SEAFOOD PROCESSING BYPRODUCTS AN ALTERNATIVE SOURCE ANIMAL FEED INDUSTRY

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ABSTRACT

The fish industry is a major economic source for a number of countries worldwide. Fish protein is an essential source of nutrients for many people, especially in developing countries. It is estimated that, worldwide, one billion people depend on producing, processing, and trading fish for their livelihood. The total world marine fishery production in 2009 was estimated at 100.0 million tons, of which 75 % was used for direct human consumption and the remainder for other uses, such as meal production and other non-food purposes. The fish processing industry produces more than 60 % of byproducts as waste, which includes head, skin, trimmings, fins, frames, viscera, and roes, and only 40 % of fish products for human consumption. These large quantities of fish byproduct waste from fisheries create serious pollution and disposal problems in both developed and developing countries. These byproduct wastes contain satisfactory amounts of protein-rich material normally processed into low-market-value products. Considerable studies have been done on the characterization of processed products as well as the different possible modes of the utilization of fish and sea foods. The marine bioprocess industries convert and utilize these discards or byproducts as valuable products, such as fish oil, fish meal, fertilizer, pet food, and fish silage. The increasing awareness of the potential use of byproducts and the recycling of waste materials presents nutritionists with new and interesting challenges. There are several reasons for this. Firstly, many waste and byproducts, hereafter referred to as waste suitable for animal feeding, are produced in small quantities in differing localities. Secondly, the motive of industrial producers for using organic wastes for animal feeding is more often a desire to obtain a positive return by selling waste rather than paying for their disposal than real interest in meeting the requirements of the animals.

INTRODUCTION

The increase in the world population (+30% from the current 7.5 billion people expected by 2050) and changes in worldwide consumption patterns towards higher consumption of products of animal origin are affecting the livestock production sector. In 2018, global feed production reached 1.1 billion tonnes showing an increase of 3% compared to an annual mean growth rate of 2.5% in the last 5 years. The protein shortage is a global concern, and extensive research to find new sustainable protein sources is ongoing. The sustainability of food production and processing systems based on low greenhouse gas emissions, efficient use of raw materials, and waste minimization has become a priority. As regards wastes deriving from human consumption, about one-third of food is lost or wasted worldwide. International non-governmental organizations are emphasizing the urgency of limiting waste and recovering valuable resources/compounds. In Europe, Article 4 of the EU Waste Framework Directive, after the revision updated in 2008, outlines a "waste hierarchy" and highlights the financial and environmental advantages of reducing, reusing, and recycling materials compared to landfill disposal. According to the circular economy approach based on the "reduce, reuse, repair, and recycle" theory, waste from food can be valorized, leading to the production of proteins and other valuable compounds. This situation leads to economic and environmental issues, such as the possibility of using wastes as substrates for insect farming or to recover valuable nutrients in the case of seafood byproducts.

Seafood Processing Byproducts: Trends and applications in processing and trading fish for their Livelihood. The total world marine fishery production in 2009 was estimated at 100 million tons, of which 75 % was used for direct human consumption and the remainder for other uses, such as meal production and other non-food purposes. The fish processing industry produces more than 60 % waste byproducts, including head, skin, trimmings, fins, frames, viscera, and roes, and only 40 % of fish products are for human consumption. These large quantities of fish byproduct waste from fisheries create serious pollution and disposal problems in both developed and developing countries. These byproduct wastes contain satisfactory amounts of protein-rich material normally processed into low-market-value products. Considerable studies have been done on the characterization of processed products as well as the different possible modes of the utilization of fish and seafood. The marine bioprocess industries convert and utilize these discards or byproducts as valuable products, such as fish oil, fish meal, fertilizer, pet food, and fish silage. The increasing awareness of the potential use of byproducts and the recycling of waste materials presents nutritionists with new and interesting challenges. There are several reasons for this. Firstly, many waste and byproducts, hereafter referred to as waste suitable for animal feeding, are produced in small quantities in differing localities. Secondly, the motive of industrial producers for using organic wastes for animal feeding is more often a desire to obtain a positive return by selling waste rather than paying for their disposal, than real interest in meeting the requirements of the animals. The processing of marine fi for filleting, canning, and "surimi" production results in an immense quantity of byproducts, which include trimmings, belly flaps, heads, frames, fins, skins, and viscera.

MARINE BYPRODUCTS AND THEIR COMPOSITION

Every year, thousands of tons of marine fish byproducts high in nutrient content are dumped or discarded by fish processing plants throughout the World. Discarding these byproducts creates two major problems. The first is the Underutilization of a huge amount of nutrients, such as proteins, minerals, and oil. Second, the disposal of such huge quantities of highly polluting organic matter Contributes to major environmental and economic problems. On the other hand, The fish processing industry needs to develop efficient byproduct Recovery and utilization methods. Instead of disposing of these fish products as waste, they can supply high-protein feed ingredients and palatability-enhancing Agents for use in animal food.

FISH AND SHELLFISH BYPRODUCTS

Fishing generates large quantities of waste daily in fish markets and processing industries. Fish remains have been discarded usually without putting their wealth of nutritional elements to useful production. Fish offal derived mainly from processing byproducts has been carried out in various parts of the world in search of alternative and viable techniques for transforming fish waste into useful agricultural products.

FISH SKIN

Processing byproduct waste of fish skin is a rich source of collagen and gelatin. Several studies demonstrate the potential of fish skin processing byproduct waste for conversion into fish protein hydrolysates. North Atlantic lean fish (Picot et al., 2010) and grass carp (Wasswa et al .2007) fish species have a high potential for their fish skin byproducts to be used to produce protein hydrolysates. A study has been carried out on the catfish skin isolated soluble and insoluble protein hydrolysates from hydrolyzed catfish skin and described the rheological and functional properties of the protein hydrolysates. Aleman et al. (2011) attempted to prepare protein hydrolysates from tuna and halibut skin gelatins. Wasswa et al. (2007) conducted a study regarding prepared protein hydrolysates from grass carp skin using alcalase and optimized the hydrolysis conditions using a response surface methodology.

FISH MUSCLES

The muscles of different animals are very similar, containing similar proteins and similar amino acid profiles. There are slight differences between fish muscle and the muscle of land animals. A mass of water supports fish, thus the muscle fibers require less structural support than those of land animals. Because of this, fish muscle tends to have less connective tissue than muscles from terrestrial animals, resulting in a more tender texture. Protein composition in muscles varies by muscle type of the three types (striated, smooth, and cardiac muscle); the striated muscles are the predominant form in fish. Fish muscle has "white" and "dark" meat. White meat is generally more abundant, contains fewer lipids than dark meat, and is the most widely consumed type of muscle tissue. Fish dark muscles have limited uses due to their susceptibility to oxidation and off-flavor. The conversion of these high protein-content dark muscles into protein hydrolysates for further utilization will produce value-added products (Hsu 2010) with a low cost of production. Nakajima et al. 2009 have carried out research use for the production of hydrolysates from Micromesistius australis dark muscle

FISH BONES

Fishbone is largely composed of calcium phosphate mineralized cartilage models. Fish backbone waste is another source of protein and minerals. It contains around 30 % protein, and Je et al. (2007) experimented the protein hydrolysates from tuna backbone protein using different proteases, such as papain, pepsin, trypsin, alcalase, α-chymotrypsin, and neutrase. Morimura et al. (2002) found that the hydrolysates derived from fish bone would be suitable as a food additive due to their high antiradical activity. For the production of protein hydrolysates and peptides, collagens containing yellowtail fish bone and swine skin wastes were used as raw materials and protein hydrolysates have potential use as food ingredients for many kinds of foods and animal feed production (Morimura et al., 2002).

FISH SCALES AND FINS

Fish scale is considered worthless, impracticable, and dismissed as a waste. However, it is known that fish scale contains numerous valuable organic and inorganic components, mainly collagen and hydroxyapatite (Hola et al. 2011), which have commercial value for use in manufacturing functional foods, cosmetics, and biomedical products (Lin et al., 2010; Pati et al., 2010). Okuda et al. (2009) and Chen et al. (2011) studied fish scale waste and focused on isolating and characterizing collagen from fish scales.

FISH LIVER, VISCERA, AND STOMACH

Another important fish waste is fish liver and Je et al. (2009) reviewed those protein hydrolysates from the liver of skipjack tuna (*Katsuwonus pelamis*). This fish byproduct is used to produce fish meal and animal feed or is directly discarded as processing waste. These fish liver wastes can mainly produce commercial proteases such as Flavourzyme, alcalase, Protamex, and Neutrase. Fish viscera waste generated in large amounts during processing is a potential source of protein that can be used as a raw material for producing protein hydrolysates. The solubilization of cod (Gadus morhua) visceral proteins has been studied by Aspmo et al. (2005) at natural substrate pH using endogenous enzymes alone or in combination with one of alcalase, Neutrase, Protamex, papain, bromelain, actinidin, and a plant protease mix of different commercial protease preparations. A study was carried out on protein hydrolysates produced from yellowfin tunas stomachs by commercial neutral protease described fish protein hydrolysates exhibiting variation in their amino acid composition. The enzymatic hydrolysis of native proteins produces these protein hydrolysates. Protein hydrolysates are used as readily available sources of protein for humans and animals due to their functional properties. Raw material, enzyme source, and hydrolysis conditions are the main factors affecting the variation in the amino acid composition of different fish protein hydrolysates.

TRASH FISH

The overcapitalization of fisheries due to the commissioning of highly efficient vessels and the degradation of aquatic habitats from pollution has increased catches of non-targeted fishes and the resultant practice of discarding large quantities of catch. These discards were large in quantity, with varying species relative to the targeted species. Much of the composition of the discards were juvenile and those that could not be marketed because they were not considered edible or a delicacy or had been disfigured through poor handling had no market value. The demand for trash fish has steadily increased with the continued expansion of the mariculture industry because, in terms of absolute volume, carnivorous fish consume less feed, but they cannot thrive without fish (or other marine proteins, including squid) as a major component of their diet. But the disadvantages are an often-ignored risk of continued use of trash fish as feeds in the mariculture industry is the likelihood of it being a direct or indirect source of disease in cultured fish. It also constitutes a first-order environmental threat due to the significant risk of spreading diseases to the fish population. Muroga (2001) conducted a study on one of the most serious viral diseases caused by the betanoda virus, a major viral pathogen affecting several marine fish species during their seedling and culture process in aquaculture hatcheries. Vertical transmission through the egg may be the most common mode of transmission for these viruses. Also, the direct infection of cultured fish can be via the consumption of trash fish containing high bacterial loads, especially streptococcal types. Furthermore, organic components of trash fish (e.g., bones, muscles, viscera, and scales) contribute to organic loading, and their decomposition rate in water is dependent on their physical and chemical characteristics, as well as the conditions of the environment. The recovery of chemical components from seafood waste materials, which can be used in other segments of the food industry, is a promising area of research and development for using seafood byproducts. Upgrading or recovering the edible high-grade protein from these wastes will result in renewed interest in using fish meal and hydrolysates in animal diets. Chemical and biological methods are the most widely used for protein hydrolysis, with chemical hydrolysis being used more commonly in industrial practices. Biological processes using added enzymes are employed more frequently and enzyme hydrolysis holds the most promise for the future because it results in products of high functionality and nutritive value. The functional properties of fish protein hydrolysates are important, particularly if they are used as ingredients in food products. Enzymatic hydrolysis of fish proteins generates a mixture of free amino acids, di-, tri-, and oligopeptides, increases the number of polar groups and the solubility of the hydrolysate, and, therefore, modifies the functional characteristics of the proteins, improving their functional quality and bioavailability (Gildberg, 1993)

SAFETY IMPACT ON HUMAN HEALTH

Animal feed or forage may be the source of a limited number of infections for farm animals that could lead to human illness. Likely organisms include *Salmonella enterica, Toxoplasma gondii, Trichinella spiralis,* and possibly the agent of bovine spongiform encephalopathy. The risk to human health from other infectious agents which may contaminate either feed or forage appear to be either negligible, e.g., *Bacillus anthracis* and *Mycobacterium bovis*, or non-existent, e.g., Clostridium botulinum toxin and *Listeria monocytogenes*

CONCLUSION

Fish waste management has been one of the problems with the greatest environmental impact. Fish farming's detrimental effects on the marine environment, in particular, have become an issue of public concern. The intensive farming of marine finfish, commonly practiced in cages or ponds, involves the supply of high-quality artificial feeds and medication with consequent impacts on the environment, mainly because of the release of organic and inorganic nutrients and chemicals used for medication. These impacts tend to be the most severe in areas with poor water exchange. Not only can the surrounding area be directly affected by the effluent, but fish waste can also affect a wider coastal zone at different ecosystem levels, thus reducing the biomass, density, and diversity of the benthos, plankton, and nekton and modifying natural food webs Therefore, most common environmentally friendly and economical methods for the utilization of marine seafood waste are the manufacture of fish meal/oil, the production of silage, or the use of waste in the manufacture of organic fertilizer. Using byproducts is an important cleaner production opportunity for the industry, as it can generate additional revenue and reduce disposal costs for these materials.

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