Review Article

Replacement of Fish Meal with Fermented Soybean Meal in Fish Feed: A Review

ABSTRACT

Soybean meal is a source of vegetable protein substitute for fish meal that is widely used because it has a high protein content, relatively cheap price and easy to obtain. Besides being high in protein, soybean meal also contains anti-nutrients that can inhibit growth, feed effectiveness, and lower nutrient utilization in fish. So it is necessary to process feed ingredients to remove anti-nutrient content. Fermentation can be a solution for the utilization of soybean meal by reducing the anti-nutritional content and crude fiber so as to produce components that can be utilized properly, such as protein, β-glucan, vitamins, mannan oligosaccharides, organic acids, and antibiotics. The type of soybean meal fermentation that is widely used is with *Bacillus* spp ., *Aspergillus* spp. , *Lactobacillus* spp. , and yeast. The purpose of this literature review study was to determine the effect of replacing fish meal with fermented soybean meal on fish feed. Several types of fish that have been fed with fermented soybean meal include seabasses, green snapper, mud grouper, rainbow trout, star pomfret, tilapia, and turbot. Giving fermented soybean meal to fish can increase growth rate, intestinal morphology, intestinal microecology, feed digestibility, feed preference, fish innate immunity and produce antimicrobial peptides. Soybean meal fermentation as a substitute for fish meal has been shown to have a good effect on fish so that it can continue to be developed to increase the utilization of soybean meal.

Keywords : Fish feed, fermentation, soybean meal, growth, digestibility

1. INTRODUCTION

Fish meal has a high protein content so that it can be used as the main protein source in the manufacture of carnivorous fish feed with additional content such as a balanced amino acid content and the content of other growth triggering factors [1] . However, the use of fish meal has a negative impact on the development of a sustainable aquaculture industry and is an obstacle to increasing demand for feed production [2] . The diminishing fishery resources and increasing fish prices are the main factors in urging nutritionists to replace fish meal without reducing the protein content and easy to find [3] .

Candidate sources of protein as a substitute for fish meal are soy flour extracted with solvents, because of its wide availability and stable supply [2] . Soybean meal is a by-product of processed soybean oil with a high protein content (about 40-50%) and balanced amino acids, so it can be used as the main protein source in the manufacture of animal feed and the food industry [4] . Besides having a high protein content, soybean meal also has a high carbohydrate

content [5] . However, the use of soybean meal as an alternative raw material is still limited because soybean meal contains anti-nutrients such as oligosaccharides, saponins, protease inhibitors and phytic acid [6] which can inhibit growth, physiological conditions and feed utilization so that the nutrients in the feed are not absorbed completely [7] .

Substitution of fish meal using soybean meal flour often causes stunted growth and lower nutrient utilization in feed [8] [9] . Previous studies suggested the reduction or even elimination of anti-nutritional content in soybean meal using various techniques to increase the nutritional value content [10] . So it is necessary to process feed raw materials before being given to fish [11].

Fermentation is the process of chemical changes in certain materials with the help of enzyme activity derived from microorganisms [12] . make other beneficial components such as probiotics and prebiotics [13] . Making this journal review aims to determine the effect of replacing fish meal with fermented soybean meal on fish feed.

2. SOYBEAN MEAL AS A SUBSTITUTE FOR FISH MEAL

Soybean meal is often used as a substitute for fish meal because it has a relatively high protein content, easy to find and low price [14] . Several studies also said that soybean meal has been widely used as an alternative protein source to replace fish meal in fish culture feed, because of its high protein content, relatively low cost and easy to find [15] . Besides having a high protein content, soybean meal also has a high carbohydrate content [5] . However, the use of soybean meal in the diet of carnivorous fish such as orange spotted grouper (30%) [16] , Eur opean seabass (25%), and turbot (30%) [17] needs a benchmark in feeding soybean meal because it can hamper performance. growth of the carnivorous fish.

The high use of soybean meal in feed can cause adverse effects on growth, feed utilization and fish health status [15] . Several studies have shown that feeding fermented soybean meal in aquaculture ponds can affect immune function, adverse inflation responses and stress in fish. [3] . The antinutrient content in soybean meal raw materials can inhibit the efficiency of feeding so that the nutritional content is disturbed such as the content of phytic acid [18] . In general, plant-type feed ingredients contain antinutrients which are the main source of phosphate and cause low feed solubility in monogastric animals. The strategy that can be used to remove anti-nutritional content in soybean meal is to utilize the fermentation process by microorganisms which has many benefits such as increasing the nutritional content and increasing the solubility of vegetable protein sources by fish [14] .

3. FERMENTATION FUNCTION

Fermentation is one method that is widely used in increasing the utilization of fish meal substitutes with soybean meal [19] . Previous studies have determined that fermentation is an effective method to improve the quality of soybean meal by producing probiotics or prebiotics. So it can improve nutrient digestibility, fish immune system and palatability by eliminating antinutrients, oligosaccharides, protein and fiber. [20] . In the soybean meal fermentation process, the most widely used microorganisms are *Bacillus* spp ., *Aspergillus* spp. , and *Lactobacillus* spp. [21] [22] . Several studies also explained that the use of fermented soybean meal with *Bacillus* spp. can increase protein content, tioxidative activity, total amino acids, fish digestibility and can reduce antinutrient content and immunoreactivity [9] . So that fermentation is highly recommended to increase the utilization of soybean meal [14] .

4. NUTRIENTS IN FERMENTATION OF SOYBEAN MEAL IN FISH FEED

Feed ingredients that are processed by the fermentation process will experience an increase in nutrients such as increased protein and feed digestibility through a decrease in crude fiber and fat levels [23] . Several studies say that fermentation can be used to improve the quality of soybean meal. The nutritional content of fermented soybean meal can improve fish growth performance, digestive physiological conditions and the coefficient of digesting nutrients. The type of fermentation that is widely used is with the bacterium *Bacillus subtilis* and *Lactobacillus* spp. [7] . List of nutritional content and type of fermentation in several studies can be seen in (Table 2.).

Table 1: Nutrient content of fermented soybean meal

Fermentation Type	Crude protein (%)	Carbohydrates (%)	Ash Content (%)	Lipids Rough (%)	Reference
Bacillus pumillus SE5	42	-	-	10	[2]
Aspergillus layor	60.58	-	-	2.7	[15]
Bacillus subtilis E20	48.82	-	11.85	7.50	[16]
Bacillus subtilis , Lactobacillus, yeast	65.5	-	-	-	[6]
Lactobacillus spp.	50	-	-	-	[7]
Saccharomyces cerevisiae	29.7	57.15	5.91	-	[24]

5. FERMENTATION OF SOYBEAN MEAL AS FISH FEED

Soybean meal fermented using microorganisms has been widely used in several types of fish and produces soybean meal with a higher preference as vegetable protein [25] . Fermented soybean meal has been widely used as feed for seabasses [2] , green snapper [26] , mud grouper [16] , rainbow trout [6] , star pomfret [7] , tilapia [24] , and turbot [15] . Another study mentioned the use of soybean meal fermentation using *Bacillus* spp. can produce antibiotics [27] and do not cause any morphological changes in the intestines of fish, especially in ranbow trout [25] . Soybean meal fermentation using lactic acid bacteria can increase the acidity of the feed, increase feed preference, and can produce antimicrobial peptides [28] . Soybean meal fermented using yeast can produce useful components such as mannan oligosaccharides, organic acids, vitamins, antibiotics, β-glucans, and chitin [29] . Components produced from soybean meal fermentation using microbes can increase the growth rate, intestinal morphology, intestinal microecology and innate immunity of fish [30]. [31] . The use of fermented soybean meal in fish has different optimum levels (Table 1).

Table 2: Growth and optimum dose of fermented soybean meal

Species	*Results (WG %)*	*Optimum Dose*	*Reference*
Lateolabrax maculatus	12.3	26.9-37.1%	[2]
Micropterus salmonides	14.71	30%	[26]
Epinephelus coioides	34.81	29.32%	[16]
Oncorhynchus mykiss	5.5	40%	[6]
Trachinotus blochii	25.3	35%	[7]
Oreochromis niloticus	21.87	37.4%	[24]
Scophthalmus maximus L.	N/A	45%	[15]

6. CONCLUSION

The use of fermented soybean meal in replacing fish meal is an alternative that can be used because the protein content in fermented soybean meal is not much different from that of fish meal. In addition, fermented soybean meal is also easy to find and the price is relatively cheap. Although the use of fermented soybean meal in fish feed is very promising, there are still not many efficient uses for fish growth. Therefore, it is necessary to determine the species and type of fermentation that are suitable for the use of fermented soybean meal in fish feed.

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