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Utilisation of tuna resources: Some by-products

Tuna is the most widely consumed sea food, and is the corner stone of the global fish trade. The world tuna market can be divided into two distinct types: The higher prized *Sashimi* market, which consumes fresh and uncooked tuna; and low, priced canned tuna markets. A third segment involving trade in fresh and frozen tuna, particularly loins, is coming up well. The other tuna products which are of importance are breaded and battered products, sausages, pickled tuna, smoked tuna and other value added by-products which can ensure total utilisation leading to zero wastage during processing.

Tuna, commonly known as chicken of the sea is highly prized and relished in a wide variety of forms. Currently tuna contributes 8% of the total fish commodity traded internationally in terms of value. The major species include yellowfin (*Thunnus albacares*), bigeye (*T obesus*), bluefin (*T thunnus*), skipjack (*Katsuwonus pelamis*) and albacore (*T alalunga*). Yellowfin and albacore are tropical warm water highly migratory species that are found throughout the world oceans. Skipjack tuna contribute to the third largest single species of capture fisheries.

The main internationally traded tuna forms are raw material for canning (fresh, frozen and pre-cooked loins), tuna for direct consumption (fresh, chilled and frozen) and canned tuna (solid pack, chunks, flakes and grated). *Sashimi* grade tuna is a delicacy in Japan and is from very fresh tuna. Bluefin, bigeye and yellowfin are the most preferred species for *Sashimi*, whereas skipjack and yellowfin are preferred for canning. Canned products are packed in oil, brine, spring water or sauce. The principle producers of canned tuna are Thailand, the Philippines, Indonesia and Spain. USA is by far the main canned tuna importing country followed by European countries.

By-products from tuna processing waste

Tuna is generally processed as raw meat and marketed as loins/steaks or as a canned food. In the canning process, only about one-third of the whole fish is available for value addition. Processing discards from the tuna canning industry are estimated at 450 000 mt annually. With profits getting leaner due to global competition, tuna industry would do well to look into the possibility of developing by-products from the waste from tuna processing. By-products from tuna would include skins, heads, bone, viscera and muscle after loins. The by-products from the waste could be processed for the food, feed and pharmaceutical industries. Value addition and waste utilisation are two

areas in the tuna industry which have shown some interesting developments over the last few years. There has been significant growth in non-canned, innovative value added tuna products in some major markets such as US, Japan, and EU.

Tuna silage

Silage processing which does not depend on quantity is a good option for value addition. Fish silage is a liquid product made from whole fish or parts of the fish to which no other material is added other than acid and in which liquefaction is brought about by enzymes already present in the fish. The main benefit of silage is the high level of protein and essential amino acids in the proteins especially lysine. Fish silage is usually added to pig, poultry and aqua feed to substitute for fish meal which is one of the most expensive ingredient added to feed.

Tuna protein hydrolysate

Fish viscera and frames are used as a potential source of protein hydrolysate which is defined as proteins that are chemically or biologically broken down to peptides of varying sizes. The fish protein hydrolsyate is of increasing interest due to their potential application as a source of bioactive peptides.

Tuna bone powder

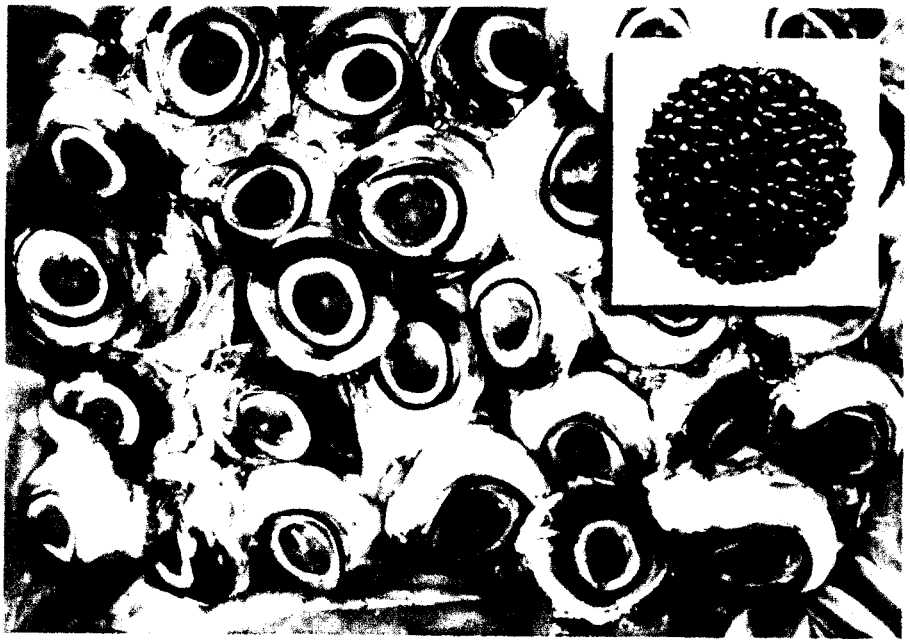
Fish bone contains proper balance of calcium and phosphorous that can be used as a calcium food supplement mainly in animal feed. It can be an environmental hazard if disposed without any value addition. Such food supplements can be taken as an alternative to drugs to treat osteoporosis.

Tuna gelatin

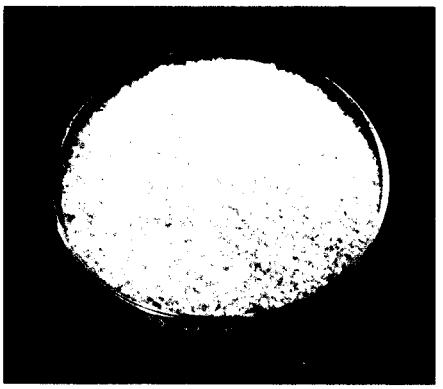
Gelatin is a hydrolysed form of collagen and is a gelling protein which has widely been applied in the food and pharmaceutical industry. Industrial application of fish gelatin are in the areas of micro encapsulation, light sensitive coatings, low set time gels, and as an active ingredient in shampoo with protein. Gelling needs large molecules greater than 10 000 D and the non-gelling contains smaller molecules less than 10 000 D, since gelatin extracted from tuna contains a higher percentage of molecules larger than 10 000 D, it has good gelling property and has the potential to use as a gelling agent in the food industry.

Tuna oils

Tuna orbital oil comprises of a total lipid content of 22.4% of which PUFA constitute 26.4 g/100g extracted oil, DHA 19.7 g/100 g and EPA 3.9 g/100g. The sum of n-6 is 3.8 g/100g and MUFA constitute 23.3g/100g. Tuna eyes are one of the most popular 'Brain foods' in Japan. Fish heads are a culinary delicacy in most Southeast Asian countries. However, the health food image of tuna head, particularly tuna eyes, is unique in Japan. The popularity has also related to the reported high DHA/EPA content of eye muscles. Tuna eye balls are now available pre cooked and vacuum packed.



Tuna eyes and encapsulated tuna orbital oil (inset).



Gelatin from tuna.

Tuna meal

The wastes from tuna processing plant, especially head, fins, bone and red meat can be effectively utilised by converting them into valuable fish meals to be used in cattle/poultry/ pet feed manufactures.

Tuna viscera powder

Tuna viscera powder is made from tuna viscera and the resulting hydrolysate is formed by enzymatic action. It can provide fish flavour to animal feed products which attracts fish and shrimp or as a flavour enhancer in pet foods. It is soluble, dark brown coloured, hygroscopic (moisture absorbing) powder.

Functional protein concentrates from little tuna

Mechanically separated mince from tuna is first washed with water, then with 2% (W/V) aqueous solution of sodium bicarbonate and finally with water to remove pigments, lipids, colour and odour bearing compounds. Homogenisation of the washed meat in water followed by acidification of the dispersion with acetic acids produced

a weak gel which was diluted and spray dried. Protein powder contained 5% moisture, 1.2% lipids and 89.55% protein with good functional properties.

Fish calcium

Tuna bone can be used as calcium source, and is effective in maintaining skeletal metabolism. Calcium powder processed from the back bone of tuna can be used to combat calcium deficiency in the diet of children, which causes weak bones and spine curvature problems. The method mainly involves removal of the gelatin from the crushed bone and pulverising the remaining portion. First the bone frame is crushed and washed in clean water many times. A solution containing 10% calcium carbonate is then added to the residue and left for an hour. After draining off the solution, washing and treatment with calcium carbonate solution is repeated several time. Finally, the washed bone residue is dried and pulverised to the required mesh size.

Tuna skin leather

Tuna skin can be used for producing good quality leather. This can be used to manufacture leather products like bags belts, wallets, slippers *etc.*

Tuna flavour powder from cooking juice

Spray dried tuna flavour powder for human consumption obtained from tuna precooking juice is an effective way to utilise this waste from canning factories. Tuna precooking juice was centrifuged and concentrated to 15% total soluble solid (TSS) by flash evaporation. Maltodextrin (DE 9) was added to increase the TSS of tuna precooking concentrate and then dried by spray dryer at 180°C inlet air temperature. Based on the composition and physical properties, the spray dried tuna flavour powder produced from 22% TSS tuna precooking concentrate was providing desirable finished product.

Enzymes from the gut of tuna

Rennet is a complex of enzymes produced in mammalian stomach and is often used in the production of cheese. Fish gut also has proven to be an excellent source for rennet. Six proteolytic active enzyme fractions were separated from bigeye tuna stomachs by isoelectric focusing. Comparison of proteolytic activity of tuna gastric and commercial rennet enzymes on milk clotting showed that bigeye tuna protease can more efficiently clot milk at low temperatures.

Tuna skin.

Silo feed (fish feed) from tuna waste

Tuna waste obtained during processing can be used as a raw material for the production of fish feed. Waste generated during processing of tuna was converted in to a liquid protein source by converting into silage. The silage was mixed with cereal flours followed by cooking and extrusion in a single screw extruder and drying at 60°C. Feed after drying was packed in polyester/polythene laminated bags. Silo feed was found to be rich in protein (46%), fat (7%) and ash (7%) content. Feeding trials conducted by Central Marine Fisheries Research Institute, Cochin proved that it is a promising feed for seabass, grouper and cobia.

Silo feed.

Pig feed from tuna waste

Pig feed from tuna red meat.

Red meat from tuna is usually discarded during processing; it contains about 18% protein and other essential nutrients. To utilise this portion, red meat was converted into silage which can be stored in plastic drums. It can be used as ready protein source for the preparation of pig feed. For the preparation of this feed, rice bran and liquid red meat silage is mixed with different proportions to get different protein content of finished product. This dried feed can be packed in moisture proof HDPE gusseted bags. Pig feed prepared by mixing 1kg rice bran and 400 ml red meat silage is having 20% protein, 23% fat and 8.8% ash content.

Pet food from tuna waste

CIFT Cochin has developed a pet food from tuna processing waste. Tuna processing waste was dried at 60°C for

Pet feed from tuna waste

Tuna kure.

12 hours and powdered. This powder was mixed with cereal flours and extruded using a single screw extruder. Nutritional quality and acceptability of the feed was analysed. The pet feed was found rich in protein (20%), fat (5%) and ash (3.5%) content including good acceptability.

Extruded snack 'Tuna kure' from tuna red meat

Tuna red meat from the processing plants can be incorporated with the cereal flour to develop a new ready-to-eat product by extrusion technology. The required quantity of the ingredients (cereal flours, red meat mince, salt and spices *etc*) were weighed and mixed in a silent cutter. The ingredients after mixing were then sieved through 1 mm mesh size sieve and kept for moisture equilibration for 45 minutes at 20°C. After equilibration the mix was extruded at a temperature of 140°C maintaining a screw speed of 360 rpm and feed rate of 200g/ minute using a twin screw extruder. The product obtained was then coated with spices in a coating pan and packed in 12µ metallised polyester - 60µ polythene laminated pouches with nitrogen. This innovative and convenient product has been named as 'Tuna Kure'.

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