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APPLICATIONS OF PHYSICAL AND BIOLOGICAL PROCESSING FOR FISH FEED INGREDIENTS

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ABSTRACT

The use of alternative feeds is mostly done by using local feed raw materials that are easily available and usually in the form of waste that has not been utilized optimally. However, these local ingredients have limitations as the ingredients are still experiencing problems, namely the high content of crude fiber, low content of crude protein raw materials, low balance of amino acids, and the presence of anti-nutritional substances. This causes the need for processing local feed raw materials before being used as feed ingredients. Various ways of processing that can be done one of them physically and biologically to improve and improve the quality of feed ingredients. In general, physical and biological feed processing technology is able to produce products that have a simpler structure and are easier to digest than the original ingredients. Through the application of physical and biological feed processing technology, improvements and improvements can be made to the nutritional value of local feed raw materials so that they can be used optimally for fish feed raw materials.

INTRODUCTION

Feed is the largest component of production costs in aquaculture activities, reaching 60%-70%. The demand for feed increases along with the development of aquaculture activities. However, the price of conventional feed ingredients for protein sources, such as fish meal, and soybean meal fluctuates and still has to be imported to meet the needs of the livestock and fishery industry (Ginting 2006). This encourages efforts to find alternative feed raw materials that are locally available, abundant, and maintained in continuity and can replace or reduce the use of fish meal and soybean meal.

The use of alternative feed raw materials has been widely carried out to overcome the problem of the high cost of obtaining protein source feed raw materials such as fish meal and soybean meal. Efforts to utilize alternative feed raw materials are mostly carried out using local feed raw materials that are easily available and usually in the form of waste that has not been utilized optimally. Some local feed raw materials that have potential as alternative feed raw materials are those from agricultural industrial waste such as palm oil cake, sago pulp, rubber seed meal, coconut meal, copra, cocoa pod skin, flax leaves, banana plant waste, cassava waste, and rice bran (Mathius 2001) as well as livestock waste such as rumen contents, shrimp waste, chicken feather waste and so on. However, efforts to utilize local feed raw materials are still experiencing problems, namely high crude fiber content, low crude protein content, low amino acid balance and the presence of anti-nutritional substances. This causes the need for processing local feed raw materials before being used as feed ingredients.

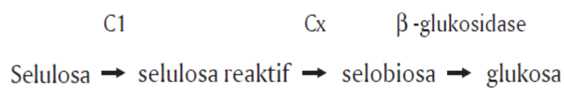
Various processing of high fiber feed ingredients has been carried out to increase the efficiency of feed use, such as physical, biological or combination processing. In general, feed raw materials from processed products contain compounds that are simpler and easier to digest than the original ingredients (Laelasari & Purwadaria, 2004). Furthermore, it is stated that the processing of feed ingredients also functions as a method of processing in the context of preserving materials and ways to reduce or even eliminate toxic substances contained in a material as well as the presence of various types of microorganisms that have the ability to convert starch into protein with the addition of inorganic nitrogen through fermentation.

Utilization of local feed raw materials from agricultural industrial waste whose nutritional value is increased is expected to be able to meet the needs of raw materials and can overcome feed problems that are part of a series of aquaculture.

Biological Processing of Feed Ingredients

Fermentation is one of the biological treatments to improve the quality of feed ingredients. Fermentation is the process of breaking down organic compounds into simpler compounds by involving microorganisms. According to Ganjar (1983), fermentation is a process of chemical change from organic compounds (carbohydrates, fats, proteins, and other organic materials) both in aerobic and anaerobic conditions, through the work of enzymes produced by microbes. Fermentation of feed ingredients is able to break down complex compounds into simple ones so that they are ready to be used by larvae. In addition, a number of microorganisms are known to be able to synthesize certain vitamins and amino acids required by aquatic animal larvae.

In the fermentation process, a substrate is needed as a microbial growth medium that contains nutrients needed during the fermentation process (Fardiaz, 1988). It is further stated that the substrate can be a carbon source substrate and a nitrogen source substrate. Cellulose as a carbon source in the fermentation process has been widely used because it is easy to obtain. Fardiaz (1988) also stated that the use of cellulose as a carbon source cannot be used directly but must undergo a chemical or enzymatic hydrolysis process first. According to Enari (1983) in Ekawati (1993), the mechanism of enzymatic hydrolysis of cellulose can be divided into two stages, namely the activation stage by the C1 enzyme (exo-β-1.4 glucanase or cellulase) followed by the hydrolysis stage by the C× enzyme (endo-β-1.4). glucanase) and -glucosidase (Figure 1).



Cellobiose Glucose

Figure 1. Mechanism of enzymatic hydrolysis of cellulose (Ekawati 1993)

Furthermore, in the glucose fermentation process, pyruvic acid will be formed and from the form of pyruvic acid it will be converted into specific end products for various fermentation processes (Fardiaz, 1988). One example of a fermentation process is the fermentation of glucose by lactic acid bacteria which produces lactic acid and other products (Figure 2).

Glucose Lactic acid + ethanol/acetic acid + CO_2

Figure 2. The reaction of glucose fermentation by bacteria (Fardiaz 1988)

Fermented products are generally easily biodegradable and have a higher nutritional value than the original material (Winarno et al. 1980). This is not only caused by the catabolic nature of microbes or breaks down complex components into simpler ones so that they are easier to digest, but also can synthesize some complex vitamins. The benefits of fermentation include converting complex organic materials such as proteins, carbohydrates, and fats into simpler and easier-to-digest molecules, changing unwelcome tastes and aromas into favored ones and synthesizing proteins. Another benefit of fermentation is that foodstuffs are more resistant to storage and can reduce the toxic compounds they contain, so that the economic value of the basic ingredients is much better. Rusdi (1992) stated that the results of fermentation are very dependent on feed ingredients as the basic material (substrate), types of microbes or inoculum and environmental conditions that greatly affect the growth and metabolism of these microbes.

Several research results on fermenting feed ingredients that significantly increase the nutritional value of feed ingredients show that fermentation technology can increase the use of local feed raw materials that have low nutritional value before being fermented into feed ingredients that can be used as animal or fish feed ingredients that have high nutritional value. good and can be used by fish.

Table 1. Effect of Fermentation on increasing the nutritional value of local feed ingredients

No.	Microbe	Substrate	Result	Reference
1.	*Aspergillus oryzae*	Soy	increase protein and small peptide levels and remove trypsin inhibitors	Irianto 2003

2.	*Lactobacillus acidophilus*	flaxseed (*Linum usitatissimum*)	Able to reduce anti-nutritional substances (phytic acid) and tannin content in flaxseed from 2.45% to 1.32%	Mukhopadhyay & Ray (2005).
3.	*Bacillus amyloliquefaciens*	sago and rumen contents	resulted in a decrease in crude fiber content from 23.73% to 16.56% and an increase in crude protein from 9.11% to 16.37% with a fermentation time of 9 days, a dose of 2% and a temperature of 40°C.	Wizna *et al*. 2008
4.	*Bacillus amyloliquefaciens*	cassava waste	increase crude protein content up to 360% and reduce crude fiber content up to 32%	Wizna *et al*. 2005
5.	*Aspergillus niger*	palm kernel cake	Increase protein content from 15.03% to 18.50%.	Mirwandhono & Siregar (2004)
6.	*Aspergillus niger*	palm kernel cake	Increase the gross energy content of BIS from 1,661 kcal/kg (BIS before fermentation) to 1,837 kcal/kg (after fermentation)	Mirwandhono & Siregar (2004)
7.	*Trichoderma koningii*	palm oil cake	Resulted in an increase in crude protein content, from 17% to 32%.	Ng & Chen (2004)
8.	*Aspergillus niger*	Cassava peel	The content of ash, crude protein, Ca, and P increased after fermentation, whereas the content of LK, starch, sugar, and ME decreased.	Nurhayati (2005)
9.	*Trichoderma harzianum*	palm kernel cake and cassava	Resulting in a 45% reduction in crude fiber and an increase in protein from 12% to 16%-17% crude protein content	Indariyanti *et al*. (2011)
10	*Aspergillus niger*	Soybean meal, bran, polar, coffee skin, shrimp head	The fermented material increased its protein content, namely soybean meal 1.94%, bran 1.96%, polar 3.48%, coffee skin 8.99% and shrimp head 16.63%. However, the fermentation process also increases the ash and crude fiber content	Darmawiyanti *et al*. 2019
11	*Phanerochaete chrysosporium, Candida utilis*	Three seaweeds (*Caulerpa lentillifera, Eucheuma cottonii, Sargassum fulvellum*) and oil palm	The increase in ash percentage and total carbohydrate of S. fulvellum was found to be 52.28 mg/g, 61.31% and 445.89 mg/g substrate respectively.	Jamal *et al*. 2015

The results of the study of fermented feed ingredients that significantly increased fish growth, increased fish appetite and made efficient use of feed that was cheaper than local feed with high protein.

Table 2. Effect of Fermentation to Quality of Fish Feed

No.	Microbe	Substrate	Result	Reference
1.	*Rhizopus oligosporus*	palm kernel cake	The use of 18% fermented products in carp feed significantly increased the amount of feed consumption, the highest weight gain, and decreased feed conversion.	Amri (2007)
2.	-	Restaurant organic waste	The Tukey Post-hoc pairwise comparison test also proved a similar effect exerted by 14-28 days of fermentation period on this protein content has increased by about 50% compared to unfermented or fermented for 7 days, ie, 0.32-0.34 mg against 0.22– 0.25 m	Djamalu *et al*, 2019
3.	Bacterial consortium	Restaurant organic waste	Optimum protein content that has been fermented for 14 days with 0.5% by weight of powdered bacterial consortium produces at least 25% higher protein content.	Andriani *et al*, 2021
4.	*Trichoderma reesei*	palm kernel cake	carried out up to 15% in broiler rations without disturbing body weight, consumption, and ration conversion, as well as the percentage of carcass weight	Jaelani (2007)

5.	Rumen enzym	palm waste	can be used for rearing tilapia, although it has not been able to match the feed that uses soybeans. However, in terms of price, this feed is cheaper so it can be used as an alternative feed	Hadadi et al. (2007)
6.	*Rumen cattle*	Lamtoro leaf (*Leucaena leucocephala*) and soybean meal	40% fermented lamtoro gung leaf flour gave the best growth rate and feed efficiency, which were 3.45% and 38.00%, respectively.	Arin *et al.* 2020
7.	*Aspergillus niger*	Soy bean meal, rice bran, polard, coffee peel, and shrimp meal	Increasing the nutritional value of fermented ingredients can reduce the percentage of fish meal use by 18.51% in the feed formula for rearing snapper with feed conversion of 1,178.	Darmawiyanti *et al.* 2019
8.	*Saccharomyces cerevisiae*	Soy bean meal and fish meal	the addition of baker's yeast (*S. cerevisiae*) at a dose of 3 g/kg of feed in the feed had a significant effect (P<0.05) on the feed conversion ratio (FCR) and specific growth (SGR) of Tawes (*P. javanicus*).	Sumardiyani *et al*. 2020
9.	*Lactobacillus sp.*	Rice bran	Feeding with the addition of fermented rice bran in feed using Lactobacillus sp. as much as 15-20% can increase the growth rate and enzyme activity of tilapia.	Surianti *et al*. 2020

Physical Processing of Feed Ingredients

Physical treatment in general is usually carried out on feeds with high fiber content to overhaul the physical structure of the material and break down the carbohydrate matrix that makes up the cell wall. Physical treatment of feed in feed ingredients is very necessary, in order to obtain materials that can be made into pellets with particle sizes that match the fish's mouth opening. In milling feed ingredients, the feed particle size must be adjusted properly to strike a balance between increased feed consumption and feed rate efficiency of the animals consuming it.

Besides that, physical treatment can be used to preserve and remove anti-nutritional content of feed ingredients. Several methods are often used in the physical treatment of waste feed, namely drying and soaking.

Drying

Drying of feed ingredients is one of the simplest treatment methods in processing waste-based materials, especially materials that contain high water or materials that contain anti-nutrients that are easily lost by heating. Waste originating from livestock and fishery products that still have a high water content needs to be dried so that it can be stored for a long time. The tools used for the drying process of the material can be in the form of an oven, freeze drier and blower. Drying using sunlight is the cheapest and easiest way, especially in the tropics. Drying of feed ingredients is carried out to reduce the density of some livestock wastes by about 20-30% of the initial volume. Besides that, drying is intended to suppress the decomposition process of organic matter. Substance losses such as nitrogen and energy are affected by drying techniques and methods. Freeze drying using freeze dry can reduce the amount of nitrogen and energy lost by 4.8% and 1.3%, respectively. While vacuum drying using vacuum dry at a temperature of 40oC can result in nitrogen loss.

Soaking

Feed treatment using the immersion method is usually aimed at eliminating or reducing the antinutrient content in the feed. The media used for soaking feed ingredients can be water, salt or alkaline solutions. According to Leahu & Rosu (2014), that immersion in sodium bicarbonate solution resulted in a significant reduction in ripening time for dry seeds of both varieties. Cooking time decreased from 120 minutes to 75 when using a 5% sodium bicarbonate soaking solution for white beans, and 60 to 30 minutes for kidney beans.

Efforts to eliminate anti-nutrients, one of which is to reduce the content of cyanide and phytic acid in feed ingredients. This can be done by immersion. In cassava, soaking for 4 hours can reduce the cyanide acid content by 20%. The content of phytic acid in nuts seeds can decrease up to 50% after the material is soaked in water for 24 hours. Increasing the immersion time can reduce the phytate content of feed ingredients. Immersion provides the main advantage in the form of an increase in feed consumption with a decrease in dust elements in fibrous feed ingredients (Doyle et al., 1986). Immersion at 30 °C/75% relative humidity for 6 months and immersion at 50 to 60 °C, the hardness during cooking is further increased. This shows that the softening suppression mechanism is different depending on the effect of immersion and storage (Koriyama, et.al. 2000).

Besides the advantages, there are several possible negative effects of the Immersion Technique, namely:

1) Immersion causes dry matter loss of about 8-14% which indicates that the content of materials that are easily soluble during the soaking process (Davendra, 1990).

2) Soaking can reduce both consumption and digestibility of feed organic matter (Devendra, 1990)
3) The change in color to a paler color was obtained from samples of beans that received different soaking treatments measured by the lightness value (L*), chroma index (C*) and coloration (H*) parameters (Leahu & Rosu, 2014).

Conclusion

Physical and biological processing technology is able to increase or improve the nutritional value of local feed raw materials so that they can be used as fish feed raw materials. The high crude fiber content and the low protein value of local feed ingredients, which are one of the obstacles in its utilization, can be improved through fermentation techniques. Fermentation of feed raw materials can reduce the content and crude content, increase the value of crude protein and eliminate anti-nutrients from local feed raw materials. Physical treatment methods have advantages that can be adapted to feed conditions, costs, equipment availability and level of convenience. In general, physical treatment of feed can increase the speed of digesta flow which leads to increased consumption and digestibility of feed.

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