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EFFECTIVENESS OF LUT-BASED PREBIOTICS IN ARTIFICIAL FEED ON THE GROWTH RATE OF MILKFISH

Efektivitas Prebiotik Berbasis Kacang-Kacangan Dalam Pakan Buatan Terhadap Laju Pertumbuhan Ikan Bandeng

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ABSTRACT

The purpose of this study was to evaluate the effectiveness of legume-based prebiotics in milkfish feed, with the hope of increasing growth rate, survival rate, and feed efficiency. The study was conducted using five feed treatments containing soybean flour, peanuts, green beans, red beans, and control. Feed was given at a percentage of 5% of fish biomass per day for 60 days. The results showed that feed containing red beans (Feed D) gave the best results, with a survival rate of 77.777% and the highest specific growth rate of 12.937%. However, the feed conversion ratio was not significant. Feeding containing red beans is thought to improve the performance of fish digestive microflora, contribute to improved health and feed digestibility, and support faster growth. However, although increased survival and growth were achieved, feed utilization efficiency (FCR) still needs to be improved. This study shows that red bean-based feed has the potential to increase milkfish cultivation results sustainably, but feed management and environmental factors are also very important to support cultivation efficiency.

Keywords: Chanos-chanos, Fcr, Growth, Red Beans, Prebiotics, Survival.

ABSTRAK

Tujuan penelitian ini yaitu mengevaluasi efektivitas prebiotik berbasis kacang-kacangan dalam pakan ikan bandeng, dengan harapan dapat meningkatkan laju pertumbuhan, sintasan, dan efisiensi pakan. Penelitian dilakukan menggunakan lima perlakuan pakan yang mengandung tepung kacang kedelai, kacang tanah, kacang hijau, kacang merah, dan kontrol. Pakan diberikan dengan presentase 5% dari biomassa ikan per hari selama 60 hari. Hasil penelitian menunjukkan bahwa pakan yang mengandung kacang merah (Pakan D) memberikan hasil terbaik, dengan tingkat kelangsungan hidup mencapai 77,777% dan laju pertumbuhan spesifik tertinggi sebesar

12,937%. Meskipun demikian, rasio konversi pakan tidak signifikan. Pemberian pakan yang mengandung kacang merah diduga meningkatkan kinerja mikroflora pencernaan ikan, berkontribusi pada peningkatan kesehatan dan daya cerna pakan, serta mendukung pertumbuhan yang lebih cepat. Meski demikian, meskipun peningkatan kelangsungan hidup dan pertumbuhan tercapai, efisiensi penggunaan pakan (FCR) masih perlu ditingkatkan. Penelitian ini menunjukkan bahwa pakan berbasis kacang merah berpotensi untuk meningkatkan hasil budidaya ikan bandeng secara berkelanjutan, namun pengelolaan pakan dan faktor lingkungan juga sangat penting untuk mendukung efisiensi budidaya.

Kata Kunci: Bandeng, Pertumbuhan, Prebiotik, FCR, Sintasan.

INTRODUCTION

Milkfish (*Chanos-chanos*) is one of the brackish water fishery commodities that has important economic value in Indonesia, especially in the South Sulawesi region. This fish is in high demand and economically, milkfish has great potential for further development (Iskandar *et al.,* 2023). However, despite growing market demand, milkfish production in intensive aquaculture systems faces a number of challenges, mainly related to production costs which are largely influenced by high feed prices. Feed is a major component in the cost of aquaculture, and increasing feed prices, particularly those based on fishmeal, are a major problem (Mushocheh *et al.*, 2023). Although protein-rich fishmeal is necessary in fish feed, its high price and low digestibility rate can reduce the efficiency of feed utilization by fish (Husnain *et al.,* 2020).

Various efforts have been made to improve feed efficiency, one of which is by using probiotics. Probiotics are microorganisms that provide benefits to the fish digestive tract, helping to balance the gut microflora, inhibit the growth of pathogenic bacteria, and facilitate food digestion by producing digestive enzymes (Saha *et al*., 2018). However, existing research shows that the effectiveness of probiotics in improving feed efficiency still requires further development. The way to improve the performance of probiotics is by adding prebiotics to fish feed.

Prebiotics are substances that cannot be digested by the host body, but can be used by intestinal microflora, including probiotic bacteria. In other words, prebiotics serve as a food source for good bacteria, which in turn can increase the number and activity of probiotic bacteria and support the health of the fish digestive tract (Yadav *et al*., 2020). Prebiotics can also help improve feed digestibility, reducing organic waste. One source of prebiotics that has been widely studied is oligosaccharides found in legumes, such as soybeans, mung beans, and peanuts (Sari *et al*., 2021).

Legumes contain oligosaccharides that cannot be digested by fish, but can be utilized by probiotic bacteria as energy for their growth and development. Therefore, the use of legumes as a source of prebiotics can increase the number of probiotic bacteria in the digestive tract of milkfish, which in turn is expected to improve feed digestibility and overall feed efficiency (Zokaeifar *et al*., 2021). The combination of probiotics and prebiotics in feed, known as synbiotics, can have a greater impact on the balance of digestive microflora, ultimately supporting more optimal fish growth (Olsson *et al*., 2019).

Research on the use of legume-based prebiotics in milkfish feed is very important to be carried out to overcome the challenges of increasing feed costs and to increase the efficiency of milkfish farming in a sustainable manner, the purpose of this study is to evaluate the effectiveness of legume-based prebiotics in milkfish feed, it is expected to improve the performance of digestive microflora, improve feed digestibility, and ultimately accelerate milkfish growth.

METHODS

Research Location

This research was conducted in the Mini Hatchery of the Department of Fisheries FIKP Unhas. The results of proximate analysis were carried out at the Takalar Brackish Water Aquaculture Center. Water quality was analyzed at the Water Quality Laboratory of FIKP Hasanuddin University.

Containers and Treatments

The containers used were glass aquariums measuring 50 x 45 x 45 cm as many as 15 pieces filled with brackish water with a salinity of 15 ppt. and juvenile size milkfish obtained in Maros Regency, each container containing 15 fish/m3. The feed used was formulated with a nutritional composition according to the needs of milkfish and added soybean, mung bean, peanut and kidney bean flour as prebiotics. The composition of the feed raw materials is presented in Table 1.

Table 1. Feed formulations used during the study

Raw Material	Percentage				
	Feed A	Feed B	Feed C	Feed D	Feed E
Fish meal	29	30	31	32	40
Soy bean meal	20	8	9	8	0
Peanut meal	9	20	8	9	0
Mung bean meal	9	8	20	8	0
Red bean meal	8	9	9	20	0
Coconut meal	8	9	8	9	35
Wheat flour	12	11	10	9	20
Fish oil	1	1	1	1	1
Vitamins & Minerals	4	4	4	4	4

Maintenance began with an acclimatization process aimed at adjusting the fish to the environment and feed given. Acclimatization to the environment was carried out by adjusting the temperature and salinity of the rearing medium, while for adjustment to feed, fish were given artificial/control feed without additional treatment three times a day at 07:00, 12:00, and 17:00 WITA for about one week until the fish got used to it. At the experimental stage, fish were first weighed to record initial weights before being put into their respective experimental containers. Maintenance was carried out for about ± 60 days, with 3 feedings, with the amount of feed given amounting to 5% of the fish body weight. Sampling was done every 10 days to monitor the growth of fish weight and adjust the amount of feed given. Before the fish were put into the experimental tanks, the fish were weighed using analytical scales to record the initial weight. Milkfish were studied for 30 days and feed was given at the same time and percentage as in the acclimatization stage.

This study was designed using a completely randomized design with 5 treatments and 3 replications. Therefore, 15 containers were required. The treatments tested included the provision of several types of prebiotics from legumes in the feed, namely: Soybean.

A. Groundnut
B. Green Mung Beans
C. Red Bean
D. Control

Researcher Parameters

Survival Rate

Fish survival is tested with the formula according to Widyanti (2009):

$$Survival\ (\%) = \frac{No - Nt}{No} x100\%$$

Specific Growth Rate

Specific growth rate (%/day), analyzed by the formula Hardjamulia *et al.,* (1986):

$$\text{SGR} = \frac{\ln \text{Wt} - \ln \text{W0}}{\text{T}} \text{x } 100$$

Feed conversion ratio (FCR)

Feed conversion is calculated by the formula Djajasewaka (1985), yaitu :

$$FCR = \frac{F}{(Wt\ +\ D) - Wo}$$

Data Analysis

Data analysis used in this study is analysis of variance or Analysis of Variance (ANOVA) test if the results are significantly influential, then continued with the W-Tukey test to see which treatment gives the best results.

RESULTS

Survival Rate

Survival with artificial feeding using different types of legumes is shown in Table 2.

Table 2. The results of milkfish survival during rearing.

Treatments	Parameters ±Std
	Survival Rate
Feed A	51,113±.13,87[a]
Feed B	73,333±.6,66[ab]
Feed C	60,003±.11,54[ab]
Feed D	77,777±.3,85[b]
Feed E	66,670±.0,00[ab]

Notes: Different superscript letters in the same column indicate statistically significant differences (P < 0.05)

The results of the analysis of variance showed that the treatment of various types of legumes in feed had a significant effect ($p<0.05$) on milkfish survival. W-Tuckey test showed that the survival value of feed D was different from feed A but the same as feed B, C and E.

Specific Growth Rate

The average growth values of milkfish treated with various types of legumes are presented in Table 3.

Table 3. Growth results of milkfish during rearing.

Treatments	Parameters ±Std
	Specific Growth Rate
Feed A	9,830±.2,69^{ab}
Feed B	5,743±.1,78^{a}
Feed C	6,960±.3,07^{ab}
Feed D	12,937±.3,19^{b}
Feed E	6,273±.2,37^{ab}

Notes: Different superscript letters in the same column indicate statistically significant differences (P < 0.05)

The results of the analysis of variance showed that the provision of various types of legumes in the feed had a significant effect ($p < 0.05$) on the growth of milkfish. W-Tuckey further test showed that feeding type D produced the best growth in milkfish, which amounted to 12.937 ± 3.19%.

Feed conversion ratio (FCR)

Feed conversion ratio of milkfish with artificial feeding using different types of legumes is shown in Table 4.

Table 4. Average feed conversion ratio results of milkfish during the study

Treatments	Parameters ±Std
	Feed conversion ratio
Feed A	1,433±.0,85
Feed B	2,867±.1,70
Feed C	2,233±.0,81
Feed D	1,900±.0,79
Feed E	2,067±.1,50

The results of the analysis of variance showed that feeding with different types of legumes did not have a significant effect on FCR ($p > 0.05$). Feed conversion ratio refers to the ratio between the amount of feed consumed and the increase in body weight achieved.

DISCUSSION

Survival Rate

The results of the analysis of variance showed that the treatment of various types of legumes in feed had a significant effect ($p<0.05$) on milkfish survival. W-Tuckey test showed that the survival value of feed D was different from feed A but the same as feed B, C and E.

The survival rate of milkfish in this study ranged from 51.113% to 77.777%, with the red bean-containing feed (Feed D) producing the highest survival rate of 77.777%. The high survival rate in this treatment is most likely due to the better quality of nutrients, such as protein, carbohydrates, and energy that match the metabolic needs of milkfish. These adequate nutrients allow the fish to maintain endurance and reduce stress, which contributes to higher survival. Protein content is instrumental in improving the body structure as well as the immune system of the fish, while carbohydrates and energy support more efficient metabolism, enabling the fish to withstand variable environmental conditions (Fazil *et al*., 2023; Yadav *et al*., 2022).

In addition, the addition of legumes to artificial feed is thought to play a role in increasing the survival rate of milkfish. Legumes, especially kidney beans, contain oligosaccharides that cannot be digested by fish but can be a source of nutrients for probiotic bacteria in the fish's digestive tract, which in turn improves the digestive health and endurance of the fish (Viana *et al*., 2021). In addition to the nutritional aspect, another factor that affects the survival rate of milkfish is feeding according to the needs of the fish. In this study, feeding 5% of biomass per day, divided into four feedings, proved effective in avoiding cannibalism and ensuring that the fish received enough food without competition between individuals. This supports previous findings that explain regular feeding will increase fish survival by reducing stress due to food competition (Saravanan *et al*., 2020).

However, environmental factors also play an important role in milkfish survival. Biotic factors such as fish density and competition between individuals, as well as abiotic factors such as temperature, pH, and dissolved oxygen, can affect fish survival rates. Reksono *et al*., (2012) and Serdiati *et al*., (2011) revealed that good water quality and ideal fish density are essential to support fish growth and survival. Therefore, water quality and appropriate fish density settings are necessary to create optimal conditions for milkfish survival. Overall, the results of this study indicate that feeding red kidney bean-containing diets can improve the survival rate of milkfish, with a greater positive effect seen in red kidney bean-containing diets than other types of diets. Proper feed management and good monitoring of environmental conditions are essential to support the success of milkfish farming.

Specific Growth Rate

Based on the results obtained, feed with red bean content (Feed D) produced the highest growth rate of milkfish compared to other treatments. This is likely due to the high protein content in kidney beans. Protein is an important component in feed that supports the growth process, maintenance of body tissues, and synthesis of enzymes and hormones that play an important role in fish metabolism (Sundararaj *et al*., 2021). Red kidney beans are known to contain high-quality protein that can meet the metabolic needs of milkfish, thus supporting faster and more efficient growth. Based on recent research, the success of fish growth is highly dependent on the availability of protein in the feed. Protein provides essential amino acids needed for the formation of new body tissues, hormones, and digestive enzymes, all of which play a role in accelerating fish metabolism and growth (Fazil *et al*., 2023; Yadav *et al*., 2022). For example, kidney beans contain about 23-25% protein, which plays an important role in increasing the digestibility and efficiency of feed utilization by fish, as described by Viana *et al*., (2021), who mentioned that plant-based protein sources such as beans can improve feed quality for brackish water fish.

However, milkfish growth is also influenced by internal factors such as genetic traits and physiological conditions of fish, as well as external factors such as feed quality and environment (Rehman *et al*., 2020). Factors such as dissolved oxygen availability, water temperature, and fish density can affect the ability of fish to digest and utilize feed optimally. Therefore, the management of milkfish farming should consider these factors as a whole. In addition, feeding the right amount of feed is essential to support optimal growth. If feed is given in too small quantities, fish will lack nutrients, which can slow down their growth, and even cause competition between individuals leading to differences in the size of the resulting fish (Saravanan *et al*., 2020). Conversely, overfeeding can lead to environmental pollution, degraded water quality, and feed wastage, which ultimately reduces the efficiency of aquaculture (Kumar *et al*., 2022). Overall, the results of this study conclude that red bean-containing feed can significantly increase growth for milkfish. However, to achieve optimal results, in addition to feed quality, good environmental and feed management also need to be considered.

Feed Conversion Ratio

The smaller the feed conversion ratio value, the better the quality of the feed, as it indicates a higher level of digestibility (Nur, 2011). Statistically, the feed conversion ratio did not show significant differences. An increase in feed conversion ratio indicates that the treatments applied are not effective and efficient. Feed containing soybean, peanut, mung bean and kidney bean meal produced similar feed conversion ratios in all treatments.

The legume meal-based diet resulted in consistent FCR across treatments. However, the slightly higher FCR value in this study could be due to the inability of milkfish to utilize the feed properly. In addition, the feed provided was also wasted through the recirculation filtration system, so the fish could not fully consume the feed provided. According to Handayani (2008), a low feed conversion ratio indicates that the feed is more effective. In addition, the microbes involved in the feed fermentation process have the potential to increase the metabolism of the fish body. The study by Apines-Amar *et al*., (2015) examined the use of protein from mung beans (Vigna radiata) as a partial replacement for animal protein sources in milkfish feed. Results showed that up to 20% replacement with mung bean protein had no negative effect on growth and FCR. In fact, protein utilization efficiency increased. Meanwhile, Borlongan et al. (2003) in a previous study also examined the use of pea flour (Pisum sativum) as a replacement ingredient in milkfish feed. They found that substitution up to 10% did not affect growth and FCR. However, substitution higher than 15% decreased the growth performance of the fish. However, at the 20% level, there was a better FCR improvement compared to commercial feed.

CONCLUSION

It can be concluded that feeding with various types of beans has a significant effect on the growth, survival, and feed conversion ratio of milkfish. Feed containing red beans gave the best results, with the highest growth rate of 12.93 ± 3.19% and fish survival rate reaching 77.77 ± 3.85%. However, although this treatment showed good growth and survival, the feed conversion ratio (FCR) showed no significant difference between treatments. Overall, feeding with kidney beans proved to be more beneficial.

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