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GROWTH PERFORMANCE OF NILE TILAPIA (*Oreochromis niloticus*) FRY IN THE STAGNANT WATER POND SYSTEMS WITH DIFFERENT FEEDING RATES

Kinerja Pertumbuhan Benih Ikan Nila (*Oreochromis niloticus*) Dalam Sistem Kolam Air Tergenang Dengan Tingkat Pemberian Pakan Berbeda

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ABSTRACT

The activity of cultivating nile tilapia in a stagnant water pond system allows fish to utilize resources in the form of natural food and commercial feed in a balanced manner, thereby reducing the amount of external feed. This research aims to evaluate the growth performance of tilapia fry in a stagnant water pond system with different feeding levels. This research was carried out using a completely randomized design (CRD) consisting of 3 treatments for rearing tilapia fry in a stagnant water pond system with different feeding levels with three replications each, namely 3% feeding rate, 4.5% feeding rate. % and feeding rate 6%. The test tilapia fish had an average initial weight of 2.66-3.06 g and were reared for 21 days with feed supplementation containing a commercial probiotic mix dose of 0.2% and a feeding frequency of 1 time per day. The results of the research showed that different levels of feeding had a significant effect ($p<0.05$) on feed efficiency, feed conversion ratio and amount of feed consumption, but could still provide optimum growth rates.

Keywords: feed efficiency, feeding level, growth, Oreochromis niloticus, stagnant water pond

ABSTRAK

Kegiatan budidaya ikan nila dalam sistem kolam air tergenang memungkinkan ikan dapat memanfaatkan sumber daya berupa pakan alami dan pakan komersial secara seimbang, sehingga dapat mereduksi jumlah pakan eksternal. Penelitian ini bertujuan mengevaluasi kinerja pertumbuhan benih ikan nila dalam sistem kolam air tergenang dengan tingkat

pemberian pakan berbeda. Penelitian ini dilakukan dengan menggunakan rancangan acak lengkap (RAL) yang terdiri dari 3 perlakuan pemeliharaan benih ikan nila dalam sistem kolam air tergenang dengan tingkat pemberian pakan yang berbeda dengan masing-masing tiga ulangan yaitu tingkat pemberian pakan 3%, tingkat pemberian pakan 4,5% dan tingkat pemberian pakan 6%. Ikan nila uji memiliki ukuran bobot awal rata-rata 2,66-3,06 g dan dipelihara selama 21 hari dengan suplementasi pakan mengandung probiotik mix komersial dosis 0,2% dan frekuensi pemberian pakan 1 kali sehari. Hasil penelitian menunjukkan bahwa tingkat pemberian pakan yang berbeda berpengaruh nyata ($p<0,05$) terhadap efisiensi pakan, rasio konversi pakan dan jumlah konsumsi pakan, tetapi tetap dapat memberikan laju pertumbuhan yang optimum.

Kata Kunci: efisiensi pakan, kolam air tergenang, *Oreochromis niloticus*, pertumbuhan, tingkat pemberian pakan

INTRODUCTION

The productivity of tilapia aquaculture (Oreochromis sp.) currently continues to increase production from 2022 reaching around 1.4 million tons per year or contributing more than 25% of the total production of fresh, brackish and marine fish farming. Of the total production, around 85% is absorbed by the domestic market and the rest is to meet the needs of the main export destination countries, including the United States, Mexico, the European Union, the Middle East and Ivory Coast (DJPB 2024). Moreover, the Government of Indonesia through the Director General of Fisheries and Aquaculture is intensifying the shrimp pond revitalization program in the Pantura area of 78-80 hectares for saline tilapia cultivation, which will certainly boost the value of tilapia production in the country. Some of the superior characteristics of tilapia are the rapid growth of monosex males, relative disease resistance and environmental stressors.

Tilapia cultivation in Indonesia is one of the important activities of most household-scale fish farmers in order to support food security programs and the fulfillment of balanced animal protein. The main problems in tilapia maintenance include low feed efficiency which has an impact on slow fish growth, especially in flooded soil pond systems. Behmene et al., (2021) revealed that the best growth of tilapia larvae (*Oreochromis niloticus*) during a 30-day rearing period was long and the average weight was 1.4 cm and 0.03-0.04 g, respectively, could be achieved with the number of feedings per day of 35% and 17.5% of the biomass weight in the first two weeks and the last two weeks, respectively, as well as the frequency of feeding four and six times a day.

Supplementation with a combination of mannanoligosaccharide (MOS) prebiotics and commercial probiotics containing three species of probiotic bacteria, namely Lactobacillus acidophilus, Enterococcus faecium and Bifidobacterium sp. can increase the integrity and capability of tilapia intestinal goblet cells to produce digestive enzymes and the host's immune response which is characterized by increased production of leukocytes, lymphocytes and neutrophils (Cavalcante et al., 2020). The combination of commercial probiotics Bacillus subtilis and Bacillus licheniformis at a dose of 10 g/kg feed contributed positively to increasing the specific growth rate and feed conversion ratio as well as the immune response of tilapia to artificial infections of Streptococcus agalactiae with the ability to reduce the mortality rate by only 20% compared to the control which reached 80% (Abarike et al., 2018). The addition of the commercial probiotic Probio-7 at a dose of 108 CFU/g feed can increase feed utilization efficiency and the protein efficiency ratio of gift tilapia (**Oreochromis niloticus**) (Shofura et al., 2017).

In general, fish farmers, including tilapia, implement a "pump" system feeding program, that is, as long as the fish have an increased appetite and respond positively to feed, then feeding will continue to be carried out in a day without taking into account the "restricted feeding rate".

This is because of the logical reason for the acceleration of growth and the maintenance period to be shorter. The longer the fish farming period, the more potential commercial feed use becomes more and more and the risk of attack of pathogenic infections. Therefore, this study needs to be conducted to evaluate the growth performance of tilapia with different feeding levels in the flooded pond system.

METHODS

Place and Time

This research was conducted from August to September 2024 at the Fish Pond owned by community members located on Jalan Soekarno, Palangka Village, Jekan Raya District, Palangka Raya City.

Tools and Material

The tools used in this study include a digital scale with a capacity of 500 g x 0.01 g, 9 pieces of hapa mesh measuring 1 x 1 x 1 m3, measuring cups, spoons, trays, thermometers, Lutron DO-5510 DO meters, and ATC digital pH meters. The materials used in this study were 270 tilapia, commercial mix probiotics, commercial feed with 40% protein content, and egg whites.

Procedure

This study uses a complete randomized design (RAL) consisting of tilapia fry maintenance in a flooded pond system with three feeding levels and three replicates. These treatments are the treatment of a 3% feeding rate (TPP3), a feeding rate of 4.5% (TPP4.5) and a feeding rate of 6% (TPP6) (Amorocho et al., 2024).

Fish Keeping

The fish used in this study are tilapia seeds obtained from the Mandiangin Freshwater Aquaculture Fisheries Center, Banjarbaru, South Kalimantan. The test fish had an initial average weight of 2.66-3.06 g. Fish fry were acclimatized for 14 days before being transferred into a hapa measuring (1x1x1) m3 as a research container. There are 30 fish stocked in each hapa. The feed used during maintenance is TP-50 pellet feed which contains 40% protein and 6% fat. The preparation of test feed is carried out by adding and mixing commercial feed with commercial probiotic mix by coating method, namely adding 2% egg white as an adhesive (Djauhari et al., 2023). The probiotics used in powder form, which have advantages, among other reasons, are product safety, ease of use and longer life span of microorganisms (Decamp & Moriarty 2007), produced by CV. Pradipta Paramita which contains a consortium of probiotic bacteria with a density of ≥ 107 CFU/g in accordance with PERMEN KP No. 1 of 2019 concerning Fish Medicine. The probiotic dose used refers to the procedure for using probiotics written on the modified packaging, which is 0.2% (0.2 g per 100 g of feed). Next, the feed is dried for approximately 10 minutes and is ready to be given to the test fish. Tilapia seed maintenance is carried out for 21 days. Fish are fed once a day with the level of feeding according to the treatment. The feeding time is 12.00 WIB. The water quality of the maintenance medium is monitored during maintenance with parameters and ranges: temperature 30-31.9 ºC, DO 6.4-8.0 mg/L, and pH 6.79-7.37.

Data Collection

Fish weight data is taken every 10 days during the 21-day rearing period. Weight measurement was carried out using a digital weighing device with an accuracy of 0.01 g. Water quality was measured at the beginning, middle and end of the study. The quality of the water measured is temperature, pH and dissolved oxygen.

Research Parameters

The research parameters measured consisted of survival rate, amount of feed consumption, feed conversion ratio, feed efficiency, daily growth rate, final body weight and harvested biomass.

TKH (%) = (Nt/No) x 100, where (Nt) and (No) are the number of live fish at the end and beginning of rearing respectively.

LPH (%/days) = [(Ln Wt − Ln Wo)/t] x 100, where (Ln Wt) and (Ln Wo) are the natural logarithms of the body weight of fish at the end and beginning of the study (g), and (t) is the length of fish rearing time (days).

FCR = JKP, g/ΔB, g, where JKP is the amount of feed consumption, and ΔB is the difference between the final biomass and the initial biomass.

EP (%) = ΔB, g/JKP, g x 100, where ΔB is the difference between the final biomass and the initial biomass, and JKP is the amount of feed consumption.

Data Analysis

Data analysis using Microsoft Excel 2016 software and SPSS version 25.0. Statistical analysis was carried out with SPSS software version 25.0. Testing of diversity homogeneity and data normality was carried out using the Levene test and the Shapiro-Wilk test. A one-way ANOVA analysis was then performed and the apparent difference between the treatments was determined using the Duncan test using a 95% confidence interval. The explanation of the water quality of the maintenance medium is carried out in a descriptive manner.

RESULT

The results of the study for all treatments, the daily growth rate value during maintenance ranged from 4.9-5.86%, the harvested biomass was 224.55-295.31 g and the survival rate of 90-100% did not differ significantly between treatments. The feed conversion ratio in all treatments showed a value below 1, which ranged from 0.37-0.85, where the feeding rate of 3% and 4.5% differed significantly from 6% (Table 1). Furthermore, Table 2 shows that the feeding rate of 3% in tilapia fry raised for 21 days in a stagnant water system produces the best values that differ significantly from the feeding rates of 4.5% and 6% in the parameters of feed consumption and feed efficiency.

Table 1. Initial body weight (Wo), final body weight (Wt), initial biomass (Bo), final biomass (Bt), difference between final and initial biomass (ΔB), amount of feed consumption (JKP), feed efficiency (EP), feed conversion ratio (FCR), daily growth rate (LPH), and survival rate (TKH) of tilapia fry fed with commercial probiotic mix dosage of 0.2% with a feeding rate of 3% (A), 4.5% (B) and 6% (C) during 21 days of maintenance on flooded ponds

Parameters/ Treatment	Wo (g)	Wt (g)	Bo (g)	Bt (g)	ΔB (g)	JKP (g)	FCR	EP (%)	LPH (%/hari)	TKH (%)
A1	2,85	8,35	85,37	250,48	165,11	66,21	0,40	249,37	5,10	100
A2	2,92	9,31	87,48	270	182,52	67,73	0,37	269,48	5,38	96,67
A3	2,83	8,87	84,83	239,42	154,59	65,68	0,42	235,37	4,95	90

B1	3,06	10,18	91,82	295,31	203,49	106,71	0,52	190,69	5,57	96,67
B2	2,86	10,14	85,85	294,18	208,33	99,8	0,48	208,75	5,86	96,67
B3	3,03	9,65	90,87	260,65	169,87	105,63	0,62	160,82	5	90
C1	2,86	9,31	85,81	270	184,19	133,07	0,72	138,42	5,48	96,67
C2	2,81	9,76	84,24	273,22	188,98	130,59	0,69	144,71	5,62	93,33
C3	2,66	8,02	79,69	224,55	144,86	123,5	0,85	117,30	4,90	93,33

Table 2. The average value of initial biomass (Bo), final biomass (Bt), total feed consumption (JKP), feed conversion ratio (FCR), daily growth rate (LPH), and survival rate (TKH) of tilapia fry fed with commercial probiotic mix at a dose of 0.2% with feeding rates of 3% (A), 4.5% (B) and 6% (C) during 21 days of maintenance in flooded ponds

Parameters/ Treatment	Wt (g)	Bt (g)	JKP (g)	FCR	EP (%)	LPH (%/hari)	TKH (%)
A	$8,84^{a}$	$253,3^{a}$	$66,54^{a}$	$0,40^{a}$	$251,41^{a}$	$5,14^{a}$	$95,56^{a}$
B	$9,99^{a}$	$283,38^{a}$	$104,05^{b}$	$0,54^{a}$	$186,75^{b}$	$5,48^{a}$	$94,45^{a}$
C	$9,03^{a}$	$255,92^{a}$	$129,05^{c}$	$0,75^{b}$	$133,48^{c}$	$5,33^{a}$	$94,44^{a}$

Remarks: Different top-print letters on the average value in the same line indicate a noticeable effect of the difference ($p<0.05$).

DISCUSSION

The optimal feeding rate will result in maximum growth in fish. The results of the study show that the feeding rate of 3% produces the highest feed efficiency value, which is 251.41%, this is supported by the value of the amount of feed consumption and the lowest feed conversion ratio, which is 66.54 g and 0.4. It is even strengthened by data on daily growth rates and harvest biomass that are not significantly different from higher feeding rates, namely 4.5% and 6%. In fact, the results of the study suspect that tilapia fry that are given a feeding rate of 3% are still slightly below the maximum gastric capacity, meaning that tilapia seeds can still take advantage of natural feed available in the pond in the form of zooplankton, phytoplankton and beneficial bacteria (heterotrophic bacteria). This is in line with the statement of Abd El-Hack et al., (2022) tilapia's eating habits are omnivores and have peculiarities compared to other fish species in terms of the need for the quantity and quality of specific nutrients of amino acids, fatty acids, minerals and vitamins that must be met through the consumption of bacteria, microalgae (Iba et al., 2024), phytoplankton and zooplankton available in the rearing container. When macroalgae bloom occurs, tilapia raised in ponds tend to prey on microzooplankton, such as rotifers and nauplii through their filter-feeding properties rather than preying on copepods and macroalgae (Vasconcelos et al., 2017; Ibrahim et al., 2015). Furthermore, Ibrahim et al., (2022) said that microalgae, phytoplankton and zooplankton consumed by fish play an important role in controlling probiotic homeostasis while eliminating the potential for

the presence of pathogenic bacteria, so that the health status of fish and survival rate increase. The optimal amount of feed consumption like this will greatly support the digestive metabolic process to run well. Organs and digestive glands such as the stomach, gallbladder, intestines (mucocyte cells and enterocytes) and liver (hepatocytes) can carry out their roles and functions optimally, starting from the production and availability of digestive enzymes: amylase, protease, lipase, so that the digestion process and absorption of feed nutrients also take place very efficiently, in other words there is a real increase in the efficiency of digestion and absorption of feed nutrients. The next process is that energy production and allocation can be stored and utilized more to meet the needs of basalt metabolism and the excess can still be used to support maximum growth. Islam et al., (2021) revealed that tilapia that consumes various types of probiotics, microalgae and yeast results in an improvement in the morphological structure of microvilli, namely the elongation and expansion of microvilli, so that it can significantly increase the digestive capacity and nutrient absorption. In addition, mucocyte cells become more active in producing mucus and digestive enzymes, such as amylase, protease and lipase which contribute positively to improving the efficiency of digestion and absorption of feed nutrients, thus ensuring the biological availability of amino acids, fatty acids and vitamins as growth support factors (Sumon et al., 2018).

The optimal amount of feed per day greatly supports the improvement of the health status of digestive metabolism through modulation, viability and stability of the intestinal microbiome, related to the diversity, balance and number of intestinal microbiomes which are beneficial for improving the health status of tilapia fry that are raised. This is reflected in the survival rate of tilapia fry with the highest value at the feeding rate of 3%. This phenomenon is clearly visible during maintenance, namely the absence of the growth of stickiness during the hot day on the surface of the water in the inner feed rate of feeding level 3%. Meanwhile, in the treatment of the amount of feed per day of 4.5% and 6%, it is very clear that the growth of stickiness on the surface of the inner hapa net, the most abundant and concentrated is found at the feeding rate of 6%. It can be explained that tilapia seeds that are raised with the lowest feeding rate of 3% can maximize the use of ecological niches, namely all types of natural feed available in the pond, and the use of heterotrophic bacteria, zooplankton and phytoplankton actually greatly supports the improvement of the health status and immunity of tilapia seeds. The feeding program is usually at 8 am, 12 pm and 4 pm, with the note that the sun shines brightly (days are not rainy), because if it is cloudy or rainy, the water temperature drops, the digestive metabolism also drops, so the fish are lazy to eat. In this study, only 1 feeding a day was deliberately carried out, so that fish can take advantage of all the ecological niches available in the pond, such as heterotrophic bacteria, zooplankton and phytoplankton as additional feed, which actually makes the digestive metabolism of fish healthier, increases immunity, increases the health status of fish, and is also accompanied by an increase in daily growth rate and harvest biomass. This was confirmed by the specific growth rate and harvest biomass values at the feeding rate of 3% which were 5.14% and 253.3 g respectively, which were not significantly different from the parameter values at the feeding rate of 4.5% and 6%. The results of the research of Hendriana et al., (2023) which applied the frequency of feeding 3 times a day, started their research with the average initial weight size of tilapia fry raised in an aquarium, which is 2.63-2.77 g which is relatively the same as this study, that the feeding rate of 4% resulted in the FCR value, feed efficiency and specific growth rate of the best tilapia fry of 1.68, respectively, 59.41% and 4.2%%.

Ali et al., (2016) stated that there is a positive correlation between the frequency of feeding and tilapia growth, that feeding regularly every day without squeezing results in a significant increase in harvested biomass, daily body weight gain and specific growth rate. The higher the feeding rate, the lower the efficiency of feed utilization, even though the feed conversion ratio is still below 1. The results explained that the feeding rates of 4.5% and 6%

resulted in the value of feed conversion ratio, the lowest feed efficiency and the declining daily growth rate, which were 0.75, 133.48% and 5.33%, respectively, in line with De Silva & Anderson, (1995) who stated that the amount of overfeeding will reduce growth. This is likely because in this study only one feeding per day was carried out, it is very clear that at the feeding rate of 4.5% and 6% tilapia fry takes a bit longer to finish the feed. In contrast to the 3% feeding rate, it can be seen that tilapia seeds consume feed very quickly. This fact illustrates that at the feeding rate of 4.5% and 6%, it has slightly exceeded the gastric capacity. The amount of feed that exceeds the capacity of the stomach has the potential to interfere with the health of digestive metabolism, there is an imbalance between the amount of feed consumed and endogenous and exogenous digestive enzymes. Furthermore, this will have an impact on the reduction of digestive efficiency and absorption of feed nutrients, meaning that less feed is converted into fish meat. It is very clear to see the feed efficiency values at the feeding rates of 4.5% and 6% which are 186.75% and 133.48%, respectively, as well as the value of feed conversion ratios of 0.54 and 0.75. Based on the results of this study, it may be estimated that the most optimal feeding rate for tilapia fry is 3.75%. This conjecture is in line with the opinion of Tian & Qin, (2004) that compensation for energy allocation for growth can only be achieved if white snapper fry (Lates calcarifer) are fed the amount of feed per day at an optimal feeding rate. Hybrid tilapia fry (*O. mossambicus* x *O. niloticus*) can still catch up with the growth of tilapia fry that are fed daily on a regular basis even though they are not fed for 7 days in a 1-month period. This means that about 75% of the tilapia fry stomach capacity can be filled with commercial feed, while the remaining 25% can be filled by additional feed that is naturally available in the pond (Wang et al., 2000; Wang et al., 2009; Gao et al., 2014).

All treatments in this study received the addition of commercial probiotic mix containing 5 species of microorganisms, namely *Bacillus subtilis*, *Biffidobacterium biffidum*, Lactobacillus plantarum, *Nitrobacter winogradsky* and Saccharomyces cerevisiae. The addition of probiotics to feed has been widely proven to have beneficial effects on various fish species, namely increased growth and immunity (Opiyo et al., 2019). Improvement of growth performance is possible by the biological availability of important nutrients as a result of highly efficient digestion and absorption due to the improvement of the microvilli structure on the surface of the enterocytes which makes the surface of the nutrient-absorbing cell wider so that feed efficiency increases and by the induction and activity of digestive enzymes (amylase, protease and lipase) adequately, and is also supported by the production of essential amino acids, short-chain fatty acids (SCFAs), and vitamins (Sumon et al., 2018). Tilapia feed supplementation with the same probiotic densities of Bacillus subtilis and Bacillus licheniformis, i.e. 1.6 × 1010 CFU/g and doses of 0.04 and 0.08%, respectively, resulted in the best growth performance, modulation of the intestinal microbiome and reduced the potential for potential pathogen attack (Tachibana et al., 2021).

CONCLUSION

The tilapia feeding rate in the flooded pond system of 3% can increase the feed efficiency value and reduce the amount of external feed consumption significantly, but can still provide an optimal growth rate.

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