proteins along with calcium, phosphorus and vitamins. The product has very good shelf life because of its very low fat content.

11. Marketing of value added products

Marketing of value added products is completely different from the traditional seafood trade. It is dynamic, sensitive, complex and very expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine the successful movement of a new product. Most of the market channels currently used is not suitable to

trade value added products. A new appropriate channel would be the super market chain, which want to procure directly from the source of supply. Appearance, packaging and display are all important factors leading to successful marketing of any new value added product. The retail pack must be clean, crisp and clear and make the contents appear attractive to the consumer. The consumer must be given confidence to experiment with a new product launched in the market. Packaging requirements change with product form, target group, market area, species used and so on. Packaging must also keep abreast with the latest technology.