The 3rd International Seminar of Science and Technology
ISST 2023 Vol 3 (2024) 02 011
Trends in Science and Technology for Sustainable Living
Faculty of Science and Technology
Universitas Terbuka

Effect of probiotics addition on artificial feed for catfish growth

Wiwit Denny Fitriana[1*], Bakri[2], Mukhamad Masrur[1], Anna Qomariana[2], and Chandra Sukma Anugrah[1]

[1]Universitas Pesantren Tinggi Darul Ulum Jombang, Science and Technology Faculty, Jombang, Indonesia, 61481
[2]Universitas Pesantren Tinggi Darul Ulum Jombang, Islamic Faculty, Jombang, Indonesia, 61481

Abstract - The research aimed to investigate the impact of probiotics supplementation in artificial feed on the growth of catfish (*Clarias gariepinus*). Catfish farming is a vital component of aquaculture, and optimizing feed formulations can enhance both the economic and environmental sustainability of the industry. In this study, probiotics were incorporated into the catfish feed to assess their potential benefits on growth performance. A fully randomized design was employed, encompassing four distinct treatment groups denoted as follows: P0, representing the control group without any treatment; P1, involving the incorporation of 2 cc/kg of probiotic into the feed; P2, entailing the inclusion of 4 cc/kg of probiotic in the feed; and P3, comprising the use of 6 cc/kg of probiotic in the feed. Data analysis was conducted using analysis of variance with a confidence level set at 5%. The growth parameters, including weight gain, length increase, and feed conversion ratio (FCR), were monitored over 2 months. The results revealed a significant improvement in the growth performance of catfish in the probiotics-supplemented group compared to the control group. Catfish fed with probiotics exhibited a higher average weight gain and increased length, indicating better growth.

Keywords: aquaculture, catfish, composition, fish farming, probiotic

1 Introduction

Jombang, located in East Java, is a renowned city known for its thousands of Islamic boarding school students, commonly referred to as "santri." The Millennial Farming Students Movement, which focuses on freshwater fish farming, is one of the programs supported by the government through the Ministry of Marine Affairs and Fisheries. In 2017, the santri actively participated in promoting the culture of fish consumption within the community. One of their approaches to enhance freshwater fish farming within the boarding school context was by fostering a culture of fish consumption. This initiative is expected to contribute to increased protein consumption among the community, ultimately improving freshwater aquaculture based on the boarding school system [1]. The increasing consumer demand for catfish is being propelled by a growing awareness of the significance of fish consumption. This has led to the adoption of intensive farming practices to meet consumer demand for catfish. Intensive farming technology involves high stocking densities, aiming to produce yields that can meet the market demand for catfish. Feed plays a crucial role in intensive catfish farming. Commercial feed pellets significantly contribute to increasing production, but the high cost of these

*Corresponding Author: wiwitdenny@mipa.unipdu.ac.id

pellets poses a major obstacle in catfish farming. Approximately 60-70% of the production costs are allocated to feed expenses. The impact of intensive catfish farming is the accumulation of leftover feed and metabolic waste in the cultivation water, leading to a decrease in the water quality. This deterioration can even result in catfish mortality due to the build-up of ammonia, nitrate, and nitrite. To ensure that feed can have a maximum impact, generate a larger biomass, reduce feed costs, and enhance the water quality in catfish farming, a solution needs to be found by incorporating probiotics in both feed and the cultivation water [2],[3].

Probiotics are living microorganisms suspended in a carrier medium that provide significant benefits to livestock by creating an ideal digestive environment and enhancing feed conversion efficiency. They make it easier for catfish to absorb the nutritional elements in their feed, promote livestock health, expedite growth, and offer protection against diseases.Probiotics can be administered through various means, including incorporation into feed, addition to water, or introduction through living intermediaries such as rotifers or artemia [4]. These probiotics produce enzymes like amylase, lipase, protease, and cellulose, which play a crucial role in breaking down nutrients like carbohydrates, proteins, and fats into simpler molecules. Fermentation of feed has been demonstrated to reduce the FCR value to as low as 0.997 in the cultivation of dumbo catfish fed with commercially fermented feed using probiofish [5]. The utilization of probiotics in feed at a dosage of 6 ml/kg resulted in the highest daily growth rate and feed efficiency, which were recorded at 3.12% and 31.65%, respectively [6].

Intensive cultivation of catfish (Clarias gariepinus) can lead to a decline in the quality of the cultivation medium, including a decrease in dissolved oxygen content and an increase in waste content, especially organic nitrogen [7]. Furthermore, the application of probiotics in feed, plays a significant role in improving water quality, enhancing productivity and feed efficiency, and reducing feed usage. The objective of this study is to investigate whether the addition of probiotics containing herbal ingredients to the fish feed can enhance the growth rate (SGR) and feed efficiency (FCR) of catfish.

2 Materials and methods

This research was conducted from June to July 2023 at the fishpond of PT Tirta Lestari Indonesia. The methodology employed in this study was an experimental approach using a Completely Randomized Design (CRD) with one factor having four treatment levels and three replications. The treatments applied in this research were as follows:

- P0: Without probiotic supplementation
- P1: Addition of probiotic at 2 cc/kg of feed
- P2: Addition of probiotic at 4 cc/kg of feed
- P3: Addition of probiotic at 6 cc/kg of feed

The catfish are fed three times a day, namely in the morning, noon, and evening until they are satiated. Length and weight measurements (sampling) are conducted every seven days. The research subject comprises catfish fingerlings ranging in size from 5 to 6, all derived from a single parent source purchased from a Hatchery located in Jombang, Jawa Timur, known for its reliable fingerling quality. The primary parameters measured include absolute weight, absolute length, specific growth rate, survival rate, feed efficiency, and feed conversion. Meanwhile, supporting parameters include water quality, such as temperature and pH. The sampling technique was performed by selecting 3 catfish from each pond, followed by weighing to determine the catfish's growth rate. Weighing was carried out under wet conditions by placing the catfish in another container filled with water of known weight. The difference in weight between the container with catfish and the container without catfish represented the individual weight of the catfish.

The weight of catfish fry was assessed every 7 days throughout a 60-day cultivation period. Initially, the process involved weighing a bowl filled with freshwater. Following this, the fish in each aquarium were delicately removed, dried with tissue, and then transferred to the pre-weighed bowl containing freshwater. The total weight of the fish, water, and bowl was documented, and this figure was subsequently deducted from the weight of the water and bowl alone. Following the measurements, the fish were reintroduced to their original aquariums after renewing the water with fresh water.

To determine feed efficiency, the calculation involved the disparity in fish biomass between the end and the beginning of the study, divided by the weight of the provided feed, utilizing the formula:

$$\text{feed efficiency} = \frac{\text{Wt-Wo+Wd}}{\text{F}} \text{ x } 100\% \quad (1)$$

Information:
FP = Feed efficiency (%)
Wd = Weight of dead fish (g)
Wt = Final weight of fish biomass (g)
Wo = Initial weight of fish biomass (g)
F = Weight of the feed provided (g)

Data collection was conducted using an experimental method to examine the daily growth rate of catfish due to the administration of probiotic levels at 2 cc/kg of feed, 4 cc/kg of feed, 6 cc/kg of feed. This involved weighing the initial body weight of the research subjects and determining the total number of fingerlings. Subsequently, regular weighing was performed every week for a duration of 2 months. At the end of the study, the body weight was measured en masse, and the total number of fish was counted. The initial and final weighing were used to calculate the specific growth rate (SGR). Evaluating feed efficiency involved measuring the total feed provided to the catfish during the study and weighing the total initial and final biomass (FCR). Water quality in the catfish cultivation system was assessed using digital instruments, including a water temperature and pH meter. A TDS (Total Dissolved Solids) meter is utilized to quantify the total amount of dissolved substances in water. This encompasses various inorganic compounds and other dissolved substances found in water, such as minerals, salts, metals, ions, and more. TDS measurement can offer crucial insights into the level of contamination or the presence of compounds that can impact water quality and environmental health.

The collected data, which consists of primary parameters, is tabulated and analyzed using the SPSS application. This analysis involves employing Analysis of Variance (ANOVA) within a 95% confidence interval to determine whether the treatments significantly affect growth rate, feed conversion, and survival rate.

3 Results and discussion

3.1 Absolute weight, absolute length, specific growth rate, survival rate, feed efficiency, and feed conversion

Based on the observations of the average weight and length growth of catfish, there were noticeable differences in both length and weight between the probiotic-fermented feed treatment and the non-fermented feed treatment. The use of probiotic-fermented feed resulted in higher average length and weight compared to the control feed. The measurements for Specific Growth Rate (SGR), absolute weight, absolute length, survival rate, feed efficiency, and feed conversion of catfish are presented in Table 1.

Table 1. Specific Growth Rate (SGR), absolute weight, absolute length, survival rate, feed efficiency, and catfish feed conversion ratio.

Parameter	Treatment			
	P0	P1	P2	P3
absolute weight (g)	81,78±0,02^{a}	88,13±0,30^{a}	96,48±0,90^{b}	112,86±0,81^{c}
Absolute length (cm)	15,1±0,37^{a}	15,92±0,29^{b}	16,56±0,26^{c}	16,94±0,13^{d}
Specific Growth Rate (SGR) (%)	2,2271±0,046^{a}	2,3970±0,0605^{b}	2,419±0,009^{c}	2,4475±0,012^{a}
survival rate (%)	95,00±6,06	96,54±1,23	96,75±2,38	97,58±1,56
feed efficiency (%)	104,56±2,13^{a}	108,16±2,23^{b}	110,90±1,03^{b}	117,33±1,37^{c}
Feed Conversion Ratio (FCR)	0,96±0,02^{c}	0,92±0,01^{b}	0,91±0,01^{b}	0,85±0,01^{c}

The highest absolute weight of catfish was observed in P3, which is the feed fermentation with a probiotic dosage of 6 ml/kg, measuring 112.86 grams, while the lowest was in the control treatment, which recorded 81.78 grams. The significance value in the ANOVA test is 0.000, indicating that $P < 0.05$, meaning that feed fermentation with probiotics has a significant effect on the absolute weight of catfish.

Fermented feed is more easily digested by fish compared to non-fermented feed, resulting in fish requiring less energy for digestion. The surplus energy can be utilized for various purposes, including fish growth, such as an increase in fish weight. After fermentation, most of the components are converted into simple compounds that can be directly used as fish feed, eliminating the need for further digestion by the fish [8]. Probiotics, as beneficial microorganisms, play a pivotal role in the fermentation of feed within the digestive system. This fermentation process facilitates the breakdown of complex nutrients, making them more accessible for absorption by the catfish. Consequently, improved nutrient utilization contributes to enhanced feed efficiency, as reflected in better feed conversion ratios. he presence of specific probiotic strains in catfish feed has been associated with accelerated growth rates. Probiotics promote the synthesis of essential nutrients and assist in the digestion of complex compounds, providing the catfish with a more efficient means of extracting energy from the feed. This, in turn, contributes to the overall growth and development of the fish.

The highest absolute length of catfish was obtained in treatment P3, measuring 16.94 cm, while the lowest was in P0, which recorded 15.1 cm. The results of the ANOVA test indicate that $P < 0.05$, signifying that feed fermentation with probiotics influences the absolute length of catfish. The growth in fish length is directly related to the growth in fish weight, which is why the highest absolute length was observed in P3, as the highest absolute weight was also achieved in P3.

The specific growth rate (SGR) of catfish, monitored every 7 days for 8 weeks following treatment, reveals that the highest SGR value was obtained through the application of a 6 cc/kg probiotic concentration, yielding an average SGR of 2,4475±0,012. In contrast, the lowest SGR was observed in the absence of probiotics (control), registering at 2,2271±0,046. The administration of probiotics containing Bio Teje, which are heterotrophic bacteria, in different quantities through both food and water has a significant impact on the specific growth rate (SGR) of catfish fry raised for 8 weeks, with statistically significant differences observed ($P<0.05$). This suggests that catfish are capable of utilizing fermented feed for growth during their cultivation. The catfish's growth is clearly reflected in the increase in body weight and specific growth rate (SGR) values over the 8-week cultivation period. The specific growth rate of catfish exceeds that of previous research involving the supplementation of probiotics to catfish. For instance, introducing probiotics at a concentration of 108 CFU/mL into the Dumbo catfish feed yielded a specific growth rate of 2.16% [9].

The survival rate in this study ranges from 95.00% to 97,58%. It is believed that this phenomenon is a result of probiotic bacteria activity, particularly Lactobacillus sp. These bacteria have the capability to generate lactic acid from sugars and other carbohydrates produced by photosynthetic bacteria and yeast. *Lactobacillus* sp. bacteria contribute to the equilibrium of the gut microbiota, thereby enhancing fish digestion through the conversion of carbohydrates into lactic acid, leading to a reduction in pH. Consequently, this process stimulates the production of naturally occurring enzymes, which improves nutrient absorption, feed intake, growth, and acts as a deterrent to pathogenic organisms [10]. The utilization of probiotic technology has led to a notably high survival rate among catfish, as it effectively preserves the quality of the aquatic environment.

The efficiency of catfish feeding is remarkably high. The peak feed efficiency value was achieved in P3, reaching 117,33%, whereas the lowest was documented in P0 at 104,56%. This is the reason behind the notably high feed efficiency observed in this research. The addition of carbohydrates to the cultivation medium can be converted into an energy source by heterotrophic bacteria, leading to the production of a significant quantity of protein-rich bacterial biomass. This bacterial biomass can be subsequently utilized by fish as a plentiful source of high-protein supplementary nutrition [8].

The lower feed conversion ratio in P3 is believed to be due not only to the fact that fish utilize the flocculants for food but also because the fermentation process results in higher fish absorption of the feed. The digestive enzymes produced by microbes during the fermentation process assist in breaking down complex compounds into simpler components, making the feed more easily absorbed by the intestines [11].

The feed conversion values for all treatments are considered favorable, ranging from 0.96 to 0.85. Feed Conversion Ratio (FCR) is the ratio of the amount of feed required to produce 1 kg of fish meat. The FCR of catfish in the probiotic treatment is lower compared to the control group. Feed utilization efficiency signifies the amount of feed that can be utilized by the fish, converting it into an increase in the fish's body weight. Feed efficiency can be assessed through various factors, with one of them being the FCR. The highest level of feed utilization efficiency is achieved when the calculation of the feed conversion ratio is the lowest, indicating superior feed quality compared to other treatments [12]. Good feed quality results in the catfish channeling more energy towards growth, thus anticipating improved growth rates with reduced feed intake. Factors influencing the level of feed efficiency include the type and quantity of each nutrient source in the feed. The quantity and quality of the feed provided to the catfish significantly affect their growth. The higher the feed efficiency value, the more favorable the catfish's response to the feed, as evidenced by rapid growth rates.

4 Conclusion

The research findings indicate that the provision of fermented feed has an impact on body weight growth, absolute length, feed efficiency, and feed conversion, but it does not affect the survival rate of catfish. The best results were obtained in P3. For the next research, we can conduct economic analyses to assess the cost-effectiveness of integrating probiotics into catfish farming, taking into account factors such as feed conversion ratios, growth rates, and overall production costs.

Acknowledgements

We acknowledge the support recieved from Universitas Pesantren Tinggi Darul Ulum for the support, PT Tirta Lestari Indonesia, Directorate General of Research and Higher Education, Ministry of

Education and Culture, Republic of Indonesia, for their generous funding support through the Matching Fund Program in 2023.

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