



Reviews; Utilization of Fish Offal for Non-Food

Junianto¹, Givani Sifa Muhararan², Resvi Junisa Supriatna², Annisa Azahra Fathoni², Qeanu Vaulfino Dayeef², Zaky Yoana Putri² and Raihan Putra Fajar²

1) *Staff lecturers of the Perikanan_ department of Padjadjaran University*

2) *Fisheries Study Program Students – Padjadjaran University*

Abstract

Waste generated from the fish processing industry includes fish offal. This article aims to review the processing or utilization of fish offal into non-food products both on a commercial scale and on a research scale. Based on the literature of the review, fish offal contains proteins of $14.01.01 \pm 0.68\%$ lipids of $20.00 \pm 1.04\%$, minerals of 4.75 ± 0.64 and water of $60.62 \pm 2.15\%$. This fish offal can be processed into non-food products that have high relative added value. Products that can be made are liquid fertilizers, hydrolyzed into peptones, extracted to take (isolated) enzymes, made feed ingredients and fermented into silage as a feed ingredient.

Keywords: intestines, silage, feed, peptone, liquid fertilizer.

INTRODUCTION

The development of the fisheries sector on the one hand has succeeded in increasing the country's foreign exchange and providing jobs, but on the other hand it has also created environmental problems with the presence of waste, one of which is fishery waste (Aditya *et al.* 2015). According to Jayanti *et al.* (2018), waste is processed residue or waste produced from a production process both from industry and from domestic (households) that have no economic value. About 70% of fish are processed before the final sale, producing 20-80% of fish waste depending on the level of processing and the type of fish (Ghaly *et al.* 2013).

Fish waste can be classified into two forms, namely whole fish waste that is not sold and fish waste that is not intact or in the form of fish internal organs, both forms of fish waste it is rarely used so that it can cause landfilling of waste and cause a foul odor (Kurniawati *et al.* 2018). According to Caruso (2015), it is estimated that more than 50% of

fish parts including fins, head, skin and offal are simply thrown into the environment without prior treatment.

Fisheries waste is expected to increase along with the increase in human consumption. The resulting fishery waste is in the form of skin, bones, head, tail and offal. Fish offal (Figure 1) consists of the stomach, intestines, liver, gallbladder, pancreas, gonads, spleen, and kidneys, the waste has the potential to trigger the onset of air pollution and health problems to the surrounding community (Zahroh *et al.* 2018). Fish offal weighs 10-15% (depending on species) of fish biomass (Bhaskar and Mahendrakar 2008).



Figure 1. Fish offal

Source : (Susanto 2019)

Fish offal naturally has enzymes - enzymes that play a role in the process of food digestion (Suhandana *et al.* 2018). According to Hossain and Nature (2015), fish offal contains $14.01 \pm 0.68\%$ protein, $20.00 \pm 1.04\%$ lipids, 4.75 ± 0.64 ash content, $60.62 \pm 2.15\%$ moisture content. Based on the chemical compounds contained in the fish offal, there are several possibilities to increase the added value of fish offal by processing into non-food products. This article aims to review the processing or utilization of fish offal into non-food products both on a commercial scale and on a research scale.

Making Organic Fertilizer from Fish Offal

In general, fish waste contains many nutrients, namely N (nitrogen), P (phosphorus) and K (potassium) which are the constituent components of organic fertilizers (Hapsari and Welasi, 2013). Fish offal that contains high enough protein so that it can be used as an ingredient in making organic fertilizer. The use of organic fertilizers when it is trending is used in organic vegetables so that people do not worry about pesticide residues in food (Jigme *et al.* 2015).

Organic fertilizers made from fish offal are an excellent source of nutrients for plants. Organic fertilizers made from fish offal contain large amounts of nitrogenous elements and

other nutrients that are known to be significant for plant growth (Ihemanma and Ebutex 2013). Organic fertilizers based on fish waste has been reported to reduce the attack of pathogens *Macrophomina phaseolina*, *Fusarium spp.* and *Rhizoctonia* on okra and string bean plants (Kurniawati *et al.* 2018).

The process of making liquid organic fertilizer from fish offal can be done by adding microorganisms or it can also be done by adding enzymes. The addition of microorganisms or enzymes is aimed at accelerating the process of hydrolysis of proteins into nutrients needed by plants.

Making liquid fertilizer from fish offal with the addition of microorganisms (Kurniawati *et al.* 2018) is carried out as follows: First of all, offal is cut into pieces until it becomes smooth. After smoothing, put into the plastic drum, then into the drum it is also put water as much as 10 times the weight of fish offal, EM4 as much as 10% of the weight of offal (volume / weight), brown sugar as much as 20% (weight/ weight) of the weight of fish offal. The mixture of fish offal and other ingredients contained in the drum is stirred until homogeneous. Next the drum is closed and kept at room temperature for 2 weeks, once every 6 hours it is stirred.

The manufacture of liquid fertilizer from fish offal with the addition of enzymes (bromelin, pineapple fruit extract) is carried out as follows: First make or extract enzymes from pineapple fruit, done as following: a) Fresh pineapple fruit that has been cleaned from the skin of the fruit is grated for the juice to be taken. b) The juice is then squeezed out with double gauze and the liquid obtained is filtered with filter paper through a Buchner funnel. c) The liquid obtained is ready for use. The next stage is the process of making liquid fertilizer from fish offal, which is as follows: a) Fish offal is cut into small pieces b) After that the fish offal is included in a saucepan. c) After that to them of the pot is added water in a ratio of 1:1 with the viscera of the fish to be hydrolyzed. d) Warm up for 15 minutes at a temperature of 90-95°C. e) After that, it is followed to a temperature of 50 °C and then added a rough extract of pineapple fruit as much as 6% of the weight of the fish offal. f) The mixture is stirred, after which it is poured into a plastic drum for a hydrolysis process at room temperature for 1 week. g) The hydrolysis results are accommodated and ready to be used as a liquid organic fertilizer.

Liquid organic fertilizer from fish offal is applied to red spinach plants to improve plant growth, so that with good plant growth will produce high yields (Kurniawati *et al.* 2018). According to Niddai *et al.* (2015), The application of liquid organic fertilizer made from offal of whitefish and pineapple skin waste affects the growth rate of mustard greens (*Brassica juncea*).

Making Peptone from Fish Offal

According to Nurhayati *et al.* (2013), peptone is a raw material for making bacterial growth media to provide nitrogen elements for bacteria. Peptone is obtained by hydrolyzing proteins found in fish offal (Pratomo *et al.* 2020). According to Ariyani *et al.* (2001) protein hydrolysis can be perfectly performed using proteolytic enzymes. Proteolytic enzymes that are often used are papain, alkalase, or bromelin. .

Peptone is used in laboratories and biotechnology industries, such as food, pharmaceuticals, and medicine (Atma *et al.* 2018). Fish peptone is a protein hydrolyzate product that has an important economic value in the fishing industry because it has a very high market price when compared to other by-products for example, fish and fish meal.

The procedure for making peptone from fish offal (Nurhayati *et al.* 2013) is as follows: Fish offal is washed with clean water and then chopped. Fish offal is mixed with distilled water (aqueous) in a ratio of 1:2 (w/v). A mixture of fish offal and water is put into a container, then the addition of papain enzymes is carried out as much as 0.26% of the weight of fish offal. Afterward was hydrolyzed at a temperature of 60°C using a water bath for 3 hours. After that, enzyme activation is carried out by heating it at a temperature of 85°C for 15 minutes. The next step is precipitated for 24 hours at a temperature of 4°C with the aim of separating the fat from the liquid phase. The liquid phase is taken by filtering using nylon size 375 mesh. The next process is the phase of the liquid being drained using a spray dryer, the obtained powder pepton is stored in a container or thick plastic that is tightly closed.

According to the research of Nurhayati *et al.* (2013), peptone characteristics of cob fish offal in general have the same characteristics as commercial peptones except for a slightly lower solubility (98%), nitrogen (8.03%), as well as amino acid composition. The cob fish offal peptone has a free nitrogen α -amino value of 1.12% and has been included in the range of bactopectone-free nitrogen α -amino levels (1.2-2.5%).

Peptones that have a high nitrogen content are of good quality (Pratomo *et al.* 2020) because nitrogen is one of the elements used for the growth of microorganisms (Najim *et al.* . 2015). According to Khalil (2012), the longer the hydrolysis time in the viscera of *Tilapia nilotica* fish gives an increase in the content of dissolved proteins.

Making Enzyme Extraction from Fish Offal

An enzyme is a protein that has biochemical activity as a catalyst for a reaction (Safaria *et al.* 2013). Enzymes are catalysts of choice that are expected to reduce the impact of environmental pollution and energy waste. The three main properties of biocatalystizers are raising the reaction speed, having specificity in reactions and products and kinetic control (Akhdiya 2003). Enzymes are widely used in various chemical processes in the field of

industry and biotechnology (Nurhayati *et al.* 2020).

Fish offal has great potential as a source of protease enzymes (Gildberg 1992). According to Li *et al.* (2006) states that the viscera of fish part spleen is a source of protease enzymes.

The process of extracting enzymes from the intestines (offal) of fish (Arbayanti *et al.*, 2021) can be carried out as follows: The intestines of fish are cut into pieces with a thickness of 1-1.5 cm then added liquid nitrogen and mashed using a mortar. The sample was then suspended into a buffer (50 mM Tris-HCl, 10 mM CaCl₂ pH 8.0) in a ratio of 1:4 (w/v). The mixture was stirred for approximately 5 min at 4°C then centrifuged at the rate of 9,500 g for 30 min at a temperature of 4°C. The obtained supernatant is dried by freeze-drying. The obtained enzyme powder is stored in a bottle and stored in a refrigerator.

Tuna offal enzymes in general consist of pepsin (in the *gastric mucosa* section), and trypsin and chemotrypsin (in the pancreas, *pyloric caeca*, and intestines) (Simpson 2000). The protease enzyme owned by tuna fish can also be extracted or made into various industrial applications such as detergents because proteases have unique properties, in food proteases can be used to increase glutenin in flour and chocolate (Kara *et al.* 2005), can also increase the specific volume of *brown rice bread* (Renzetti and Arendt 2009).

Making Feed and Fish Silage from Fish Offal

Fish feed is a mixture of various foodstuffs (commonly called raw materials), both vegetable and animal, which are processed in such a way that they are not easy to eat and digest. Fish feed is a source of nutrients for fish that can produce energy for living activities. The excess energy produced is used for growth (Djarjah 1996).

Good feed must have easy-to-digest properties, be easy to get, relatively cheap and have high enough protein levels to provide optimal individual growth. Protein is one of the important nutrients in feed. Protein is often used as an indicator of feed quality because it is a source of energy (Ratnasari *et al.* 2020).

The use of fish offal as an alternative feed raw material is one of the new breakthroughs in reducing the use of fish meal because fish offal is rich in protein and fat (Sianturi *et al.* 2022). According to Hossain and Nature (2015), fish offal contains 14.01±0.68% protein, 20.00±1.04% lipids, 4.75±0.64 ash content, 60.62±2.15% water content. In addition to feed, one alternative to the use of fishery waste is the manufacture of fish silage flour. The silage form of fish is generally liquid, so it is necessary to add fillers to speed up the drying process so that it can become silage flour (Jayanti *et al.* 2018).

As for the procedure for making feed with fish offal waste, it is as follows:

1. Fish offal is thoroughly washed to separate it from dirt that sticks to fish offal.

2. Then the viscera of the fish are mixing until smooth.
3. The already fine offal is put into a container, and mixed with additional ingredients such as fine bran, cornstarch and starch as a traditional adhesive and then mix thoroughly.
4. After that the pellet dough is put into the pellet printing machine, then the formed pellets are dried in a 45° C temperature blower oven for 8 hours.

In the research of Pinandoyo *et al.* (2020), it was stated that the nutritional content of the feed with a combination of 0% offal flour and 60% fish meal has about 30%, protein, 7.23% fat, 29.22% carbohydrates, 13.22% ash, and 20.29% crude fiber. The combination of 20% fish offal flour and 40% fish meal has about 31.79% protein, 7.43% fat, 29.22% carbohydrates, 11.16% ash, and 20.46% crude fiber. The combination of 40% fish offal flour and 20% fish meal has 30.10% protein, 7.63% fat, 29.39% carbohydrates, 11.16% ash, and 20.46% crude fiber. Finally, the combination of 60% fish offal flour and 0% fish meal has 29.56% protein, 7.78% fat, 30.49% carbohydrates, 12.72% ash, and 19.45% crude fiber.

According to Wulandari (2000), the manufacture of fish silage in Indonesia has developed and is known in two ways, namely chemically and biologically which will then be fermented. Chemical manufacturing uses the addition of strong acids, namely mineral acids (inorganic acids) which are very corrosive so that they need to be neutralized first before use (Akhirani 2011). The neutralization process requires additional time and costs so it is very ineffective to use. The acids commonly used are formic acid and propionic acid while other organic acids such as benzoic acid, acetic acid, sorbic acid, and citric acid are rarely used, even though the price is relatively the same and is also easy to obtain in the market. Biological manufacturing is utilizing certain microbes (lactic acid bacteria) by adding carbohydrate sources such as bran, pollard or molasses.

The process of making fish silage made from fish offal according to Handajani (2014), is carried out in two stages, namely the first stage of cleaning and grinding fish offal and the second stage is mixing or homogenizing the grinding results of fish offal with probiotic microorganisms (*Lactobacillus casei* and *Saccharomyces cerevisiae*) + molasses. Then fermented for two weeks (Abun *et al.* 2004) inside a sealed container. During the fermentation process, do not forget to do stirring 3 times during the first 3 days and 1 time per day after 3 days. stirring is carried out to homogenize silage during the hardening process (Suharto 1997).

The nutritional protection of fish offal silage based on the research of Sulistyoningsih (2015), it is stated that fish offal silage has a nutritional content consisting of 15.49% crude protein; 35.59% crude fat; 19.33% crude fiber; 0.86% calcium, 1.15% phosphorus; with metabolic energy (EM) 3593.67 Cal / g. Silage is said to be good if it has a pH of 3-4, sour

smell (dominated by lactic acid), not moldy, contains lactic acid bacteria more than 10^6 and has almost the same nutritional value as the original ingredient (Sulistyoningsih 2015).

Fish silage can be used as a preserve for animal feed ingredients or fish without reducing the quality of the ass. In some studies, fish silage was used to improve the quality and quantity of farm animals or fish. Fish offal silage can be used as a mixed ingredient in fish feed formulations. Silage can increase protein content, inhibit the activity of putrefactive organisms and help the breakdown of proteins into short peptides or easily digestible amino acids (Kompang and Liyas 1983).

CONCLUSION

Based on the literature of the review, fish offal contains protein of $14.01 \pm 0.68\%$ lipids of $20.00 \pm 1.04\%$, minerals of 4.75 ± 0.64 and water of $60.62 \pm 2.15\%$. This fish offal can be processed into non-food products that have high relative added value. Products that can be made are liquid fertilizers, hydrolyzed into peptones, extracted to take (isolated) enzymes, made feed ingredients and fermented into silage as a feed ingredient.

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