2. Fish Meal: An Overview
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Fish is an important and valuable source of proteins. Fish processing operations generate huge amount of waste which poses a threat to environment if not disposed properly. Utilization of fish processing waste for preparation of fish meal reduces the threat component and in addition produced fish meal would be a good alternative as ingredient in fish feed (Murthy et al., 2013). Apart from whole fish, fish byproducts are also utilized in fish meal production (Zynudheen et al., 2004).

Fish meal: Historical perspective
Fish meal production began in Europe and America way back to 1800th century. The purpose of production of oil was mainly for preparation of soaps and residual fish meal as manure. Fish meal and fish oil are considered as traditional byproducts in fish processing sector since 18th century. Fish meal production process is dependent on the fish composition, type of fish used for production especially, fat content of the fish. High protein content in fish meals allows its use in animal feed and poultry feed as an important ingredient.

What is fish meal?
Fish meal is solid product which is obtained by grinding the fish and fish byproducts and removal of water and all/ some oil (Ruiter, 1995). It is a solid product obtained by removing most of the water and some or all of
the oil from fish or fish waste. Fish meal is generally sold as a powder, and is used mostly in compound foods for poultry, pigs and farmed fish; it is far too valuable to be used as a fertilizer. Fish meal is regarded as highly concentrated nutritious supplement in feeds which contains high quality proteins, vitamin-B, minerals, etc. General fish meal production method includes cooking, pressing, drying and grinding the fish.

Raw material used for production of fish meal can be any type of fish, miscellaneous fish, bycatch, canning waste, filleting waste, waste obtained from processing of whole fish and shrimps and the like material.

Fish Meal Manufacture involves dry and wet rendering out of which dry rendering is suitable for lean varieties of fish whereas wet rendering is suitable for fatty fish species.

Fish meal is rich in proteins followed by ash, fat and moisture contents. Water soluble vitamins are found in fish meal. It is regarded as source of vitamin D as well due to the residual oil from the oil manufacturing process. Specifications related to fish meal include grade I fish meal should not contain more than 10 percent moisture. Nutritional composition of fish meal depends on several factors which include quality of raw material used for production of fish meal, fishing season for the raw material caught, fat content in fish and many more.

**Fish meal storage and transportation**

Due to the lower content of moisture in fish, it is not readily spoiled. There is no need of refrigeration for storage of fish meal. It is usually stored in sacks, plastics, and transported. Difficulty in storing fish meal is oxidation due to the oil present in fish meal. Ethoxyquin is added as an antioxidant in
fish meal. Storing fish meal in a cool and dry place which is free from rodents and birds is always advisable. Clean and hygienic practices of handling are important.

**Uses of fish meal**

Fish meal which was used only as fertilizer since 1910 is being utilized in animal feeds. It is commonly used in poultry and pig industries as feed ingredient. Feeds of dogs, cats and other pets are also prepared using fish meal as an ingredient. Fish meal is considered as a major ingredient in aqua feeds as well. Fish meal in diet formulation enhances feed efficiency and promotes growth through better food palatability. It enhances uptake of nutrients, digestion and absorption too. The balanced amino acid profile and high palatability of fish meal provides synergistic effects with other animal and vegetable proteins in the diet to promote fast growth and reduce feeding cost. Fish meal provides a balanced amount of all essential nutrients including amino acids, phospholipids, and fatty acids (DHA or docosahexaenoic acid and EPA or eicosapentaenoic acid), mineral content, for optimum development, growth, and reproduction, especially of larvae and brood stock. The incorporation of fish meal in artificial feed imparts a natural characteristic to the final product.

Fish meal contains high amount of essential amino acids such as lysine which is often deficient in grains. It also has a high methionine and cysteine content. Other vitamins in fish meal include choline, niacin, pantothenic acid and riboflavin. It is a good source of calcium, copper, iron, phosphorous and other trace minerals. Fish meal is low in fiber and easy to produce.
Measuring the quality of fish meal

Quality evaluation of fish meal is measured on the basis of specific components. There is no single laboratory test for estimation of total quality of fish meal. Amino acid analysis of fish meal gives useful outline but is very expensive technique. Availability of lysine is measured is probably useful method. Microbiological safety of fish meal is one of the most important criteria. *Salmonella* is one of the important microorganisms when fish meal quality is concerned.