A Perspective on the Fishmeal Industry in Gujarat

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About 40,000-50,000 t of fishmeal is produced annually in Gujarat. Fishmeal is a nutritious and widely used feed supplement rich in protein and B vitamins. Bycatch derived from multi-day fishing trips, which is poor in quality, is presently being used as the raw material for producing fishmeal. The availability of low cost fish or less utilized fish species is on the decline due to various reasons. The main constituents of bycatch are juveniles of fishes like ribbonfish, sciaenids, perches and other table fishes, shrimps, anchovies, squilla, puffer fish, crabs, etc. In the winter months, puffer fish, crabs and squilla contribute nearly 50% of the total bycatch. There is a practice of salting the bycatch onboard. This leads to an increase in the salt content in the final product. The presence of puffer fish in the bycatch could also lead to toxin related problems in the livestock. Apart from the bycatch, the wastes generated from the processing industry are also used for the purpose. However, due to the poor quality of the raw material and lack of organized activity in this sector, the desirable quality of fishmeal is not attained. A process has been developed for improving the quality of fishmeal by controlled fermentation, accompanied by mineral and probiotic fortification. The main benefits of this type of fishmeal are improved keeping quality due to the dominating probiotic fermentors that inhibit oxidative and autolytic changes in protein and lipid, improved palatability, presence of restorative probiotic bacteria, availability of micronutrients and lower risk of pathogens like *Salmonella*. The technique is low cost and could be easily adapted by the fishmeal manufacturers. This paper deals with the present status of fishmeal industry in Gujarat and its future prospects.

Key words : Fishmeal, bycatch, controlled fermentation, Gujarat

Fishmeal is a very stable solid product obtained by removing most of the water and some or all of the oil from fish or fish waste. It is generally sold as a powder and is mostly used in compounded feeds for poultry, pigs and other livestock. It is a source of high quality protein, essential fat, minerals and vitamins (Nilson, 1950; Orr & Wall, 1957; Anon, 1962; Brody, 1965). It also finds use in aquaculture feed. Fishmeal comprises of high quality and easily digestible protein with a higher digestibility coefficient in comparison with other vegetable

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protein sources. It is also a very good source of essential amino acids like methionine, lysine and cystine. Apart from this it is also a rich source of micronutrients like calcium, magnesium, iron, iodine, etc.

A very important consideration in determining the quality of fishmeal is the content of crude protein. Internationally marketed fishmeal has a crude protein content of 65%. The crude protein content will vary from 57 to 77%, depending on the species of fish used as raw material. The protein content and quality of fishmeal is determined by the quality of the raw materials used. Menhaden accounts for 90% of the fishmeal production in the US. International price of the fishmeal varies throughout the year depending on seasonal variation in supply of fish, both on the basis of quantity and species. The price of fishmeal in India is, however, more or less stable throughout the year.

Fishmeal is believed to be responsible for better growth and egg production when compared to diets not containing fishmeal. This additional response to fishmeal is often ascribed to the presence of unknown growth factors or growth promoters.

Composition of fishmeal

The three major components present in fishmeal are protein, fat and minerals (ash). The proximate composition of commercial fishmeal produced in Gujarat is given in Table 1.

Table 1. Proximate composition of commercial fishmeal and fermented fishmeal

Parameter	Commercial fishmeal	Fermented fishmeal
Moisture, %	13.02	10.00
Protein*, %	41.35-47.54	54.6-60.68
Fat*, %	6.46-7.42	2.16-2.40
Ash*, %	41.11-47.26	33.83-37.59
Acid insoluble ash*, %	8.42-9.67	6.99-7.76

*dry weight basis

Protein

Fishmeal is added to poultry diets as a source of highly digestible animal protein. Protein is added to livestock and poultry diets to supply the amino acids required for maintenance, growth and egg, meat and milk production (Windsor & Barlow, 1981). Animals synthesize proteins from 22 amino acids. Amino acids that cannot be synthesized by the animals have to be supplied in the diet and are classified as 'essential'. Those which can be synthesized by the animal are

termed 'non-essential'. Of these a few are synthesized at rates lower than required and are termed as 'dietary essentials' or 'limiting amino acids'.

The nutritional value of any protein is directly related to its amino acid composition. A protein that does not contain the proper amount of required (essential) amino acids would be an imbalanced protein and would have a lower nutritional value. Cereal derived proteins and most plant protein concentrates fail to supply the complete amino acid needs of the livestock due to a shortage of methionine and lysine. Soya bean meal that is widely used in feeding poultry is rich in lysine and tryptophan but is deficient in sulphur containing amino acids, methionine and cysteine. Fishmeal is an excellent source of all essential amino acids.

Minerals (ash)

Fishmeal is an excellent source of calcium and phosphorous for poultry. The ash (mineral) content of fishmeal can range from 10 to 25%. The higher ash content is an indicator of higher calcium and phosphorous levels. The calcium and phosphorous are in a biologically available form, unlike some of the plant proteins.

Energy

The energy content of fishmeal is directly related to the percentage of protein and oil (fat) in the meal. Usually the metabolizable energy (ME) value of the fishmeal ranges from 2500 to 3200 $kcal.kg^{-1}$. The quantity of the oil present in fishmeal depends on the species, feeding habits of the fish and the methods of processing. The use of antioxidants in the preservation of fishmeal is essential in order to ensure a higher ME value in the feed. Prior to the development of antioxidants, it was a common practice to turn piles of fishmeal in order to dissipate the heat arising primarily out of the oxidative process. Occasionally these piles of fishmeal are vulnerable to spontaneous combustion. It was common several years ago to hear of ships sinking due to fires caused by spontaneous combustion of fishmeal.

Fatty acids

The oil present in stabilized meal has a relatively low concentration of the essential fatty acid, linoleic acid. However, the oil is an excellent source of the fatty acid, linolenic acid. It is also observed that the fishmeal is rich in omega-3 fatty acid and low levels of incorporation of this fatty acid in the diet of poultry resulted in presence of this fatty acid in both meat and eggs. This fatty acid is cardio-protective in nature and is beneficial to human beings.

Fishmeal production in Gujarat

Veraval is the largest landing centre of marine fishes in Gujarat, with approximately 28% of the total catch being landed here. Mechanised trawling is one of the main fishing techniques. Trawling generates a lot of bycatch, as the gear is non-selective. It is estimated that a boat lands around 1 t of bycatch from multi-day voyage fishing and 100-500 kg of bycatch from daily fishing. There are nearly 300 trawlers that operate from this harbour undertaking both multi-day and single day fishing. The bycatch comprises of mostly trash fishes, juveniles of commercially important species, crustaceans, cephalopods, etc. It is locally known as *kutta* and is mainly used for drying, fishmeal and fish manure production. Earlier, species like sciaenids, lizardfish, ribbonfish, big eye, etc., were used for the manufacture of fishmeal. However, due to an increased utilization of these species for human consumption, the availability of these species for fishmeal has decreased. The material that is used for the production of fishmeal is mainly divided into two categories: (i) bycatch from the trawl fisheries and (ii) fish offal and processing wastes. The protein content of commercially available fishmeal varies between 32 and 47%.

Apart from Veraval, raw material for fishmeal is being procured from nearby landing centres *viz*., Okha, Jakhau, Porbandar, Mangrol, Navabundar, etc. Most of the plants are simple drying and pulverizing units. There are presently no operational wet reduction plants in Veraval. There were about 42 plants in Veraval, a few years ago, most of them producing nearly 2500-3500 t of fishmeal per year. At present there are only 28 fishmeal plants producing only 500-700 t per year. The fishmeal produced in Veraval is transported to various states such as Punjab, Karnataka, Andhra Pradesh, Maharashtra, West Bengal, Madhya Pradesh and Tamil Nadu. The most important marketing centres are Ludhiana, Amritsar, Batala, Bangalore, Hyderabad, Salem, Namakkal, Indore and Calcutta. Previously fishmeal was exported to countries in the Middle East, Far East, Southeast Asia and Bangladesh. However, now exports to these countries have been discontinued.

The fishmeal industry is presently facing many problems. As there is a rise in the production of *surimi* products and other value-added products in the Veraval region, most of the low cost fishes are utilized by this industry. Prohibitive cost factors on capital investment, infrastructure, raw material, running costs, etc., have cut into the profit margins. A fishmeal plant requires a regular and steady supply of fish, in order to be economically viable. The fishermen store the bycatch without icing and add large quantities of salt for its preservation. The poor quality of raw material has a deleterious effect on quality of fishmeal. This has led to a decline in the demand of fishmeal from the dairy and poultry sectors. There is a general lack of awareness among fishmeal processors regarding the quality requirements of the raw material.

Development of fermented fortified fishmeal formulation

The feed supplement should contain sufficient quantities of desirable amino acids that are biologically available. Fishmeal on an average contains methionine (3.9 $mg.g^{-1}$) and lysine (10.4 $mg.g^{-1}$). On the basis of feeding trials using chicks, it is noted that the digestibility coefficient for methionine is 97.7% and that for lysine is 92%. It is further noted that only about 90% of methionine and about 80% of lysine are available.

The freshness of the raw material used is critical for the beneficial amino acid content of fishmeal. The exposure of fishmeal to high levels of atmospheric humidity or moisture leads to growth of spoilage causing and pathogenic microorganisms. Fish silage is an alternative for fishmeal. However, fish silage has not become popular due to problems of storage and transportation (Windsor & Barlow, 1981). A biological means of processing protein includes digestion and fermentation to release oil, protein and water from the tissues or fish muscle. A fermentation inocula, comprising of a consortium of lactobacilli (homo and hetero fermentative), lactococci, streptococci, leuconostoc, etc., have a beneficial role in preserving foods, especially in reducing the coliform count. Thus, if these bacteria are incorporated they help by lowering the pH, increasing the storage stability of the product, maintaining the conformational stability of the nutrients and also by having a probiotic role in the livestock being fed.

The aim of developing a fermented, fortified fishmeal formulation was: (i) to have higher levels of biologically useful protein, (ii) to reduce and control spoilage and inhibit pathogens in the finished product, and (iii) to incorporate probiotic and growth promoting factors in the feed. The process for manufacture of fermented fishmeal involves preparing digested liquor of processing plant wastes and fish discards in closed tanks with regulated air inlets and allowing a microbial consortium containing *Lactobacillus*, in a basal fermentation media, to act on the protein rich material. In doing so they release the proteins into the liquid phase and also degrade it into assimilable forms. The fermented material is allowed to mature and a clear liquor rich in protein and also in active probiotic bacteria is obtained at the surface of the fermentation vessel. This liquor is collected and mixed with freshly pulverized dried low value fish. The mixture is allowed to stand for a period of 48 h and adjusted to a moisture level of 5-7%. The fermented and fortified fishmeal (Fig. 1) thus prepared was brown in colour with characteristic fish odour and has better composition (Table 1) compared to that of commercial fishmeal.

The sludge arising out of the fermentation process is mixed with a suitable binder such as groundnut shell and oil seed husks and treated with nitrogen fixing *Pseudomonas*. This could be then used as a good quality bio-fertiliser.

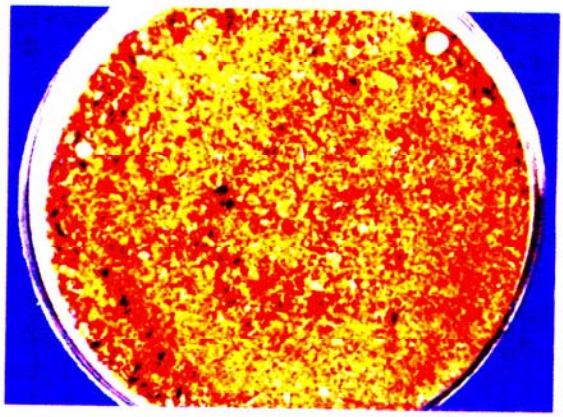

Fig. 1. Fermented fortified fishmeal

The unique features of this process are:

i. Inhibition of formation of spoilage derived biogenic amines by means of probiotic fermentative lactobacilli and yeast;

ii. Fortification of the nutrient content of the product by incorporating homo-fermentative and hetero-fermentative organisms;

iii. Low-cost and eco-freindly technology;

iv. Possible enhancement of value returns due to applications in the bovine or milch animal sector and possible application as pet food supplement;

v. Utlilisation of waste generated from fishing industry as input;

vi. Compatibility with presently utilized and widely practised method of drying of fish and pulverizing it for producing fishmeal; and

vii. Possible generation of bio-fertilizer as a byproduct of the process.

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