Fermentation involves the breakdown of proteins in the raw fish to simpler substances which are themselves stable at normal temperatures of storage. In some processes where it is controlled by adding salt, only a partial breakdown of the protein takes place so that a desired type of flavour is produced simultaneously ensuring preservation of the product. Breakdown of proteins is brought about by the action of enzymes and sometimes microorganisms are also involved.

Fermentation technology for the preservation of fish has been very popular from time immemorial. Fermented fish pastes and sauces are relished as a condiment (flavoured salt) along with cooked rice in many of the South East Asian countries. On daily basis, nobody consumes large quantity of these products but almost every one consumes a little bit every day.

Types of fermented fish products:

i) Products in which the fish retain substantially their original form or preserved as large chunks. Examples: pedah siam (Thailand), makassar (Indonesia), buro (Philippines), Colombo cured mackerel (India)

ii) Products in which fish are reduced to a paste. Examples: ngapi (Burma), prahoc (Kampuchea), belachan(Malaysia), trassi (Indonesia), bagoong(Philippines)

iii) Products in which fish are reduced to a liquid. Examples: budu (Malaysia), patis (Philippines), nuoc-mam (Vietnam) , nampla (Thailand)

Traditional fermented fish products are basically salt fermented products. Depending on the proportion of salt added, the products can also be classified into high salt (more than 20% of total weight), low salt (6 to 8%) and no salt products

The dominant flavour giving components of fermented fish products are proteins and their hydrolytic cleavage products such as peptides, peptones, amino-acids; higher fatty acids and their esters; glycerides and their derivatives, monosodium glutamate, nucleotides and inosine monophosphate

Nutritive value of fermented fish products:

Fermented fish sauces and pastes generally contain amino acids and polypeptides equivalent to about 10% protein. Amino acids occur in such products without much change in composition and quality with respect to fish and hence contribute towards nutrition just like fish protein. They are good sources of calcium, iron and some B group vitamins. However, nutritional importance of these products is limited by its high salt content which restricts its bulk consumption. Moreover, these traditional products are used as a condiment rather than to derive nutrition

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Byproducts

Fish processing and filleting industries turn out large quantities of fishery waste which are good sources of high quality protein, fat minerals etc. The shellfish processing industry is also a major source of waste comprising of head and shell. The proper disposition of such fish and fishery waste is achieved by processing these wastes into different products intended for human consumption, animal nutrition or industrially useful products. These are generally termed as byproducts.

Fishmeal

- Fishmeal is a highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. It is produced by cooking, pressing, drying and grinding the skeletal remains along with the adhering proteinaceous tissues of fish from filleting or canning operations or by processing whole miscellaneous fish mainly caught along with prawns, which include Jew fish, Sole, Silver bellies, Ribbon fish and the like.
- The composition of fishmeal differs considerably due to the variations in the raw materials used and in the processing methods and conditions employed. Fishmeal is rich in all essential amino acids, B group vitamins and minerals

particularly phosphorous and calcium and therefore finds an important place as a feed supplement for poultry and cattle.
- The main raw material for fishmeal is the abundant but sporadic catches of oil sardine on the West Coast. In addition to this the fishmeal plants also draw some of the miscellaneous fishes like silver bellies, flat fish, ribbon fish, juveniles of some commercially important fishes, wastes from fish canneries etc. as raw materials for fishmeal and oil production.
- Traditional fishmeal production in India was from the sun-dried fish collected from various drying centers all along the coast and the product was chiefly used as manure. Better quality fishmeal has been a prominent item of export from the very beginning of this industry. The importance of improving the quality for better use was felt and the Ministry of Food and Agriculture has, as early as in 1959, laid specifications regarding the quality of fishmeal. Later the Indian Standards Institution has brought out the Indian Standards Specification (IS: 4307-1967) for fishmeal as livestock feed for facilitating proper quality control.

Manufacturing process

Fish can be reduced to fishmeal by two general processes:

- Dry-rendering.

Dry-rendering or dry-reduction process is suitable only for lean or non-oil fish such as silver bellies, Jew fish, sciaenids, ribbon fish, sole, anchoviella, carcasses of shark etc., fish offal and filleting waste. In this process if the quantity of fish processed is very small, it is dried to a moisture content of 10% and pulverised. If the quantity to be handled is sufficiently large a steam-jacketed cooker-dryer equipped with power driven stirring device is used. Sometimes, if the size of fish is comparatively large a coarse grinding is also done before being fed into the cooker-drier. The cooker drier may be operated at atmospheric pressure or under partial vacuum.

Being a batch operation the process will have only limited capacity and labour costs will be high. However, the water-soluble materials are retained in the meal. It has the additional advantage for changing the operating conditions like cooking time and temperature depending on the raw material handled.

- Wet-rendering.

Wet-rendering

Wet-rendering or wet reduction process is normally applied to fatty fish or offal where simultaneous production of fishmeal 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, centrifuging the press liquor to remove suspended particles and to separate oil and concentrating the stick water. The process requires elaborated 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 or fresh raw fish or offal is passed through a stationery horizontal cylindrical cooker by means of a screw conveyor at a predetermined rate. Steam is admitted into the cooker through a series of jets. While the cooked mass is pushed forward by the conveyor the expressed liquid is allowed to drain through a screen on the bottom half of the cylinder. The cooked mass is passed through a continuous screw press. The press cake is fluffed and dried to a moisture content about 8%. The suspended fishmeal present in the press liquor is separated by centrifugal sedimentation and the oil by centrifugation or other conventional methods.

Fish liver oil

From time immemorial fish liver oils were used for the treatment of vitamin A & D deficiency diseases. The therapeutic values of fish liver oil was discovered in the 18th century and fish liver oil became a common medicinal product. Both vitamin A and D are found in certain fish liver oils. The most important fish liver oils are obtained from cold, haddock and shark. Halibut and Tuna livers are also rich sources of vitamin A & D. The weight of liver, fat content and presence of vitamins are dependent on a number of factors like species, age, sex nutritional status stage of spawning, and area from where it is caught.

In Cod (Gadus collarius), Coal fish (Pollahius vireus), and Haddock (Melanogramms aenglefinus), the weight of liver normally amount to 4 to 9% of the whole fish and livers contain about 45% to 67% oil. The species of shark such as dog fish (Squalus acanthias), Greenland shark (Somniosus microcephalus) and basking shark (Certorhinu maximus) have large fatty livers weighing up to 10 – 25% of the whole fish containing 60 – 75% oil. But halibut, tuna and whale have 1 % liver having 4 to 25% oil with high vitamin A & D potency.

Elasmobranch fishes, Sharks, Skates and Rays constitute a good percentage of the total marine landings in India. Of these, sharks possess commercial importance owing to their liver oil content. Sharks are available in the east and west coasts of India and their size vary from 25 cm to about 600 cm. Of the 37 species of sharks available in Indian waters, only certain varieties, viz. Tiger shark, black fin shark, hammer headed shark and saw fish, are commercially important, and yield liver oil with vitamin A content. The potency of vitamin A has been reported from 1000 to 3,53000 International Units per gram and oil content up to 80% weight of liver. With decreasing fat content, the colour of liver changes from yellow to brown and texture from soft to firm. In India a shark liver oil factory was in existence at Calicut in 1854 which had to be closed down due to competition from imported cod liver oil. The industry was revived in 1940 with the establishment of a shark liver oil extraction unit at Calicut by the Govt. of Madras. The industry again is facing another set back with the introduction of synthetic vitamin A. Present trend is that shark liver oil is valued for highest unsaponifiable matter in the form of squalene which is present in the liver of certain species of deep sea shark. Apart from liver oils, shark fins and teeth are also items of commercial importance.

Depending on the oil content and vitamin A potency fish livers are generally classified into three groups:

- Low oil content – High vitamin A potency
- High oil content – Low vitamin A potency
- High oil content – High vitamin A potency

Preservation of livers for oil extraction

The fish is to be eviscerated and livers processed as quickly as possible, especially in warm climates to obtain high quality, light coloured oil with good flavour and odour having minimum free fatty acids (FFA). The FFA content of good quality liver oil should be less than 1%. The spoilage of livers may be

- Chemical spoilage causing rancidity
- Biochemical spoilage caused by enzymes
- Microbial spoilage resulting in fermentation or putrefaction.

Before processing, the livers should be freed from gall bladders and other visceral matter and washed to remove slime.

Processing

The processing procedures of fish livers without affecting the quality of the oil extracted can be summarised as:

- Steaming
- Solvent extraction and
- Alkali/ednzyme acid digestion.

The process selected should depend on the vitamin and oil content of the livers. Depending on the oil content and vitamin A potency., fish livers are generally classified into three groups as :

High Oil – Low Vitamin A Livers : In such livers the large volume of oil present acts as a solvent for vitamin A thereby facilitating the extraction. The method of heating the fish livers with steam, either directly or indirectly was employed for extraction. Cooking results in the thermal rupture of the cells and releases the oil. If heated indirectly in steam jacketed kettles, it should be stirred mechanically to facilitate digestion.

Low Oil –High Vitamin A Livers : For such livers which maintain only very low oil but high potency vitamin the direct or indirect steaming procedure will not release the oil without degradation of vitamin A. In such cases the protein is digested and solubilized to release the enclosed oil and vitamin A or a solvent is used to extract the oil. The different methods of digestion employed are:

- Alkali digestion
- Enzyme and alkali digestion
- Acid digestion.

Mild alkali digestion is the easiest and most general practice followed in many establishments. The process involves addition of 1 – 2% by weight sodium hydroxide or 2 to 5% sodium carbonate to the disintegrated livers and heating to 80-90° C with live steam while stirring. This results in the release of vitamin A and oil from the cell. The digested liquor is centrifuged while hot, to separate the oil.

Livers with very low oil content which do not yield their oil directly are minced and covered with any suitable oil and heated, with stirring, to extract the oil soluble vitamins and centrifuged. The process is repeated for further recovery of oil and vitamins.

Heating the livers with steam applied either directly or indirectly has been generally employed for the large scale extraction of oil. For this purpose various processes/equipment are used in different countries, the important among them being (1) Malbu cooker (North Cape Cooker),j (2) Lofoten and Finmark Cooker (3) Scholotterhose vacuum Cooker (4) Titan Plant (5) Delaval Process. All these equipment and processs are for large scale extraction of oil and are expensive.

For small scale and cottage scale extraction of good quality liver oil, the following method may be adopted:-

The livers are chopped into small pieces. They are then mixed with ½ to 1 part of water and heated in a cooking vessel described in the extraction of fish body oil to a temperature of 80-90°C for one hour. The mixture is stirred well and heating controlled to keep the mass around 90°C. The floating oil is transferred to a separating vessel. The residue is taken in a canvas bag and pressed in a screw press and the press liquor is collected for separation of the residual oil.

The oil water separator is a galvanized iron cylindrical vessel with two outlets, one at the bottom, and one at half way up the side fitted with stoppers or valves. The oil water mixture collected during cooking or from the screw press is taken in the separator and allowed to stand for about 30 minutes when the oil and water separates in two layers, the oil remaining at the top. After separation, the oil is run off through the side outlet, a suitable oil level being maintained by adjustment of the water level in the tank by means of the bottom outlet. The equipment is simple and easy to construct and can be built by any sheet metal workshop.

High oil content with high hydrocarbon content (chiefly squalene) : Squalene a highly unsaturated aliphatic hydrocarbon, is present in certain shark liver oils, mainly of the family Squalidae, cod and some vegetable oils like olive oil, wheat germ oil, rice bran oil. Chemically it is known as 2, 6, 10, 15, 19, 23, hexamethyl-2,6, 10, 14, 18, 22 tetracosahexaene having a molecular weight of 410.70. it is an isoprenoid compound containing six isoprene units