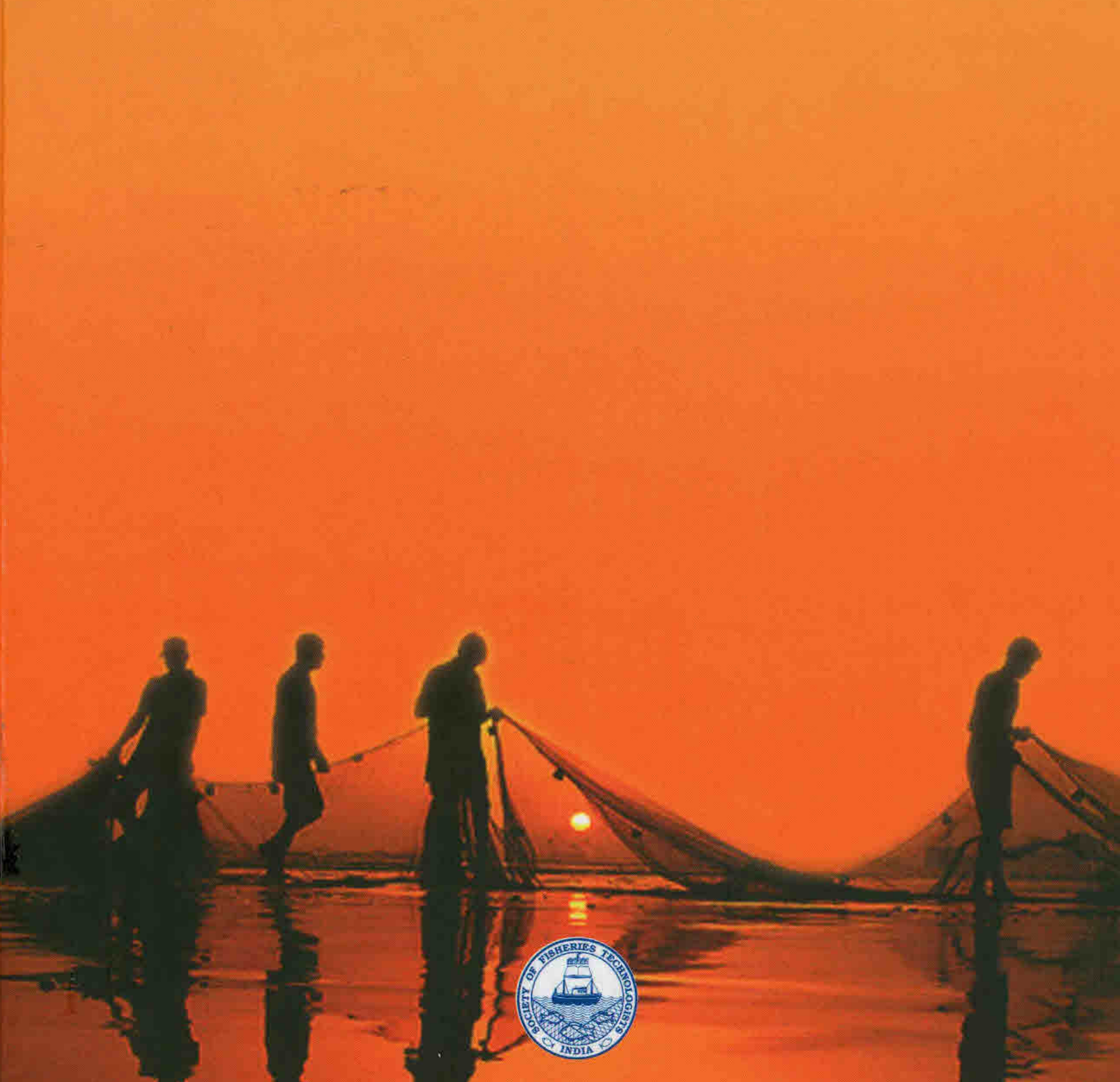
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



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Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

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Fax : 91 (0)484-2668212

Telegram : FISHTECH / MATSYAOUDYOGIKI
E-mail : cift@ciftmail.org
enk_ciftaris@sancharnet.in

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Editors

B. Meenakumari

M.R. Boopendranath

Leela Edwin

T.V. Sankar

Nikita Gopal

George Ninan

Society of Fisheries Technologists (India)

P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

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Fish Waste Utilisation in India

P.T. Mathew
Central Institute of Fisheries Technology
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, Kerala, India
E-mail: thomasmatp@gmail.com

Introduction

Processing of fish leads to enormous amounts of waste. It is estimated that fish processing waste after filleting accounts for approximately 75% of the total fish weight. About 30% of the total fish weight remains as waste in the form of skins and bones during preparation of fish fillets. This waste is an excellent raw material for the preparation of high value products including protein foods. The utilization of fish wastes help to eliminate harmful environmental aspects and improve quality in fish processing. Fish processing generates solid wastes that can be as high as 50-80% of the original raw material. Skin and bone are sources of high collagen content. An important waste reduction strategy for the industry is the recovery of marketable byproducts from fish wastes. Hydrolyzed fish wastes can be used for fish or pig meal as well as fertilizer components. The three most common methods for utilization of aquatic waste (either from aquaculture or wild stock) are the manufacture of fishmeal and oil, the production of silage and the use of waste in the manufacture of organic fertilizer. The utilization of by-products is an important cleaner production opportunity for the industry, as it can potentially generate additional revenue as well as reduce disposal costs for these materials. The transportation of fish residues and offal without the use of water is an important factor for the effective collection and utilization of these by-products. Another important waste which can be used for industrial purpose is prawn shell waste and crab shell waste. An estimate of waste generation in during fish processing is given in Table 1.

During 2006-07, it was estimated that 3,02,750 t of processing and pre-processing wastes was generated. The maximum waste was generated during processing of shrimps, followed by finfishes and cephalopods. In the context of environmental pollution, waste generated in fish processing industry is a matter of great concern. Among the maritime states, the largest waste generation was observed from Gujarat

(30.51%), followed by Maharashtra (23%) and Kerala (17.5%) (CIFT, Cochin; unpublished data)

Table 1: Waste generation in industrial fish processing in India

Products	Waste generated (%)
Shrimp products (PD, PUD, HL, etc.)	50
Fish fillets	70
Fish steaks	30
Whole and gutted fish	10
Cuttlefish rings	50
Cuttlefish whole	30
Cuttlefish fillets	50
Squid whole cleaned	20
Squid tubes	50
Squid rings	55

Source: Anon (2005)

Fish meal

Fish meal is highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. Fishmeal is rich in essential amino acids. It is produced by cooking, pressing, drying and grinding the fish, by-catch fish, miscellaneous fish, filleting waste, waste from canneries and waste from various other processing operations. The composition of fishmeal differs considerably due to the variations in the raw material used and the processing methods and conditions employed (Windsor and Barlow, 1981). Traditional fishmeal production in India was from the sun dried fish collected from various drying centres and the products were mainly used as manure. Better quality fish meal has been a prominent item of export from the very beginning of this industry. BIS has brought out the specification for fish meal as live stock feed for facilitating proper quality control (Brody, 1965). The proximate composition of fish meal, in general, is protein, 50-57%; fat,5-10%; ash, 12-33% and moisture, 6-10% (Windsor and Barlow, 1981) Fish can be reduced by either dry rendering or wet rendering process.

Dry rendering process

Dry rendering or dry reduction process is suitable for only lean or non oil fish such as silver bellies, jew fish, scaenids, ribbon fish, sole, anchoviella, carcasses of shark, fish offal and filleting waste. In this process, it is dried to moisture content of 10% and pulverized. If the quantity to be handled is sufficiently large a steam jacketed cooker dryer equipped with power devises for stirring is used. Sometimes, if the size of the fish is comparatively large a coarse grinding is also done before being fed into the cooker drier. The cooker dryer may be operated at atmospheric pressure or under partial vacuum. Being batch operation, the process will have only limited capacity and labour cost is very high. Merit of this process is that the water-soluble materials are retained in the meal.

Wet rendering process

Wet rendering or wet reduction process is normally applied to fatty fish or offal where simultaneous production of fish meal and fish body oil is envisaged. The process consists of grinding, cooking to soften the flesh and bones and to release the oil, pressing to expel the liquor and oil, fluffing the press cake drying, grinding and packing the meal, The press liquor is centrifuged to remove the suspended particles and to separate oil. The stick water is concentrated. The process requires elaborate equipment and is normally a continuous one and therefore adaptable to the reduction of large quantities of fish. In a continuous wet reduction process the coarsely ground fish or fresh raw fish or offal is passed through a stationary horizontal cylindrical cooker by means of a screw conveyor at a predetermined rate. Steam is admitted through a series of jets. The cooked mass is passed through a continuous screw press. The press cake is fluffed and dried to a moisture level of 8%. The suspended fish meal present in the press liquor is separated by centrifugal sedimentation and the oil by centrifugation or other conventional methods.

Fish body oil

The main source of fish body oil in our country is oil sardine. A survey of the oil industry reveals that the extraction is done on a cottage scale in isolated places near the leading centres and is not well organized. The method of extraction followed is cooking the fish in iron vessels and pressing and separating the oil. Apart from sardine oil, fish body oil is also obtained from the fish meal plants operating in the country. In India oil sardine is a fishery which exhibited wide fluctuations from as low as 1% to as high as 32% of the total landings. The seasonal variation in oil content is predominant in Kerala and Karnataka coast. During the peak season fish has oil content of 17%. By the wet rendering process the fish will yield, on average 12% oil having analytical characteristics similar to other fish oils. Fatty acid composition of oil revealed that they contain high amounts of polyunsaturated fatty acids (PUFA). At present the medicinal values of fish oils are well known (Stansby, 1967)

Fish ensilage

When fish is available and which cannot be used for direct consumption for several reasons, it is used for production of fish meal. This has got ready market as an animal feed. If material is available at a place where there is no fish meal plant and no reasonable transport to the nearest plant or there may be severe restrictions on fish meal production because of fish odours, one has to look for alternate processes. When the animal farms are very near to landing centres it is worthwhile to go for silage production. Fish silage can be defined as a product made from whole fish or parts of the fish to which no other material has been added other than an acid and in which liquefaction of the fish is brought about by enzymes already present in the fish (Raa and Gildberg, 1982). The product is a stable liquid with a malty odour which has very good storage characteristics and contains all the water present in the original material. It is a simple process and it requires little capital equipment particularly if non-oily fish are used. The use of oily fish usually requires oil separation. This involves expensive equipment and is suited to a fairly large-scale operation.

Almost any species of fish can be used to make fish silage though cartilaginous species like shark and rays liquefy slowly. The production of fish silage involves preferably organic acid like formic acid (35 kg per tonne of fish) to preserve the fish and then allow the enzymes already present in the fish to liquefy the protein. Wooden or bitumen coated iron or concrete acid resistant tanks can be used for the process. Formic acid is favored as it preserves the fish with out a very low pH and so the silage can be directly fed to animal without further neutralization. When 3.5% formic acid (85% conc.) is added to the fish, the pH will be nearly 4. Mineral acid like sulphuric acid can also be used for this purpose instead of formic acid. But in this case pH would be about 2.5 which requires neutralization before feeding (Raghunath, 2002)

When the minced fish is mixed with the acid the fish tends to stiffen initially and liquefaction will proceed and the rate at which liquefaction takes place depends upon the temperature of the mixture. Fatty fish liquefy more rapidly than white fish and fresh fish liquefy more rapidly than stale fish and previously chilled or frozen fish. The warmer the fish and acid mixture, the faster is the process. At 25°C, the process needs 2 days for liquefaction, whereas at 15°C, it needs 5 to 10 days and more at lower temperature. Temperature above 40°C should be avoided as the enzymes may get deactivated. Periodic agitation will help liquefaction of the mixture. There are no problems in storage of fish silage if the correct acidity is maintained. During storage the protein becomes more soluble and there is an increase in free fatty acids if any fish oil is present. If silage is made from oily fish it is desirable to separate the oil after liquefaction. If the temperature of the silage is raised to 70 -90°C, the floating oil is separated by decantation or centrifugation.

Except for slight dilution involved by the addition of the acid silage has the same composition that of the raw material from which it is made. Nutritional studies have shown that there is no palatability problem with pigs and it is considered as equivalent to fish meal. So the ensilage can be used as a fish meal substitute for the production of feeds (Nair *et al.*, 2004). There are some advantages and disadvantages for silage over fish meal. In the case of silage the capital investment is significantly less and no skilled personnel is needed. But, in the case of silage the bulk is not reduced and so storage and transportation face problem. There is no considerable smell for silage; in fact it is having a pleasant smell. Smell is a difficult problem in the manufacture of fish meal. Marketing of fish meal is well established, whereas silage is still not well known to the farmers.

There is an alternate method of production of silage by fermentation. The fish is mixed with a carbohydrate source like molasses and lactic acid is produced in the system to reduce the pH by introducing a lactic acid producing bacteria like *Lactobacillus plantarum.*

Fish scales

Scales in freshwater fish generally constitute 1-2% of the body weight and commercially are not of much importance. Though the scales look unhygienic and litter the market, they can be used for ornamental and other purposes. Activated charcoal can be obtained by burning fish scales. Fish scales are also used in the manufacture of lipstick. Fishes like catla, mahseer and grass carp have thick and attractive scales. These scales are painted and used as playing cards, in some parts of India. They can also be coloured and could be used for ornamental purposes. The scales are cleaned by treating with dilute alkali overnight to remove slime, dirt, etc. they can be washed in clean water and treated with 4-6% hydrogen peroxide to improve colour and dipped in different colour solutions like methyl red, eosin, crystal violet and malachite green for 6-8 hours and dried for use in ornamental purposes (Anon, 2007)

Fish calcium

The filleting wastes of tuna and other bigger fishes are very good sources for calcium which can be used for pharmaceutical purposes. The wastes are boiled and backbones are carefully separated for calcium production. The bones are cut into small pieces for removal of attached tissues and gelatin. It is again cut into small pieces and washed. It is then treated with proteolytic enzymes for removal of protein to prevent moisture re absorption. It is then washed to remove the protein and enzyme and sterilized. This facilitates tenderization and after drying it is powdered to desired size. The resultant product contains calcium and phosphorus in substantial quantities. This can be made into the form of capsules or can be supplemented in other foods.

Pearl essence

Pearl essence is the suspension of crystalline guanine in a solvent. It is the irridescent substance located in the epidermal layer of the scales of the pelagic fish. This is used for coating the objects to give them a lustrous effect. The scales are placed in 10-15% brined solution and the brine is later drained and scaled squeezed and compressed. Pearl essence is extracted by washing and scrubbing the guanine form the scales. Centrifugation is carried out for separating the pearl essence from wash liquid. For purification of guanine, the protein concentrate is digested with pepsin in acid at 25-30°C for 50 h. Fat is removed with benzene or ether. Finally guanine is removed by centrigufation and suspended in water or in non aqueous liquid (Windsor and Barlow, 1981).

Fish glue

Fish glue is made from fish skins (the better quality flue) and of fish heads (the lesser quality flues). Skin can be salted for shorter period of storage but can be dried for longer period of storage. For extracting glue .for extracting glue from fish skin, the skins are initially cooled and the chloride is removed to less than 0.1% by washing. For 1-2 hours if fresh and 12 hours if they are stored) in cold running water in a roller mill. After the water treatment, the skins are placed in 0.2% NaOH or CaO, neutralized with 0.2% HCl, and again rinsed in running cold water. The skins now swollen are mixed with an equal weight of water and steam is added. Addition of 1.9 litres of glacial acetic acid, during heating, will a make the final glue a clearer product. First cooking is for eight hours and the glue layer is strained. Subsequent cooking will give weaker glue (Windsor and Barlow, 1981).

Fish hydrolysate

This is also a liquefied fish product but it differs from silage. These are products produced by a process employing commercially available proteolytic enzymes for isolation of protein from fish waste. By selection of suitable enzymes and controlling the conditions the properties of the end product can be selected. Hydrolysates find application as milk replaces and food flavouring. Enzymes like papain, ficin, trypsin, bromelein and pancreatin are used for hydrolysis. The process consists of chopping, mincing, cooking and cooling to the desired temperature, hydrolysis, sieving, pasteurizing the liquid, concentrating and drying (by vacuum or spray drying). The fish protein hydrolysate have desirable functional properties with potential applications as emulsifiers and binder agents; and can used in place of dairy based and plant based protein hydrolysates as well as protein powders currently available in market place The FPH from tuna filet by products exhibited many desirable functional properties. The production of hydrolysate from fish processing waste will reduce the pollution due to the accumulation of fish waste in the environment from the fishery industries (Gopakumar, 2002). By selection of suitable enzymes and controlling the conditions the properties of the end product can be selected. The most important methods of hydrolysis are acid hydrolysis and enzyme hydrolysis.

Acid hydrolysis

The whole fish is cleaned well to be free of slime and adhering dirt. They are then comminuted in a mechanical meat mincer. The minced meat is then cooked well with 2 to 6 N acid containing water and maintained at a about 90-100°C for about 12-24 h to get a completely soluble finished product. The disadvantage of this product is that it is acidic in nature and has to be neutralized with alkali to bring to pH 7. This process introduced large quantities of salt in to the hydrolysate. Apart from this another major disadvantage is the loss of some of the acid labile amino acids.

Enzyme hydrolysis

In the industrial process of preparation of hydrolysates enzyme hydrolysis process is followed. Papain, bromelein, pepsin, ficin and trypsin are used for hydrolysis. Most hydrolysates are bitter in taste. Hence flavouring agents are like cocoa, malt and sugar are used during the fortification in food preparation to mask the bitter taste (Thankamma *et al.*,1979).

Table 2: Yield of fish hydrolysate from different fish species

Species	Yield of hydrolysate ($g.100g^{-1}$)
Lizardfish (*Saurida tumbil*)	13.3
Large spined flathead (*Platycephalus macracanthus*	11
Ribbonfish (*Trichiurus* sp.)	9.9
Barracuda (*Sphyraena* sp.)	11.9
Jewfish (*Johnius* sp.)	9.9
Threadfin bream (*Nemipterus japonicus*)	12
Catfish (*Tachysurus* sp.)	10.9
Anchovies (*Thrissocles* sp.)	9.7
Sole (*Cyanoglossus* sp.)	8.6

Hydrolysates find application as milk replacer and food flavouring agent. Protein hydrolysates are bitter in taste and as such are not palatable. The product is highly hygroscopic and soluble in water. The formula for a beverage developed at Central Institute of Fisheries Technology Cochin is given Table 3. This product was found highly acceptable to consumers and acceptability with respect to taste, flavour and odour was over 90% (Thankamma, 2003). The Protein Efficiency Ratio of the product is 2.2 compared to casein (3.7) at 10% level of protein.

Table 3: Composition of beverage based on fish protein hydrolysate

Species	Composition by weight (%)
Fish protein hydrolysate	30
Malt	20
Sugar	20
Milk powder	10
Fat	05
Cocoa	05

Fish maws and isinglass

The word isinglass is derived from the Dutch and German words which have the meaning sturgeon's air bladder or swimming bladders. Not all fish air bladders are suitable for isinglass production. The air bladder of deep water hake is the most suitable for production of isinglass. In India, air bladders of eel and cat fishes are used for the production of isinglass. The air bladders are separated from the fish, and temporarily preserved in salt during transport. On reaching the shore, they are split open, thoroughly washed and the outer membrane is removed by scraping and then air dried (Mathew, 2003).The cleaned, desalted, air dried and hardened swimming bladders (fish maws) are softened by immersing in chilled water for several hours. They are mechanically cut into small pieces and rolled or compressed between hollow iron rollers that are cooled by water and provided with a scraper for the removal of any adhering dried material. The rolling process converts the isinglass into thin strips or sheets of 3.2 to 6.4 mm thickness. There are processes for the production of isinglass in powder form.

Isinglass dissolves readily in most dilute acids or alkalis, but is insoluble in alcohol. In hot water isinglass swells uniformly producing opalescent jelly with fibrous structure in contrast to gelatin. It is used as a clarifying agent for beverages like wine, beer and vinegar by enmeshing the suspended impurities in the fibrous structure of the swollen isinglass. India exports dried fish maws, which form the raw material for the production of isinglass and such other products. Process has been developed to produce the finished products from fish maws.

Fish collagen

Collagen is the major structural protein found in the skin and bones of all animals. Collagen is the most abundant protein of animal origin, comprising approximately 30% of total animal protein. Being a major constituent of the connective tissues, collagen plays an important part in creating mechanical strength, integrity and rheological properties of the muscles and fillets. Collagen molecules composed of three α-chains intertwined in the so-called collagen triple-helix, adopt a 3D structure that provides an ideal geometry for inter-chain hydrogen bonding.

Collagen extracted from fish skin, a polymer that is a by-product of food manufacture, has various industrial applications in cosmetology and medicine. Dermis fish collagen presents an interesting new source of collagen as it is a by-product of food fabrics and already has cosmetic uses. Fish skin, bone and fin of skipjack tuna (*Katsuwonus pelamis*), Japanese seabass (*Lateolabrax japonicus*), ayu (*Plecoglossus altivelis*), yellow sea bream *Dentex tumifrons*, chub mackerel *Scomber japonicus*, bullhead shark *Heterodontus japonicus* and horse mackerel *Trachurus japonicus* were examined for potential isolation of collagen and it was found that collagen recovery ranged from 36 to 54%, with the highest value recorded for ayu bone, and the lowest in Japanese sea bass fin. The denaturation temperatures were skin collagen 25.0 to 26.5°C, bone collagen 29.5 to 30.0°C and fin collagen 28.0 to 29.1°C, lower than porcine collagen. Collagen from fish waste can be utilized in industrial level only for supplementing the skin of land vertebrates, and as alternative to mammalian collagen in foods, cosmetics and biomedical materials (Mukundan *et al.*, 1989).

Surgical sutures from freshwater fish gut

Absorbable fine grade sutures are essential for microsurgeries and ophthalmic surgeries. CIFT has developed the method for the preparation of absorbable surgical sutures from fish gut. The production of sutures involves a low cost technology. Fish gut is separated and washed thoroughly to remove impurities and soluble proteins. The collagen fibres separated are twisted, cross-linked and bodied to give fine threads of collages. They are surface smoothened, cut to size and packed in isoporpanol. The packed sutures are sterilized to give absorbable surgical sutures. The sutures developed by this method are evaluated for tenacity, absorbability, freedom from abnormal tissue reaction etc. (Mukundan *et al.* 1989).

Gelatin

Gelatin from marine source is a possible alternative to bovine gelatin (Kim and Mendis, 2006). It is a soluble polypeptide derived from insoluble collagen. Procedures to derive this soluble polypeptide involve the breakdown of cross-linkages between polypeptide chains of collagen along with some amount of breakage of polypeptide chain bonds. When tissues that contain collagen are subjected to mild degradative processes, i.e., treatment with alkali or acid followed or accompanied by heating in the presence of water, the systematic fibrous structure of collagen is broken down irreversibly and gelatin is formed. It is the only food material that gels and melts reversibly below the normal human body temperature (37°C). Gelatin's unique and outstanding functional properties, along with its reasonable cost, make it one of the most widely used food and pharmaceutical ingredients.

The fish skins and bones can be processed into gelatin, thus contributing to solving the problem of waste disposal with the advantage of value addition. The main draw back of the fish gelatins are the gels based on them tend to be less stable and have inferior rheological properties than mammalian gelatins. It may be noted that fish gelatin has its own unique properties like better release of a product's aroma and flavor with less inherent off-flavor and off-odor than a commercial pork gelatin, which offer new opportunities to product developers. The amount of gelatin obtained commercially from fish and other species increased consistently from 2003 to 2005. Over this period, the percent of gelatin from fish and other marine species increased from 0.7% to 1.3% of total world production (Ninan *et al.,* 2009).

Ambergris

Ambergris is a compound obtained accidentally from the seas and is valued fabulously because of its use in perfumery. Its rarity, uniqueness in chemical composition and high commercial value attributed to some real and certain imaginative properties, make it one of the most priceless gifts of animal kingdom to man. It is often used in the East as an aphrodisiac although this particular property is not scientifically supported. The ambergris has a peculiar characteristic musk odour. It is used in blending of a large number of exotic perfumes. In the past its origin and harvest were a matter of much speculation as it was collected either from open sea or from the sea shores. Ambergris is often spotted in tropical and sub-tropical seashore of many countries like Australia, New Zealand, India and Bahamas, either, as large number of fragments or as a whole mass. Eighty per cent of ambergris is cholesterol. A fatty oil called ambrein, benzoic acid, some other steroids and hydrocarbons are also reported as its constituents. Ambergris is now considered as a morbid concretion from the intestinal tract of sperm whales and probably only of a male whale. It comes from the stomach of a dead whale. A piece of ambergris, weighing up to 184 kg and 150 cm in girth and another one weighing up to 418 kg were recorded in the past. This obviously shows that such a big lump would have come only from a sea animal of enormous size like whale. When sperm whale feeds on cuttlefish (*Sepia* spp.) due to some injury or unknown reason the ambergris is formed in the intestines. This theory is based on the observation that often small fragments of cuttlefish are seen in the ambergris when it is freshly collected. Ambergris is normally jettisoned from the intestines when the whale dies. By constant exposure to sun and sea water, ambergris hardens and develops a pleasant scent. Good quality ambergris is soft, waxy and grey in colour. Black ambergris is of the poorest quality. Although it is sticky it can be kneaded with the fingers. Ambergris of colours ranging from black, grey-white, muted-grey, yellow, brown or any combination of above colours are also seen. A good quality and aged ambergris is found to have a concentric layered structure resembling that of onions. It is inflammable and almost volatile by heat, insoluble in water or alkali hydroxides but soluble in hot alcohol, chloroform, ether, fats and volatile oils. It burns with a pale-blue flame and characteristic musky odour (sometimes resembling the burning smell of rubber) without leaving scum or ash. It also floats in water (Mathew and Gopakumar, 1987). Ambergris is mainly used in perfumery as tincture and essence for fixing delicate odours. Good quality ambergris has commercial value ranging from USD 1000 to 2000, depending on its quality. Ambergris, commercially sold, is often found adulterated with whale fat.

Fish sausage

Fish sausages are prepared either from surimi or fish mince. It is extremely popular in Japan and other Asian countries. In Japan, most industries use surimi as the base material for sausage preparation. The texture of sausage generally depends on the grade of surimi. Alaska pollack and threadfin bream are excellent raw materials for sausage production (Muraleedharan, 2003; Rajalakshmi, 2007). Heat sterilization should be as perfect as possible in sausage processing. One of the important organisms to be monitored in sausage is *Clostrodium botulinum*. This bacterium should be totally absent since its spore is highly heat-resistant. Strict hygiene according to HACCP should be followed in the plant to avoid microbial contamination and maintain product quality. Natural casing (mostly intestines of animals) is prone to more contamination. In the past, many preservatives were used in sausages to prevent microbial growth. Earlier AF-2 was used but its use was banned in 1974 by Japanese Health Authorities. Presently, synthetic casing, poly-vinylidine chloride, is widely used because of its excellent physical properties, heat shrinkability and barrier properties.

Chitin

The shrimp processing industry in India churns out more than 1.25 lakh tones of head and shell waste per annum. Until recently, it was creating enormous environmental pollution problems. Nearly 7,000 t of chitin can be produced from the shrimp shell which is thrown out as waste. Chitin is extracted from the prawn shell, as this is the raw material for production of chitosan and glucsamine hydrochloride. Chitin is a macromolecular linear polymer of anhydro-N-acetyl D-glucosamine whereas chitosan is its deacetylated form. Glucosamine hydrochloride is produced by the hydrolysis of chitin by hydrochloric acid. During the extraction of chitin, the protein in the shell can also be recovered for use in animal feeds. CIFT has developed technology for production of chitin, chitosan and glucosamine hydrochloride from prawn shell waste. The laboratory method worked out for preparation of chitosan is summarized below (Madhavan and Nair, 1974):

- Treat the washed prawn shell with 1.25N hydrochloric acid (commercial) at room temperature for 2 hours so as to remove the calcium and other mineral contents in the residue completely. Wash the residue free of acid. This step is called demineralization.

- Boil the demineralised shell in about 3 per cent solution of sodium hydroxide (quantity just enough to immerse the shell) for about 30 minutes. Drain off the solution and repeat the treatment with the residue. Treatment with sodium hydroxide removes the protein content of the shells. This step is called deproteinization. Wash it free of alkali. The residue obtained is almost pure chitin.

The yield of chitosan is about 4% of the weight of the fresh shrimp shell and 20% of the dry shell.

Glucosamine hydrochloride

Chitin can be hydrolysed to glucosamine hydrochloride by adding concentrated hydrochloric acid and warming until the solution no longer gives opalescence when it is diluted with water. The excess acid can be distilled off under vacuum. The crude glucosamine hydrochloride is diluted with water and clarified with activated charcoal. The solution is filtered and evaporated under vacuum. Addition of alcohol can separate glucosamine hydrochloride from the solution. It has got number of applications in pharmaceutical field Glucosamine hydrochloride and sulphate are at present marketed as food supplement for the treatment of osteoarthritis (Santhosh and Mathew , 2009). Anti ulcerogenic effect was recently reported by Santhosh *et al.* (2005). A number of products which contained glucosamine hydrochloride as ingredient are available in the market.

Carboxymethyl chitin

Carboxy methyl chitin is another value shot derivative of chitin. The conversion of chitin into carboxymethyl chitin came in to practice by carboxymethylation. It has successfully proved its use in the field of cosmetics as moisturizer, smoothener cell activator and a cleaner for face skin conditioning It is used for the preparation of food products also. Another innovative use for carboxymethyl chitin is in wound dressing, due to its hydrophobicity (Sini *et al.*, 2005).

Chitosan

Chitin is dried or centrifuged or pressed to remove water. The deacetylation is done by heating at 90-95°C with 40% (w/w) caustic soda for 90-120 min. The water present in the chitin cake should also be taken in to account while preparing caustic soda solution. To achieve this concentration, 50% caustic soda is prepared by adding calculated quantity of alkali and it is then added to the chitin cake. Completion of conversion of chitin to chitosan is tested by the solubility of the residue in 1% acetic acid. As soon as the dissolution is completed caustic soda is removed from the reaction mixture. The drained caustic soda can be reused for the next batch of deacetylation by fortification with alkali if necessary. The residue is washed repeatedly with water to make it free of alkali. It is then centrifuged and dried in the sun or an artificial drier at a temperature not exceeding 80°C and pulverized to coarse particles.

Chitosan is almost colourless, light in weight and soluble in dilute organic acids but soluble in water, alkali and organic solvents. It gives viscous solution when dissolved in dilute organic acids such as formic acid, acetic acid etc. Chitosan finds extensive applications in food industries, pharmaceutical applications, chemical industries, dental and surgical uses as a haemostatic agent, wound healing, biodegradable films as a substitute for artificial skins for removing toxic heavy metals, wine clarification, industrial effluent treatment, agriculture, photography, cosmetic applications and textiles and as an immobilizing agent for enzyme reactions (Muzzaraelli, 1977; Madhavan and Nair, 1978; Spreen *et al.*, 1984; Nair *et al.*, 1987; Muzzaraelli *et al.*, 1988; Nair *et al.*, 1993; Muzzaraelli, 1996; Santhosh, 2006; Rajalakshmi and Mathew 2007).

Biodiesel and biogas

Biodiesel prepared from the oils and fats of vegetables and animals, is a substitute for or and additive to diesel derived from petroleum. The method of production of biodiesel from fish source is reported by Arvanitoyannis and Kassaveti (2008). Fish oil was filtered and placed in a reader with catalysts iron oxide and calcium phosphate and mixed with ozone bubbling for 1 h at room temperature. It is filtered and again treated with ozone at same condition for 30 min without the presence of the catalyst which is called secondary treatment. Density, flash point and Sulphur content are important parameters of the biodiesel.

Conclusion

Fish waste stands for one of the continuously gaining ground waste management fields. The most important products prepared from the fish waste are collagen, antioxidants isolation for cosmetics, biogas and biodiesel. Dietic application of chitosan and use as a food packaging material are also worth mentioning. Most of the byproducts prepared are used for pharmaceutical purpose or for food purposes.

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