14. Agricultural and animal farm inputs from fishery waste

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Introduction

Fish processing industry generates huge quantities of waste in the form of head, skin, viscera, scales and other entrails which comes around 50% of the raw material. Even though the waste contains good protein, it is simply being discarded unscientifically causing serious environmental threats and polluting land and water. At the same time, severe resource scarcity is faced today by the animal feed industry. Conversion of these discarded resources into feed for poultry, fish and other animals can enhance the productivity of the fishery sector to a great extent. Fish processing sector generate two types of waste i.e. solid waste and liquid waste. The solid wastes can be as high as 50–80% of the original raw material which includes dark meat, head, fins, scale, skins, frames, visceral mass, gills etc. Crab shell, shrimp head/shells, cuttle fish skin and bone are generated from shellfish processing as waste. Liquid waste is mainly contributed by effluents consist of blood, slime, mucus, wash off and surimi wash water. A number of products of pharmaceutical, industrial and agricultural application can be attempted from fishery waste which needs to be segregated and properly preserved before converting it into useful products. India still remains as a supplier of raw waste at a meager rate to

developed countries who in turn convert it into high value end products of different applications.

Converting the fish waste into fishmeal is a viable option for stabilizing the otherwise highly perishable waste. The processing making fish meal from waste is almost same as that of making fish meal from whole fish, except modulating the time and temperature of operation and pressing. In the world in fish meal production, India positioned 8th rank with a quantity of about 1.03 lakh tonnes production during the year 2015 (IFFO, 2016). During the five years, it has been observed that the international fish meal prices varied from Rs. 80 to Rs. 120 per kg. In India prices varied from Rs. 25 for traditionally produced fish meal to Rs.65 for fish meal produced by modern fish meal plants. Fish meal is considered as an ideal ingredient in animal nutrition and 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. But the quality of meal from waste is inferior in quality with high content of ash. Fish meal is stable during room temperature storage and used as the protein content while compounding feed. Another option of fish meal utilization is fish silage.

Fish silage

Fish silage is a liquid product and it can be prepared from whole fish or fish waste by adding acid, enzymes, lactic acid producing bacteria or by naturally occurring enzymes in fish. Fish silage is rich in protein and amino acids and it can be used as protein source for animal feeding. Production

cost for fish silage is very cheap, cost effective and eco-friendly. Fish silage preparation usually depends on locally available raw materials and conditions (Hasan, 2003). Depending on the process employed, fish silage can be categorized into two methods, viz. acid silage and bio-fermented silage. Acid silage is produced by mixing fish waste with organic acid (formic acid, acetic acid, propionic acid), inorganic (sulphuric acid, hydrochloric acid) and or a mixture of both organic and inorganic acid. In case of bio-fermented silage, fermentation process is carried out by lactic acid bacteria (LAB) which are already present in a fish mass or added externally. Fish silage can be prepared from whole fish or parts of the fish by adding acid. During this process liquefaction of the fish is brought about by enzymes already present in the fish in which stable liquid with a malty odour, good storage characteristics with all nutrients present in the original material will be obtained. This process requires little capital equipment particularly if non-oily fish are used. If oily fishes are used it needs oil separation which add expensive equipment and is suited to a fairly large-scale operation.

Fish silages are rich in proteins. Fish silage contain higher amount of Lysine, threonine and sulfur containing amino acids as like fish meal. So, fish silage can be used as protein source for feed preparation by replacing fish meal. Foliar spray which contains soluble protein and other micro and macro nutrients is another option for fish waste utilization. In fact it is a ancillary activity of collecting the upper clear portion of fish and packing. This is diluted many folds before direct application on the foliage, which

will give quick results by enhanced productivity in plant. Besides it acts as booster for the plant and also as a pest repellant. ICAR-CIFT has been giving training on production of fish silage and foliar spray from different types of aquatic wastes including cephalopod waste. The incubates of CIFT are currently marketing their products successfully and it is a profitable venture.

Utilization of Fish Silage

Feed

Fish Silage are used for animal feeding, like powder fish silage is used to feed cattle, milk cow, swine, duck, sheep, mink and many other terrestrial animals (Rahmi et al., 2008, Al-Abri et al., 2014, Anuraj et al., 2014). Pigs resulting in higher growth rates improved health and reduced mortality. Fish silage rich in protein and it can be used as a protein source for broiler chicks alternative to fish meal to get increased weight and feed conversion ratio (Kjos et al., 2000). In many countries, it is used as bird feed (Arruda et al., 2007). It is also used as a feed supplement in aquaculture to convert nutrients into flesh. It has been reported that fish silage powder was found to give better growth than a fish meal in carp (Djajasewaka et al., 1986). Fish silage can be used directly as feed for pigs for improving higher growth rate, reduce the mortality and improving heath of animals. Fish silage can also mixed with other ingredients such as grains and dry flour for livestock feed. Since, fish silage contained hydrolysed protein it can be used as protein source by replacing fish meal at the level of 5-15% in fish feed preparation. It has been reported that inclusion of silage in pellet feed

showed stronger, more resistant and reduce the waste during transportation and feeding.

Fertilizer

Fish silage is considered as potential source of Nitrogen, Phosphorus, Potassium, Calcium, magnesium and found to have application as a fertilizer. The quantity of nutrient present in fish silage differ depends on quality of raw material used and percentage of bones and fins. Moreover, adding 5-10 % liquid silage will meet the trace element required for plants.

Fish silage Vs Fish meal

Production of fish silage more suitable in areas where there is no fish meal plant. Advantage and disadvantage of fish silage and fish meal process are summarized below;

Properties	**Fish silage**	**Fish meal**
Capital cost	Equipment required for fish silage production is very low	It requires sophisticated machinery and involves high cost
Process	Flexibility in production and large quantity of raw material can be handled. It can be prepared by unskilled workers	It requires qualified engineers and technical staff
Smell	There is no smell while preparation of fish	If specially equipped machineries not used

	silage and it reduce the ecological problems similar to fly infestation.	smell is a problem
Pathogen	Absence of pathogenic microorganisms and storage at ambient temperature. Moreover, silage either in wet or dried form found to have lower bacterial count	Fish meal is suspected to have pathogen especially Salmonella. Fish meal has higher bacterial count than silage.
Transport	Due to its liquid nature it is expensive to carry. It requires drying before transport	Since it is dry powder form, easy to transport as bulk
Marketing	Requires marketing effort	Well established and product is well known

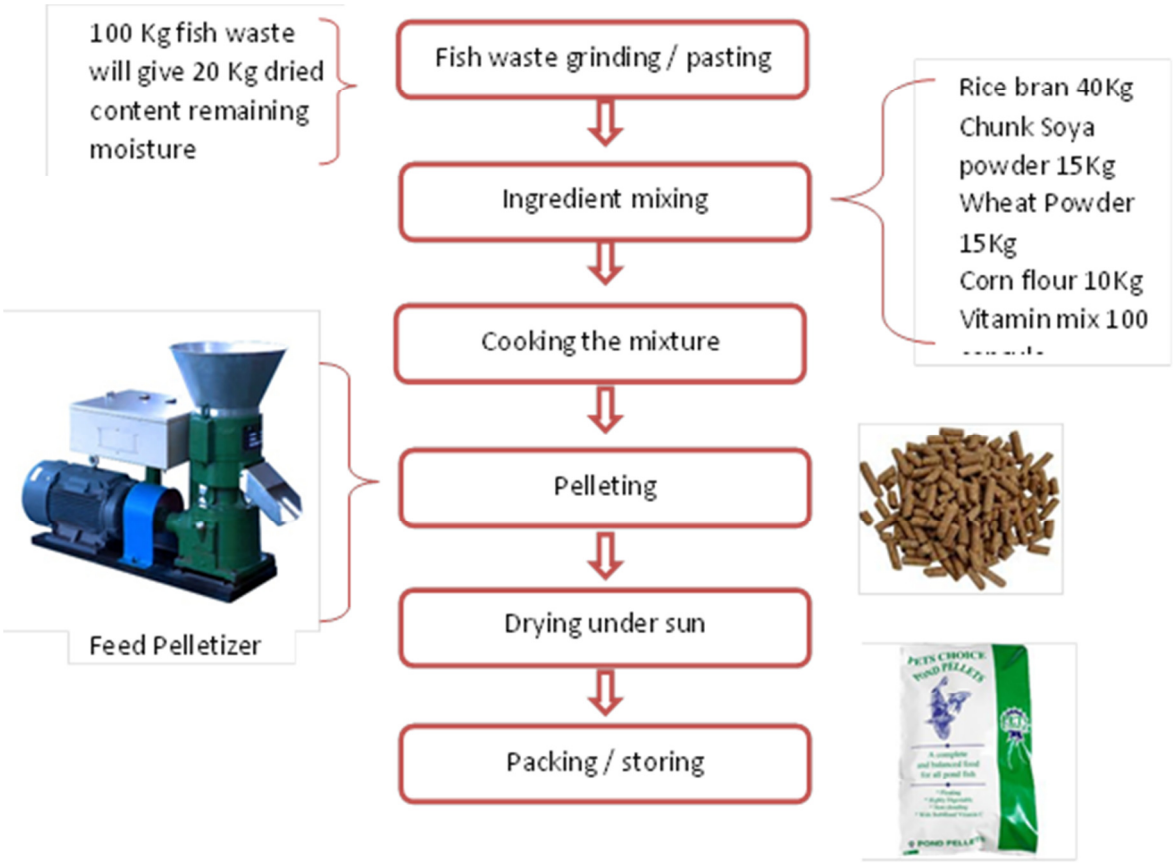
Pellet fish feed production based on fish waste

Preparation of feed for aquaculture and poultry is another 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. A significant portion of costs in the sector is for feed. The cost of feed production can be cut down by utilizing the waste generated from nearby fish markets. Apart from this, trash and juvenile fish from the landing centers can also be used as raw materials for pellet feed production. As mentioned earlier fish meal made from waste can be used for feed preparation. Fish meal quality is determined by its

protein content. Internationally marketed fish meal has a crude protein content of 65% and it varies from 57 to 77%, based on the raw material used for fish meal production.

The technology of feed processing has undergone substantial improvement in recent years from simple hand mixing to the nutritionally balanced pellet feeds available in the market today. This requires a considerable amount of specialized equipment and technical expertise. ICAR-CIFT has been working on technologies for production of low-cost alternatives to commercial feeds using locally available ingredients. The feed ingredients used are rice bran powder, soya powder, wheat powder, corn flour along with fish waste producing low cost fish pellet feeds using small indigenous machinery like grinding/pasting machine, ingredient mixing machine, cooking device and pelletizer etc. The feed developed is comparable to commercial feeds in terms of its quality. This model can be easily setup at the fish farm site itself and based on the fish age and species cultured, the ingredient mixture composition and pellet feed size can be changed considerably reducing the wastage.

The fish pellet feed production process starting from receiving the raw material to finished products is illustrated in Figure.1.



Flow chart of fish pellet feed production of ICAR-CIFT

Fish waste is fed into a magnetic drum which removes the iron and metal pieces from the fish waste. The raw material is then ground into a slurry paste form. Then, calculated quantity of other ingredients are added and mixed properly. This is extruded out after sufficient cooking and the pellets are dried. The process simplifies pelleted feed production by cutting down some steps and amalgamating some important steps. This in turn will reduce the cost of production, handling time and manpower requirement when compared to conventional process.

Economic analysis of the production of Fish feed pellets from the fish waste:

The annual investment is around ₹ 1.65 lakhs. Out of the total investment, machinery items such as grinder and pelletiser cost up to 42% of the total investment. The annual operating cost was around 8.7 lakhs and the main component of the operating expenditure were the raw material cost, which includes fish waste as well as the ingredients constituting 70% of the cost. The annual fixed cost was ₹ 0.33 lakhs.100 Kg fish contains roughly 80% moisture and 20% dry matter. 20Kg of this dry matter is mixed with 80kg ingredient to produce 100Kg pellet feed per day. A break up of ingredient costs excluding fish cost is around ₹4.75 Lakhs, out of which the cost of rice bran was 34%, remaining soya powder 25% and corn flour 17%.

The investment made is found profitable and the option for the fish farmer to start a unit locally is feasible and this technology will act as a way to mitigate the rising cost of commercial feed. Even though the ingredient cost itself was about 54% of operating cost, this can be reduced by using locally available raw materials such as agricultural by products. Species specific feeds with improved nutritional profile can also be thought of catering to the needs of the growing aquaculture industry. The technology will enable the development of rural enterprises to producing affordable fish feed and also generate local employment and economic participation of rural entrepreneurs including women. The technology will improve and fish waste management and address fish waste pollution related issues.