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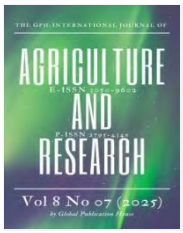

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MAKING SILASE OF TRASH FISH USING BACTERI ASAM LACTATE

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Abstract:

Indonesia is the country with the largest production of fishery products after China with a catch of almost 7 million tons in 2018, but 30-60% of its production ends up as waste. One of the alternatives to the use of fishery waste is the manufacture of fish silage. The purpose of making fish silage is to extend the shelf life and as an alternative source of protein. The method carried out is a descriptive method using literature review studies. Based on the results of the research obtained, the manufacture of silage using lactic acid bacteria can extend the shelf life of fish silage. The rate of addition of fish silage to feed ranges from 5-50% with survival results in the range of 83.33-100% and daily growth rate ranging from 1.13-5.02%, and feed efficiency ranging from 23.78-71.85%.

Keywords:

Biotechnology, Feed Efficiency, Fermentation, Fishery Waste, Fish Feed

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INTRODUCTION

Fishery waste from fish auctions, processing industries, households, and food stalls often causes various environmental pollution such as producing unpleasant odors, a medium for the growth of harmful bacteria (pathogens) and can contaminate the products produced, if not managed properly. Environmentally friendly waste management is a good solution so that the waste can be used further. Generally, fishery waste consists of liquid waste in the form of blood, mucus and fat while solid waste consists of bones, heads, gills, fins, skin, scales and stomach contents (Ifa et al. 2018; Elvina & Utami 2022). Fishery waste is usually in the form of solid waste and liquid waste. Solid waste can be bones, heads, offal, and even fish that are not the main catch can be a source of waste. Meanwhile, fishery liquid waste is usually in the form of washing water from fish processing units that are discarded and not used (Kurniawan et al. 2015).

One of the potential by-products of fisheries that has economic value but has not been fully utilized by the community is trash fish or consumption fish produced from the rest of the catch. The production of capture fisheries in Indonesia almost reached 7 million tons in 2019, but around 30-60% of the production is considered waste (Hasibuan et al. 2021). The abundant availability of trash fish if used for the manufacture of fishmeal can minimize feed production costs. On the other hand, if it is not used properly, the trash fish will only have the potential to become waste (Sofia et al. 2021).

Trash fish is an abundant fishery waste, which has a small body size and is obtained from fishermen's by-catch. Trash fish is fishery waste obtained from by-catch. In terms of nutritional content, Trash fish still has nutritional content such as protein and fat that can be used as raw materials for fish feed, especially fishmeal or in fresh form (Diamahesa et al. 2023). The protein content of roughfish that has been studied by several researchers previously ranges from 50-70% (Fauzi et al. 2008). Protein is the largest component after water, so fish is a very potential source of animal protein. This causes fish to rot easily. To maintain the quality of fish, processing is carried out (Sipayung et al. 2015).

One of the processing that can be done is to make fish silage. The production of fish silage in Indonesia has developed and there are two ways of making silage, namely chemically and biologically, which is then fermented (Handajani, 2014). Chemical manufacturing uses the addition of strong acids, namely mineral acids (inorganic acids) while biological manufacturing is using certain microbes (lactic acid bacteria) by adding carbohydrate source materials such as bran, polard, or molasses.

The purpose of this literature review is to provide readers with a summary of the biological production of roughfish silage using lactic acid bacteria, as a method to extend its shelf life and become an alternative source of protein for fish.

RESEARCH METHODS

The method used is a descriptive method by conducting a literature review study using various literature from the Google Scholar and ScienceDirect portals with keywords in the form of lactic acid bacteria, fermentation, fermentation of fish of fish, fish silage, fish of fish, fishery waste, and fish silage. The type of journal or literature studied is research related to the manufacture and use of trash fish as silage. The subjects of the animals tested were different types of fish. The results of journal reviews are grouped according to topics that have been obtained from journals that have been obtained and analyzed according to the topic.

RESULT

1. Characteristics of Trash Fish Waste

Trash fish refers to small marine fish that are not suitable for consumption and are generally sold at low prices (Badrudin *et al.* 2016). Trash fish has good nutritional content, namely ash 27.89%, crude fat 6.54%, crude fiber 1.64% and crude protein 58.97% (Rostika 2021).

Picture 1. Trash Fish
Source: Kholis *et al*. 2023

2. Fish Silage and Its Bio-Manufacturing

Fish silage is a product of whole fish and processed fish residues that are diluted by enzymes by fermenting with the help of acids and microbes that are deliberately added (Suharto 1997 in Jayanti 2018). Fish silage can be made from whole fish, Trash fish or fish waste from the processing industry and then processed until a liquid product resembles porridge is formed. The manufacture of fish silage utilizes microbes, one of which is in the form of lactic acid bacteria and is processed through fermentation (Sofia *et al*. 2021).

Fermentation is a process of converting a substance into another substance carried out by microorganisms, such as bacteria and fungi, under certain circumstances, and which can occur under aerobic and/or anaerobic conditions. The specific products resulting from a particular fermentation process are determined by the type of microorganism, the conditions

under which the processing is carried out, and the substance in which the fermentation takes place (Nafion *et al.* 2021).

Picture 2. Fish Silage
Source: youtube.com

2.1 Factors in the Making of Trash Fish Silage

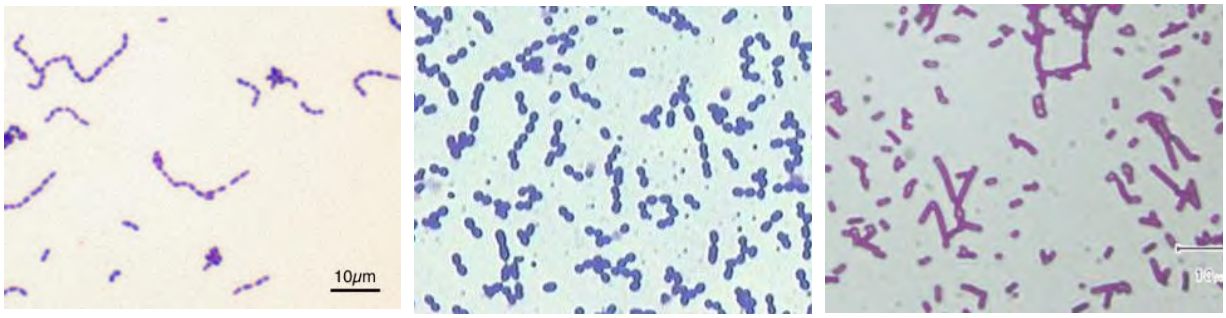
The fermentation process in making trash fish silage is influenced by several factors both directly and indirectly. Factors that affect fermentation include the substrate, temperature, pH, oxygen and microbes used. Substrate is a fermentation raw material that contains nutrients needed by microbes to grow and produce fermented products (Azizah *et al.* 2012).

2.2 Lactic Acid Bacteria

Lactic acid bacteria (BAL) are facultative anaerobic bacteria that are able to live in a wide variety of habitats in nature such as in plants, the digestive tract of animals and humans, in canned food products, dairy products, fermented products, tropical fruits and vegetables (Utami 2011 in Rahmiati 2017).

Lactic acid bacteria are often used as natural preservatives of fermented food products. The use of lactic acid bacteria as a natural preservative with biopreservative methods has been widely developed by using lactic acid bacteria directly or using their metabolites as antimicrobial agents (Ibrahim *et al.* 2015).

Trash fish silage is biologically made through a fermentation process, one of which is using lactic acid bacterial microbes by adding ingredients that contain carbohydrates such as bran, polard, or molasses. The group of bacteria that includes lactic acid is the group of bacteria of the genus Aerococus, Allococcus, Carnobacterium, Enterococcus, Lactobacillus, Lactococcus, Leuconostoccus, Pediococcus, Streptococcus, Tetragenococcus, and Vagococcus (Sofia *et al*. 2021).



(1) (2) (3)

Picture 3. Some types of Lactic Acid Bacteria: Streptococcus (1), Enterococcus (2), Lactobacillus (3)
Source: step1medbullet.com (1), microchemlab.com (2), Wirama *et al*. 2015 (3)

3. Nutritional Changes in Trash Fish Through the Fermentation Process

Trash fish has good nutritional value so that in terms of nutritional content so that no special treatment is needed. But the problem with its use is that it is susceptible to damage caused by fish contaminating bacteria. Contamination with decaying microbes is inevitable because fish is a good medium for growth. Microbes will metabolize amino acids to produce ammonia, biogenic amines (putresin, histamine and cadaverine), organic acids and sulfur compounds, so that they have an unpleasant aroma (Rimbawanto et al. 2015).

Lactic acid bacteria can naturally produce a variety of substances with antimicrobial potential, such as organic acids, carbon dioxide (CO2), hydrogen peroxide (H2O2) (Carr et al. 2002 in Bezerra and Fonseca 2023), and some strains can produce bacteriocins which are polypeptides with specific antimicrobial activity against bacteria of the same species or even different species, including pathogens (Cotter et al. 2005).

Several studies that have been conducted in the manufacture of fish silage using lactic acid bacteria have different treatments. Each study also had different results, but overall there was a similar change in each treatment, namely to be acidic. Details of research in the manufacture of trash fish silage can be seen in **Table 1**.

Table 1. Fish silage making

Bacteria	Treatment	Result	Source
Lactobacillus plantarum, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus brevis*	A cabbage solution with a salt content of 25% and 200 g of starch flour is added to 1 kg of trash fish and then fermented for 7 days.	Silage has a liquid texture and is sour in flavor and blackish-brown in color.	Wahidah *et al*. 2018
Lactobacillus plantarum	The addition of inoculum was 0.1%-1% and rice bran was 3% and then fermented for 15 days.	Silage has a pH between 4.0–4.5 and a Dry Weight (BK) percentage difference ranges from 1.73-9.55%	Ramli 2014
Acidilactic Pediococcus	90% of the pacu fish (*Colossoma macropomum*) and 10% of the sugarcane molasses were fermented for 5 days at a temperature of $35^{0C.}$	Silage has a pH of 4.25; protein 33.3%; and fat 66.4%	Bezerra dan Fonseca 2023
Leuconostoc lactis	90% pintado fish (*Pseudoplatystoma corruscansdan*) 10% sugarcane molasses is fermented for 5 days at a temperature of $35^{0C.}$	Silage has a pH of 4.06; protein 26.9 %; and fat 61.9%	

Based on the results of the study, lactic acid bacteria can cause changes in fish silage in both physical and chemical terms. According to Wahidah *et al.* (2018), lactic acid bacteria can cause raw materials to undergo an ensilase process caused by the aerobic respiration process that takes place during the fermentation process. Carbohydrates as organic sugars will be oxidized into CO2 and air. In addition, heat is also produced in the fermentation process so that the temperature rises. Uncontrollable temperatures will cause silage to be dark brown to black. The color change that occurs from all treatments and the absence of a color that resembles the color of fish porridge occurs because during the fermentation process there is a biochemical process that can change the color of fish silage.

The success of the preservation of silage materials can generally be known from the decrease in pH caused by lactic acid bacteria, which produce organic acids such as lactic acid. This decrease in pH prevents the growth of contaminating microorganisms and activates naturally available enzymes within the fish's organs responsible for protein hydrolysis (van'tLand 2017 in Bezerra and Fonseca 2023).

An important factor that affects the quality of silage stored over a long period of time is the process of fat oxidation which can cause taste changes, discoloration, texture spoilage, loss of nutritional value, and the production of toxic compounds such as peroxide. These

peroxides can form complexes with proteins through physical and covalent bonds, thus preventing the breakdown of peptide bonds and the manufacture of amino acids (Domínguez *et al*. 2021 in Bezerra and Fonseca 2023). Fatty acids in fish are mostly unsaturated resulting in them being susceptible to oxidation, especially when fish silage is exposed to light and air (de Arruda *et al*. 2007 in Bezerra and Fonseca 2023). Therefore, an alternative to reducing fat content is to extract the oil before silage processing.

Good silage quality is always indicated by the optimum pH. Silage can be stored for long periods of time without damage by keeping the environmental conditions anaerobic and acidic (pH around 4) (McDonald *et al*. 1991 in Ramli 2014). Silage that has been damaged can be seen from the texture of the silage which is fragile and blackish in color and smells bad and is overgrown with mold (Ramli 2014).

4. Application of Trash Fish Silage as Fish Feed

The application of silage as fish feed gives different results. This is due to the difference in the percentage of each grant and the response of each species that is used as the subject of the study. Details of the results of the research on the application of silage for trash fish as feed can be seen in **Table 2**.

Table 2. Application of adding fish silage as fish feed

Increase in fish feed (%)	Types of fish	Result	Source
50	Snakehead Fish (*Channa striata*)	Survival (83.33%); Absolute length growth (1.90 cm) and absolute weight (0.498 g); Feed efficiency (71.85%)	Kusuma *et al*. 2017
10	Tilapia (*Oreochromis niloticus*)	Survival (83.33%); Weight growth (1.55 g); Feed conversion ratio (1.57)	Tobigo *et al*. 2022
25	Catfish (*Clarias* sp.)	Survival (86.67%); Relative growth (222.63%); Feed conversion ratio (1.09)	Ratnasari *et al*. 2020
40	Vannamei Shrimp (*Penaeus vannamei*)	Weight growth (2.81 g); Feed conversion ratio (3.29); Survival (93.33%)	Safir *et al*. 2024
30	Biawan Fish (*Helostoma temminckii*)	Survival (100%); Daily growth rate (1.13%); Feed efficiency (23.78%); Feed consumption rate (4%)	Fahri *et al*. 2014
5	Carp (*Cyprinus carpio*)	Survival (100%); Feed utilization efficiency (34.65%); Protein efficiency ratio (1.40); Daily growth rate (5.02%)	Erfanto *et al*. 2013

Based on research, the application of trash fish silage in fish feed has an effect on fish biology. According to Fahri *et al*. (2014) Survival is the number of living organisms at the

end of the study expressed in percentages, the survival value will be high if the factors of feed quality and quantity, as well as environmental quality support the survival of the fish studied. The declining survival with increasing silage doses is thought to be related to the deterioration of water quality. This shows the need to limit the addition of fish silage in feed. The process of mixing feed with silage in a study conducted by Tobigo *et al*. (2022) no adhesive material was added, so that when the treatment feed was given to the test fish, the chance of nutrients in the silage dissolved in water was very high, even more so if the feed was not directly consumed by the test fish. This result is supported by the value of water quality, especially the ammonia level in the maintenance container, increasing with the increase in the dose of silage.

There are also other reasons why the addition of silage is limited to feeding. As mentioned earlier, Trash fish silage has high protein content (50-70%) (Fauzi *et al*. 2008). The addition of trash fish silage to excess feed will cause too high a protein content. The protein content in feed is too high so that only part of it will be absorbed (retained) and used to form or repair damaged body cells, while the rest will be converted into energy, as well as feed with low protein content can inhibit growth (Chervinsky 1982 in Erfanto *et al*. 2013). Erfanto *et al.* (2013) also states that proteins that exceed the requirement will produce excess energy to oxidize amino acids which will eventually increase the ammonia produced. The more proteins are catabolized, the more energy it will take to oxidize amino acids which will eventually increase the ammonia produced. Excess ammonia can be toxic to fish because it can cause irritation to the gills, inhibit the growth rate, and can even lead to death.

Safir *et al*. (2024) states that a low *feed convention ratio* indicates that the nutrients in feed are able to be absorbed and utilized optimally by vannamei shrimp for their growth. The absorption of protein in its simple form, namely amino acids, by vannamei shrimp is thought to take place optimally, which is the effect of the addition of silage. Erfanto et al. (2013), stated that silage has gone through the process of breaking down complex compounds into simple so that its application to feed will facilitate the absorption process by the test organism. In addition, it can increase the speed of the organism to respond to feed

CONCLUSION

Fishery waste, especially trash, has great potential to be used as an alternative source of protein for fish with the help of processing in the form of making fish silage assisted by the use of lactic acid bacteria for fermentation. The manufacture of fish silage aims to extend the shelf life. The rate of addition of fish silage to feed ranges from 5-50% with survival results in the range of 83.33-100% and daily growth rate ranging from 1.13-5.02%, and feed efficiency ranging from 23.78-71.85%.

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