

Fish processing wastes used as feed ingredient for animal feed and aquaculture feed

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Abstract:

Fish wastes management has become a global problem from the last years. Dispose of seafood wastes cause environmental pollution. To overcome this issue these unwanted seafood products are used for the formation of animal feed and aquaculture feed. These unwanted products include small fish and those parts of fish which are not used as human food. These unwanted parts include viscera, head, fins and skin of fish. These byproducts are rich source of protein, minerals and vitamins so these can be used as a supplement in animal feed. These are also used to fulfill the deficiency of protein in animals. These byproducts can be used in the form of fish meal, fish oil, and protein hydrolysates and fish silage. Protein hydrolysates provide high amount of nitrogen and fish oil provide triglycerides of fatty acids and phospholipids in the animal feed industry. These are also used in the formation of pet feed and in the formation of fertilizers. These byproducts are processed for feeding by using fermentation, biotechnological and bio preservation techniques.

Keywords: Seafood, Byproduct, Supplement, Fish silage, Fish oil, Protein hydrolysate.

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Introduction

Fishery wastes have becoming a global issue from the last decade and it is influenced by many technical, operational, biological, and economical factors (Kim and Mendis, 2006; Arvanitoyannis and Kassaveti, 2008).

"Fish wastes" described as different small fish species or unwanted catch products which have very less market value due to short size or any type of injury. Those parts of fish which are not used routinely for eating purpose like head, skin, fins and viscera are also referred as fish wastes. This type of waste makes more than 50% of fish body.

Annually worldwide fishery production includes 25% fish wastes and unwanted fish products (Rustad, 2003). Fish consumption for feed purpose can be controlled at commercial level, industrial level or by aquaculture scientists to save natural resources of fish (FAO, 2011).

Dispose of fish wastes is a main problem in many countries but it can be overcome by using these unwanted products as feed for animals and aquaculture (EU, 2003). Value of fishery by products can be increased at lower level by feed formation from these unwanted products (Ferraro *et al.*, 2010).

The purpose of using fish wastes can be profitable and fruitful by using different techniques to obtaining bioactive compounds which can be used for formation of fish meal and oil for animal feeding (FAO, 2002; Kelleher, 2005).

Literature review

The total fish industry produces only 40 % of fish products used for feeding by human and remaining 60 % are unwanted products comprising skin, head, fins, viscera and trimmings (Dekkers *et al.*, 2011). These unwanted products cause environment contamination and even large quantity of small size fish causes eutrophication in aqueous environment. These unwanted products are rich source of protein which can be obtained by simple techniques and converted into valuable feed items (Hsu, 2010). Different important research studies concluded that seafood and their wastes can be used for formation of fish meal, feed oil, fish silage, pet food and fertilizer (Stepnowski *et al.*, 2004; Ward and Singh, 2005; Kim and Mendis, 2006; Ramírez-Ramírez *et al.*, 2008).

Marine unwanted products

In whole world unwanted fish products are dispose of annually from fish industry. it causes many problems like wastage of nutrients including minerals and proteins and it also cause environmental pollution. Fish industries can use these wastes for developing highly nutritive food products which can provide rich nutrients for animal feed composition. Some unwanted products of fish are following described.

Fish skin

Fish skin is a main source of protein including Gelatin and Collagen.

Research studies on North Atlantic lean fish and grass carp shows that skin of these fish species are rich source of protein which can be converted to protein hydrolysates (Picot *et al.*, 2010; Wasswa *et al.*, 2007).

Fish bones

Fish backbone and cartilage containing high amount of calcium phosphate, minerals and approximate 30 % protein. Scientists done experiment on tuna fish backbone by using different enzymes including proteases, α -chymotrypsin, and neurases to obtain protein hydrolysates (Je *et al.*, 2007). These bone Protein hydrolysates are good antioxidant agents so these are useful for feed formation (Morimura *et al.*, 2002). These days many natural antioxidant and germicides are used to increase food quality and these are obtained from byproducts of food (Ucak *et al.*, 2018). Numerous polyphenols, flavanols, and flavanol glycosides can be obtained from seaweeds. When these compounds are used in food composition can give beneficial effects on human health (Topuz *et al.*, 2016).

Unwanted fish products are used for improvement of agriculture can be divided into dry and liquid or fresh and frozen forms. In agriculture these products are used as a fertilizer after composting of these small fish with large amount of carbon sources such as sea shells and fish bones. These unwanted products are also used in composition of pet feed and as a trap

for catching fish (Wyatt and McCourty, 1990).

Uses of marine unwanted products in animal feed industry

Formation of animal feed from unwanted products of seafood is beneficial for reducing environmental pollution and for providing cheap production of animals (Westendorf *et al.*, 1998; Westendorf, 2000).

Unwanted products of seafood which are used for animal feed composition are freely available because these are not used in human food and also cheap source of feed element. These are rich source of protein and used for the feed composition of aquaculture, swine, poultry and other animal foods (Esteban *et al.*, 2006). Seafood wastes obtained from small fish like white croaker, horse mackerel, flying fish, chub mackerel, and sardine provide lipids, minerals, proteins and fats (Rustad, 2003; Khan *et al.*, 2003).

Fish Meal

Complete fish or unwanted fish pieces have dried and grind in the form of powder to obtain Fish meal. Mostly used fish for fish meal are menhaden and capelin and anchovy (Hevroy *et al.*, 2004). For producing animal feed this fish meal is mixed with other ingredients. Main Chemical composition of fish meal is protein (70 %), minerals (10 %), fat (9 %), water (8 %), pantothenic acid, vitamins, ash and many other minerals. On the basis of

freshness, solubility, types of amino acids and processing method it can be divided into different levels of quality (Barlow and Windsor, 1984; Babbitt, 1990; Gildberg, 2002).

Advancement in techniques of fish meal production developed new less time taking processing apparatus. Fish meal is consumed in production of feed for fish, crustaceans, poultry, pigs, ruminants, and pets. Following table shows different types of fish meals which use in composition of aquaculture feed (Table 1).

Table 1: Examples for the use of different fish meals as an ingredient for aquaculture feed (Malaweera *et al.*, 2014).

Fish meal	Use in
Anchovy fish meal	Salmon
Anchovy fish meal	Shrimp
Alaskan pollock (white) fish meal	Rainbow trout
Groundfish fish meal	Salmon
Herring fish meal	Cod
Mackerel fish meal	Salmon

Fish protein hydrolysates

Fish protein hydrolysates and fish silages are formed from digestive parts of fish and from spleen and gonads. These organs provide nitrogen for feed formation of pets and aquaculture (Martone *et al.*, 2005). Many scientists prove that fish protein hydrolysate can be used in the animal feed industry (Hevroy *et al.*, 2005; Aksnes *et al.*, 2006; Aguila *et al.*, 2007).

Fish oil is also a main ingredient of animal feed which can be obtained from wastes fish and from unwanted products of fish. Composition of Fish oils comprised mainly triglycerides of

fatty acids, phospholipids, wax esters and glycerol ethers (Ruiter, 1995) (Fig. 1)

Uses of byproducts of shellfish

Shrimp waste meal including heads, appendages, and exoskeleton are rich source of lysine. For the composition of broiler feed, shrimp meal can be used in the replacement of fish meal. According to protein quality shrimp waste meal is better than fish meal due to the presence of methionine and lysine in shrimps (Fanimmo *et al.*, 2000). Squid is also an important source of best quality protein (Gokoglu *et al.*, 2017). Oyster shells are also used as a best source for the composition of animal feed (Sathiadhas and Aswathy, 2004).

Red crab is small in size so it is not used as human food but due to its highly nutritive value considered as a suitable source for animal feeds. It contains high amount of protein and minerals (Villarreal *et al.*, 2004), reported good results when using feeds supplemented with red crab meal for the American lobster. Red crab is also enriched with β -carotene, and two esters of astaxanthin (Wilkie, 1972).

Fish waste protein

Fish protein is mostly used as a feed ingredient for poultry and swine. As increasing the demand of fish protein for human food researchers found other sources of protein that can be used for animal feed formation.

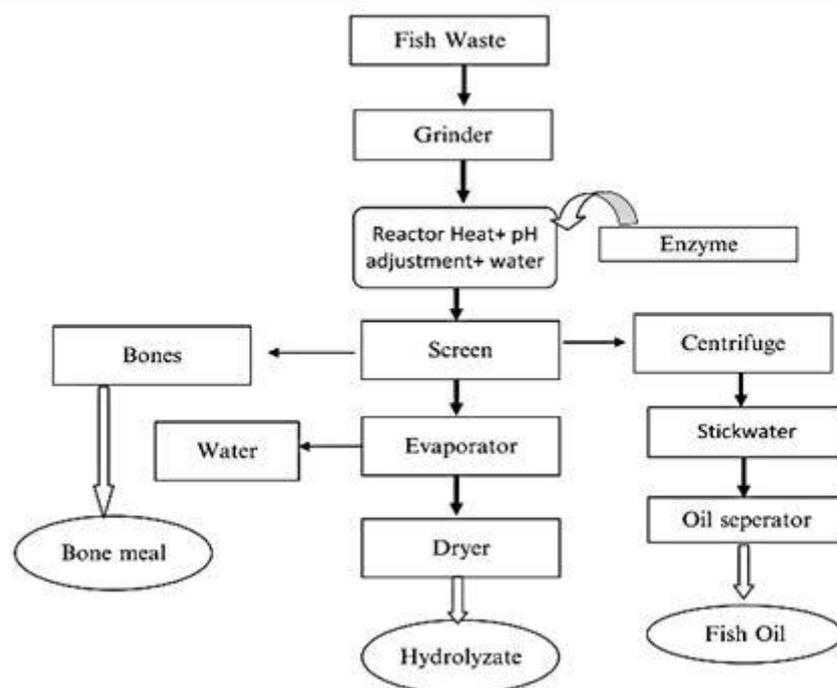


Figure 1: Flow diagram for the production of fish oil, bone meal and hydrolysate from fish waste.

In one research study scientists took Mixture of Proteinaceous wastes of fish and molasses and put it for fermentation under controlled condition. After fermentation total volatile nitrogen increased and product converted into fish silage. This fish silage used for sheep feeding and they observed those sheep were fed with fish silage has more weight gain as compared to control feed (Rahmi *et al.*, 2008).

Fish silage

Fish silage is a liquid product made by mixing complete fish or some unwanted parts of fish with enzymes, acids or required microorganisms. This formation process is carrying out with the action of fish enzymes (FAO, 2003).

Use of fish silage

Fish meal is an important component of animal feed. Now Fish silage can be used in the replacement of fish meal and it is more beneficial than fish meal, because in cheap and simple technique even at large scale production. Fish silage decrease smell and drainage problems of industry. Fish silage also has disadvantage of very high-volume product and have to consume at same production place (Kompang, 1981; Beerli *et al.*, 2004).

According to present situation of unwanted seafood products consumption in animal feed, the Scientific Steering Committee of the European Commission talked about risks which can be raised due to overconsumption of seafood wastes (Scientific Steering Committee, 1999).

To overcome these risks scientists should conduct experiments to check biological effects of these feeds under controlled conditions. This scientific research will be useful for setting best processing conditions to making these unwanted products valuable (Kennelly and Broadhurst, 2002; Perez Galvez and Berge, 2013).

Environmental and economic impact

Management of fish wastes has become a problem to effect environment (Arvanitoyannis and Kassaveti, 2008). So those methods are used for management of these wastes which are cheap and suitable for environment. These methods include the formation of fish meal, fish oil, fish silage and organic fertilizers.

Conclusion

Objective of this review is to describe applications of fish unwanted products in animal feed and in aquaculture feeding. Seafood wastes can be used further by applying different biotechnological and bio preservation techniques. The consumption of wastes in this way fulfills the deficiency of protein and other nutrients used in the processing of animal feed industry. On the basis of this review more research studies could be continue for food preservation methods and to increase the shelf life of food products.

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