Fish Processing Waste: Valuable Raw Material Source for Silage, Foliar Spray and Animal Feed Preparation

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Fishery waste which forms nearly 50% of the total weight of fish landed is an environmental issue in the present scenario. The recovery of biomolecules for the development of various products helps to eliminate harmful environmental aspects and improve quality in fish processing sector in addition to enhancing the profitability of the industry. In this respect the experiments conducted at CIFT has shown that, production of fish silage, foliar spray and feed from fishery waste has great potential as a high end product. However there are certain practical difficulties in the implementation of the techniques for utilisation. The problems in collection and processing is hindered due to highly scattered nature of availability i.e., On board, Fish markets, Preprocessing centres and processing centres. For e.g. Kerala has nearly 150 exporting companies and more than 2400 pre-processing centres. The highly perishable nature is also a major problem of handling the fishery by products.

Fish silage

Fish silage is defined as a product made from whole fish or parts of the fish to which no other material has been added other than acid and the liquefaction of the fish is brought about by enzymes present in the fish. 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 requires oil separation. This involves expensive equipment and is suited to fairly large scale operation. Almost any species of fish can be used to make fish silage though cartilaginous species like shark and ray liquefy slowly. Fish waste, cuttle fish/squid waste can be used for the preparation of silage. The production of silage involves preferably organic acids like formic acid (35kg/tonne) to preserve the fish and then allow the enzymes already present in the fish to liquefy the protein. When 3.5% formic acid is added to the fish the pH will be nearly 4. Mineral acids like sulphuric acid also can be used for this purpose. But in this case pH would be about 2.5, which requires neutralization before formulating feeds to the poultry or cattle. 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 plantarium.*

Foliar spray

Foliar spray is a technique of feeding plants by applying liquid fertilizer directly to their leaves by spraying. Plants are able to absorb essential elements and nutrients through their leaves and absorption takes place through the stomata of the leaves and also through the epidermis. Movement of elements is usually faster through the stomata and this result in faster growth and flowering. Some plants are also able to absorb nutrients

through their bark. The process of foliar spray preparation is by hydrolysing the fishery waste either by adding acid directly as in case of silage or by *in-situ* production of lactic acid by microorganisms. The clear upper portion of acid silage is decanted and suitable diluted and used as spray. In case of microbial process, the fish waste is mixed with a carbohydrate source like molasses and inoculated with lactic acid producing bacteria and the lactic acid produced will hydrolyse the protein partially. It will take 20-30 days for hydrolysis and the upper clear liquid can be used as foliar spray.

Feed from fish processing discards

Feed is considered as the major expense in fish farming, accounting for about 50–60% of the total variable costs. Preparation of feed for aquaculture and poultry is an important option for utilization of general, unsorted waste from industry as well as fish markets. There is a growing demand for pellet feeds, due to the increase in aquaculture activity. Feed is also a major input affecting water quality and subsequently effluent quality in culture ponds. Fish feed management includes several factors viz. choosing the right feed, using a correct feeding method, calculating the feeding cost and ensuring the cost effectiveness of fish farm. Currently, aquaculture accounts for 40.33% of the world's fish production. Fish frames and other discards contain significant amounts of muscle proteins. They have a better balance of the dietary essential amino acids compared to all other animal protein sources. About, 25% of the protein requirement for feed is met from fish waste

Table 1: Fat and protein content of discards from selected species

Fishmeal based Fish feed	Fat	Protein
Sardine fish	3.77	27.6
Sardine waste	7.62	27.70
Tilapia waste	3.58	28.18
Threadfin waste	3.67	28.81
Anchovy fish	5.89	27.10

Preparation of feed from fish waste

The proximate composition and characteristics of many processing wastes suggest that it can be converted directly into feed. Most of these protein sources can be converted to fish flesh, which in turn provides quality protein for man. Utilization of these wastes can be direct or indirect. In direct utilization, either the wastes can be used as such as in the case of meals; cakes etc. or it can be used with some simple processes like fermentation, silage preparation etc. In indirect utilization, the wastes can be utilized as a substrate for the growth of single cell proteins for example, and these secondary products can be included in feed with or without primary substrate.

Table 2: Nutritional composition of fish processing discards

Nutrient	Fish waste
Crude protein (%)	57.92 ± 5.26
Fat (%)	19.10 ± 6.06
Crude fiber (%)	1.19 ± 1.21
Ash (%)	21.79 ± 3.52
Calcium (%)	5.80 ± 1.35
Phosphorous (%)	2.04 ± 0.64
Potassium (%)	0.68 ± 0.11
Sodium (%)	0.61 ± 0.08
Magnesium (%)	0.17 ± 0.04
Iron (ppm)	100.00 ± 42.00
Zinc (ppm)	62.00 ± 12.00
Manganese (ppm)	6.00 ± 7.00
Copper (ppm)	1.00 ± 1.00

Values in % or mg/kg (ppm) on a dry matter basis.

Fish waste can be macerated into paste and prepared at farm site as meal and used for feed. Alternatively, fish waste may be initially converted to meal or silage, which later on can be made into feed after compounding with other essential nutrients like carbohydrate, fat, trace minerals and vitamins. A good amount of research work has focused on the replacement of fish meal in feeds by various processing wastes / byproducts. Fish soluble obtained as a byproduct of fish meal production also serves as an ideal protein source for animal feed. It is rich in B group vitamins and also contains unidentified growth factors. It also serves as an attractant in fish feed. Meals obtained from small prawns, prawn heads, mantis shrimp, crabs and krill is a potential ingredient for shrimp diet. It is reported that the crude protein level varies between 30-50% depending on species and the chitin content is 16%. Ash content ranges from 25- 40%. It is rich in cholesterol, carotenoid pigments, chitin, calcium, iron, manganese, choline, niacin, pantothenic acid and cyanocobalamine. The quality of the silage depends on the freshness of the raw material. Silage has chemo attractant properties due to the free amino acids. About 70 % of the total shrimp production ultimately gets transformed to waste. Replacement of fishmeal by shrimp meal is possible to the level of 10 -15%. Shrimp waste can also be ensiled. Crustacean silage has been found to exhibit feeding stimulatory properties in a variety of fish species. Squid waste which usually includes viscera may also contain head and tentacles, fin, skin and pen accounting for about 52%

of the total weight. Squid processing wastes are important feed ingredients particularly in shrimp diets. Protein content ranges from 70 to 90 %. Squid meal has a fat content of 4 - 7 % which contains high content of highly unsaturated fatty acids. Squid meal has chemo attractant and growth promoting properties. Inclusion in aquafeeds upto 30 % level is possible. Fish silage may be ideally seen as a source of protein and several minerals in feed preparations. Infact, it partially replaces fish meal in feeds (typically 5-15%). Silage contains comparatively, high level of free amino acids and peptides, which improve the growth performance and better disease resistance.

Quality of animal feed

Apart from nutritional composition, the quality of animal feed may be expressed in terms of physical quality and microbial quality. Physical evaluation is easy but tough in nature. One must be highly trained to identify the changes in the nature of the raw materials/ feeds. This primarily involves parameters such as such as bulk density, colour, odour, hardness (force at rupture), durability, pellet size and water stability. Handling practices followed presently for fish processing waste are not adequate and hence may harbour a number of microbial hazards including lethal toxins and metabolites. *Salmonella* is a major bacterial hazard in animal feed. *E. coli* also has been detected in animal feeds. Similarly, the contamination of foods and animal feeds with mycotoxins is a worldwide problem.Mycotoxins are fungal secondary metabolites that have been associated with severe toxic effects to vertebrates produced by many important phytopathogenic and food spoilage fungi including *Aspergillus*, *Penicillium*, *Fusarium*, and *Alternaria* species.

Environmental impacts

The utilization of fish waste derived feed for feeding livestock may clearly create a further range of potential environmental impacts, if proper measures are not taken. In the case of aquaculture feeds, leaching of protein and other nutrients into the pond can result in deterioration of water, if poor quality feed is used. Similarly, trash fish shreds may have greater loss rate (about 40%). Also, the feed residue deposited on the seabed or pond bottom will cause pollution, resulting in a heightened risk of anoxia and mortality rate.

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