GSJ: Volume 11, Issue 1, January 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

FERMENTATION WITH YEAST TO IMPROVE FEED QUALITY

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KeyWords
aquaculture, feed, fermentation, yeast, Saccharomyces sp.

ABSTRACT

Alternative feed raw materials are relatively economical, but their direct use in artificial feed is limited by the high content of crude fiber and anti-nutritional substances which have a negative effect on the level of digestibility of the feed. Application of microorganisms in an effort to improve the quality of raw materials for fish feed has been widely carried out. Fermentation is a process of chemical change of organic compounds (carbohydrates, fats, proteins and other organic matter) both in aerobic and anaerobic conditions, through the work of enzymes produced by microbes. Yeast generally contains microorganisms that carry out the fermentation and culture media for these microorganisms. Microorganisms in yeast generally consist of fungi such as *Saccharomyces* sp. The enzymes produced by *Saccharomyces cerevisiae* are protease enzymes that can break down protein, lipase enzymes that can break down fat, invertase enzymes that break down sucrose into glucose and fructose, maltase enzymes that break down maltose into glucose-glucose so that it can improve the quality of feed ingredients. Therefore the application of fermentation using yeast to improve the quality of feed ingredients must be carried out. Fermentation using *Saccharomyces cerevisiae* can improve the nutritional quality of feed ingredients through a decrease in crude fiber content by 17.43% -51.16% and fat by 25.60% -80.07%, and an increase in crude protein by 2.8% -18 .89%.

1. INTRODUCTION

Advances in aquaculture technology have made the aquaculture industry develop dynamically in recent years [1]. Increasing the productivity of cultivation requires consistency of feed supply. Feed costs account for around 70% of the total cost of aquaculture production [2] and feed prices that continue to increase are a crucial problem. The limited availability of fishmeal which is the raw material for the main source of protein in feed is one of the factors causing the high price of feed.

The use of alternative raw materials is one of the efforts to reduce production costs. However, in order to be used as feed raw materials, these non-conventional raw materials must have adequate nutritional value, be non-toxic, economical, be abundant, and not compete with human needs [3]. Non-conventional raw materials are relatively economical, but their direct use in artificial feed is limited by their high crude fiber content and anti-nutrients which have a negative effect on feed digestibility [4]. Thus, several types of non-conventional raw materials that will be used need to be processed first so that they can be used as feed.

Application of microorganisms in an effort to improve the quality of raw materials for fish feed has been widely carried out. Fermentation is one of the utilization of microbes in an effort to improve the quality of feed raw materials. The principle of fermentation is biological processing using the services of microbes, either naturally or through the addition of yeast inoculum. Yeast generally contains microorganisms that carry out the fermentation and culture media for these microorganisms. Microorganisms in yeast generally consist of fungi such as *Saccharomyces* sp. [5]. [6] stated that fermentation can improve the nutritional quality of feed ingredients by reducing the levels of crude fiber and fat, as well as increasing the protein content.

2. FERMENTATION USING YEAST

2.1 Fermentation

According to [7], fermentation is a process of chemical change of organic compounds (carbohydrates, fats, proteins, and other organic matter) both in aerobic and anaerobic conditions, through the work of enzymes produced by microbes. Yeast has several types of enzymes, namely protease which can break down protein, lipase which can break down fat, invertase which breaks down sucrose into glucose and fructose, maltase which breaks down maltose into glucose-glucose, and zymase which breaks down glucose into alcohol and carbon dioxide [8]. Enzyme chemical breakdown of complex compounds into these simple compounds will make it easier for the feed to be digested by fish.

2.2 Types of yeast

According to [9], yeast is divided into three types, namely:

1) Compressed Yeast. A type of yeast that contains 70% water content. Storage must be at low temperatures, so that its ability to form gas is maintained. Best storage at 1°C.
2) Active dry yeast. A type of yeast that contains a water content of 7.5% - 9%. Before using the yeast, it must first be soaked in water with a ratio of 4:1 (4 kg of water: 1 kg of dry yeast) for ± 10 minutes.
3) Instant dry yeast. This type of yeast is almost the same as active dry yeast. The difference is, this yeast does not need to be soaked before use. Once the packet has been opened, the yeast should be used immediately. An example of this type of yeast on the market is “Fermipan” which contains the microorganism *Saccharomyces cerevisiae*

2.3 Saccharomyces cereviseae

Saccharomyces cerevisiae is a yeast species that has a very high conversion capacity of sugar into ethanol and CO_2. *Saccharomyces* is a single-celled microorganism, without chlorophyll, and belongs to the eumycetes group. The main metabolite products are ethanol, CO_2 and water, while several other products are produced only in small amounts. This yeast is facultative anaerobic, meaning it can live in low oxygen conditions. *Saccharomyces cerevisiae* requires a temperature of 30°C and a pH of 4.0-4.5 in order to grow properly. During the fermentation process heat will arise. If no cooling is done, the temperature will continue to rise and the possibility of the fermentation process being hampered. According to [10] the classification of *Saccharomyces cerevisiae* is as follows.

Phylum : Ascomycota
Subphylum : Saccharomycotina
Class : Saccharomycetes
Order : Saccharomycetales
Family : Saccharomycetaceae
Genus : Saccharomyces
Species : *S. cerevisiae*

Figure 1. *Saccharomyces cerevisiae*[1]

Saccharomyces comes from the Latin Greek meaning "mushroom sugar" while *cerevisiae* comes from the Latin meaning beer. Yeast cells consist of a capsule, cell wall, cytoplasmic membrane, nucleus, vacuoles, lipid globules and mitochondria. This yeast is oval in shape (ovoid) with a size of about 1-5µm or 20-25µm with a width of about 1-10µm. Its colonies are flat, moist, shiny and smooth [10]. *Saccharomyces cerevisiae* was selected to be used in the manufacture of feed ingredients to produce the desired changes in terms of better texture, taste and aroma. *Saccharomyces cerevisiae* is utilized to improve the immune system in fish. Healthy fish determine good fish growth and a high success rate.

2.4 Mechanism of Fermentation

The fermentation process requires a substrate as a medium for microbial growth where this media contains the nutrients needed during the fermentation process [11]. 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 first undergo a chemical or enzymatic hydrolysis process. 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 Cx enzymes (endo-β-1.4 glucanase) and β-glucosidase.

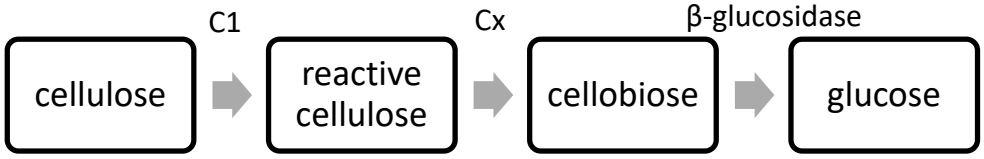

Figure 2. Mechanism of enzymatic hydrolysis of cellulose (Fardiaz 1988)

Furthermore, in the glucose fermentation process, pyruvic acid will be formed and will be converted into specific final products for various fermentation processes [11]. One example of a fermentation process is the fermentation of glucose by lactic acid bacteria which produces lactic acid and other products

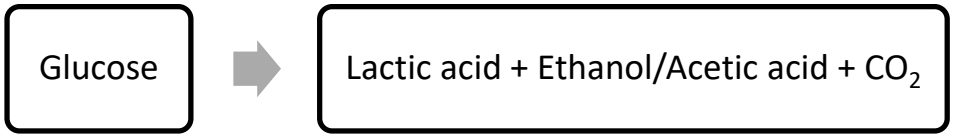

Figure 3. The reaction of glucose fermentation by bacteria (Fardiaz 1988)

[1] www.biologydictionary.net

Fermented products are generally easily biodegradable and have a higher nutritional value than their original ingredients [12]. This can be caused by the catabolic nature of microbes or the ability to break down complex components into simpler ones so that they are easier to digest and can synthesize some complex vitamins. The benefits of fermentation include being able to convert complex organic materials such as proteins, carbohydrates and fats into molecules that are simpler and easier to digest, altering tastes and aromas that are not initially liked and synthesizing proteins. Another benefit of fermentation is that food is more resistant to storage and can reduce the toxic compounds it contains, hence that the economic value of the basic ingredients is much better. According to [13] fermented products are very dependent on feed ingredients as basic ingredients (substrates), types of microbes or inoculums and environmental conditions, all of which greatly affect the growth and metabolism of these microbes.

One good medium to use as a fermentation medium is pollard. Pollard is a grain milling waste that has potential as animal feed, because it contains protein, fat, mineral substances and vitamins compared to the whole grain, but pollard contains a lot of structural polysaccharides [14]. Structural polysaccharides are polysaccharides that function as building blocks for a cell or an entire organism, such as cellulose and chitin. Microbes really need the availability of nutrients from the fermentation media at the beginning of growth. Pollard can be used as an initial growth promoter of fiber-digesting microbes, because it has a fairly high protein content, where protein is an important source of nutrition for the growth of microbial cell mass [15].

3. CHANGES IN NUTRITIONAL CONTENT AND QUALITY OF FERMENTED FEED INGREDIENTS YEAST

The fermentation process is able to simplify the particles of feed ingredients, thereby increasing their nutritional value. Feed ingredients that have undergone fermentation will be of better quality than the raw materials. According to [16], the addition of baker's yeast will improve the digestion of feed and protein by fish resulting in better growth and feed efficiency. Below are presented some research results related to the fermentation process using yeast in improving the quality of fish feed (Table 1).

Table 1. Studies results on yeast fermentation process in improving feed quality

Commodity	Treatment	Result	Reference
Palm Oil Cake Flour	There are 2 *S. cerevisiae* test factors (0%, 0.9% and 1.5%) and incubation time (0 hour, 24 hours and 48 hours)	The combination of *S. cerevisiae* dose of 1.5% and an incubation period of 24 hours was able to reduce the value of crude fiber contained in palm oil cake flour by 50%.	[17]
Tapioca	Fermentation time with *Saccharomyces cerevisiae* which consisted of 5 treatment periods, namely 0, 12, 24, 36, and 48 hours	During the 48 hours of fermentation, the maximum protein value increased from 0.28% to 2.17%. The increase in water content from 10.65% to 11.27% at 12 hours of fermentation.	[18]
Durian Seed Waste	A (control) = without fermentation FS (0.5) = Fermentation with 0.5% *Saccharomyces cerevisiae*, FS (0.75) = Fermentation with 0.75 % *Saccharomyces cerevisiae*	Fermentation with 0.75% *Saccharomyces cerevisiae* increased the crude protein content by 2.8% and the water content by 54.24%. Decrease in crude fiber by 51.16% and crude fat by 25.60%	[19]
Rice bran	Rice bran fermentation using *Saccharomyces cerevisiae* yeast at 8%	Increase in protein content by 4.78%, carbohydrates by 95.71% and ash content by 94.7%. Decreased lipid content by 80.07% and crude fiber by 17.43%,	[20]

Bran	Fermented bran with the addition of rumen fluid and *Saccharomyces cerevisiae* with an incubation time of 3 days	Has no effect on the content of crude fiber and crude fat, but has an effect on the increase in crude protein by 18.89%	[21]

Conclusion

Feed fermentation techniques can improve feed quality. Fermentation using *Saccharomyces cerevisiae* yeast can increase the protein content and water content and reduce the crude fiber content. It can be used to produce quality feed formulations. The results of fermentation using yeast can increase the value of protein which is very good for fish growth. Increased water content in fermented feed ingredients can be caused by the respiration of *Saccharomyces cerevisiae* which produces H_2O. Water content plays a role in stabilizing body temperature, carrying nutrients and metabolic waste. There was a decrease in crude fiber content caused by fermentation using *Saccharomyces cerevisiae*. This is because these organisms produce catabolic enzymes that can break down complex fiber bonds into simple ones.

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