Asian Journal of Aquatic Sciences, August 2024. Vol 7, Issue (2) 305-311

e-issn: 2716-4608
p-issn: 2655-366X

EVALUATION OF WATER QUALITY AND GROWTH PERFORMANCE OF RED TILAPIA (*Oreochromis* sp) IN CULTURE USING BIOFLOCK TECHNOLOGY

Iskandar Putra[1*], Rusliadi[1], Heri Masjudi[1], Rudi Alfinda[1], Hasby Asiddiqqi[1], Desty Syahroni[1], Ronal Kurniawan[1], Rodhi Firmansyah[1], Ade Yulindra[1]
[1]Department of Aquaculture, Faculty of Fisheries and Marine,
Universitas Riau, Pekanbaru, 28293 Indonesia
*iskandar.putra@lecturer.unri.ac.id

ABSTRACT

Water quality plays an important role in maintaining and increasing fish production. Tilapia (*Oreochromis niloticus*) is one of Indonesia's freshwater fish that has economic value. To increase production, tilapia cultivation is carried out intensively, characterized by high stocking density and provision of protein-rich feed. Good water quality control and feeding are key to the success of this intensive culture. Biofloc technology is one of the appropriate technologies for intensive tilapia rearing since fish can live at high densities and have a wide environmental tolerance. biofloc technology is an alternative solution to problems in overcoming cultivation waste such as ammonia and nitrite. Based on the above, this study was conducted to determine the effectiveness of the biofloc system in converting ammonia compounds, improving water quality in the aquaculture environment, and understanding the relationship between water quality and tilapia growth. The research was conducted for 60 days to measure several water quality parameters, namely temperature, dissolved oxygen, acidity (pH), and ammonia, and to observe the growth parameters of tilapia. The treatment applied in this study was the addition of probiotics in feed with four treatments and three replications. The results showed that the biofloc system's water quality is tolerant to tilapia growth. The best growth results in treatment A with each value of absolute weight 14.70 ± 0.10^{d}, absolute length 6.70 ± 0.10^{d}, specific growth rate 3.87 ± 0.01^{c}, and survival rate 100 ± 0.00^{b}.

Keywords: Biofloc, Survival Rate, Growth Performance

1. INTRODUCTION

The development of superintensive aquaculture is characterized by increased fish density and feed supply using entirely artificial feed. Food is a major component in aquaculture systems, with 40-60% of the cost spent on this activity[1,2]. However, fish do not utilize all feed given for growth. Some uneaten fish feed, feces, and metabolic waste will accumulate in the fish-rearing medium. This discharge causes water quality parameters to deteriorate and is not favorable for fish life, so water quality in fish farming needs to be managed properly for optimal life needs[3-5].

Water quality parameters, especially ammonia (NH_3-N) that accumulates in fish farming, are one of the causes of production failure. This condition often occurs in aquaculture systems without water changes, where the concentration of aquaculture waste such as ammonia (NH_3), nitrite (NO_2), and CO_2 will increase very quickly and is toxic to aquaculture organisms[6]. Fish farming waste resulting from metabolic activity contains much ammonia. Fish excrete 80-90% of ammonia (inorganic N) through osmoregulation, while from feces and urine, about 10-20% of total nitrogen[7].

Received: 27 June 2024
Accepted: 8 August 2024

Along with developing technology in fisheries to overcome the decline in water quality, management is carried out through a biological approach, namely by applying biofloc technology to maintain the quality of aquaculture waters. Biofloc technology is the use of bacteria, both heterotrophs and autotrophs, that can convert organic waste into a collection of microorganisms in the form of flocs in water, which fish can then utilize as a food source[3-5,8,9]. In the floc, there are several organisms, such as bacteria, plankton, fungi, algae, and suspended particles, which will affect the structure and nutrient content of bioflocs. Bacterial communities contained in flocs are the most dominant microorganisms in the formation of bioflocs[10].

Applying biofloc technology is an alternative to overcome water quality problems in aquaculture activities[5]. Biofloc technology provides two advantages: improving and maintaining optimal water quality for the needs of cultured fish and bioflocs that are formed as additional feed for high-protein fish so that these conditions can accelerate growth and increase feed efficiency. For the formation of bioflocs, a starter is needed consisting of probiotics and carbon such as molasses, tapioca flour, wheat flour, and so on, so that with the application of bioflocs in fish farming, water quality will improve fish growth and survival. Based on this description, this study analyzed water quality parameters in maintaining red tilapia (*Oreochromis* sp) with biofloc technology.

2. RESEARCH METHOD

Time and Place

This research was conducted for 40 days from April to October 2023 at the Aquaculture Technology Laboratory, Faculty of Fisheries and Marine, Universitas Riau, Indonesia.

Method

The method used in this study is an experiment with a completely randomized design. The treatment applied is the addition of probiotics in feed with different doses with four levels of treatment and three replicates. The treatments are A: Control; B: Giving with a dose of 10 mL/kg of feed; C: a dose of 15 mL/kg of feed; D: a dose of 20 mL/kg of feed.

Procedures

Preparation of Containers and test fish

The container used for fish rearing is a tub with a 100 L capacity of 12 pieces equipped with aeration to increase oxygen solubility. Red tilapia as a test fish measuring 5 cm with a stocking density of 20 fish/container. The amount of water filled was ±60L in the research container. Seeds were obtained from Jaya Seeds in Pekanbaru.

Biofloc Culture

Red tilapia fish were kept in the maintenance tanks before the Biofloc culture was carried out. Each tub is filled with 60 liters of water, biofloc culture is carried out by giving probiotics (*Bacillus* sp) as much as 0.01 mL/L[3] and giving carbon in the form of molasses is done with the amount of C / N ratio of 20:1, giving carbon to the maintenance media at the same time as giving probiotics. Probiotics and carbon were put into a maintenance container filled with water and left to be continuously aerated for one week. The formation of flocs is marked by a change in the color of the water and the formation of foam in the water.

Next, red tilapia fry was stocked at 20 fish/container density and reared for 40 days. Feeding with commercial pellets given probiotics, a multi-cell booster contains 38% protein, 5% fat, 6% crude fiber, and 13% mineral mix in the ingredients. Feeding is done ad statiation with a frequency of 3 times a day. Measurement of fish growth in the test fish every ten days for 40 days.

Data Collection

Water quality parameters consisted of temperature, dissolved oxygen, pH measured by water checker (YSI-550 A, ASTM, Alla, France), ammonia nitrogen

(NH_3), with Spectrophotometric method measured every ten days, and growth measurements were taken every ten days, including absolute weight growth, absolute length, specific growth rate, and survival rate.

Data Analysis

Data obtained in the form of water quality parameters are tabulated and analyzed using the SPSS 18.0 application, which includes Analysis of Variance (ANOVA) with a 95% confidence interval. If the statistical test shows significant differences between treatments, a further test of the Newman-Keuls Study is conducted.

3. RESULT AND DISCUSSION

Water Quality

Kundur The water quality measured in this study were temperature, dissolved oxygen (DO), acidity (pH), and ammonia (NH_3), which can be seen in Table 1.

Table 1. The average values of water temperature, pH, dissolved oxygen, ammonia concentrations

Parameter	Unit	Treatment			
		A	B	C	D
Temperature	^oC	27,10±0,10^a	27,16±0,15^a	27,30±0,26^a	26,96±0,057^a
pH	-	6,7±0,10^a	6,73±0,32^a	6,66±0,20^a	6,76±0,28^a
DO	mg/L	5,16±0,057^a	5,30±0,20^a	5,26±0,11^a	5,30±0,20^a
NH_3	mg/L	0,0064±0,002^a	0,13±0,0177^a	0,004±0,0008^a	0,003±0,0005^a

Note: Different superscripts in the same column indicate significantly different treatments ($p < 0.05$).

The results showed water quality in red tilapia rearing temperature 26.96-27.30^{o}C, pH 6.6-6.7, dissolved oxygen 5.16-5.30 mg/L, and NH_3-N 0.003-0.13 mg/L. Based on statistical analysis, all parameters were not significantly different between treatments ($p>0.05$).

Water temperature during the study ranged from 26.96-27.30^{o}C. Temperature variations between treatments were very small. Generally, the temperature of 26^{o}C occurred in the morning while 27^{o}C occurred during the day. The temperature in this study is in the optimal range for tilapia cultivation. Tilapia will experience optimal growth at temperatures between 25-30^{o}C[11]. Temperature is one of the important factors affecting physiological organisms, such as respiration, metabolism, growth, and reproduction.

The results showed that pH was in the range of 6.6-6.7. Changes in pH in this study were low and in the range that is good for the growth of red tilapia. The ideal pH value for fish reared with biofloc technology is water, generally between 7 and 8.5[12]. Greater pH stability resulted from the use of water without water changes.

Oxygen in the waters greatly affects the growth and survival of fish. Aquatic organisms will utilize oxygen for respiration and metabolic processes. If oxygen conditions are sufficient, fish will grow well in addition to other factors. The characteristics of biofloc technology are high oxygen demand and high bacterial biomass production rate, so this system requires strong aeration and stirring to ensure that the biofloc remains suspended in water and does not settle. Dissolved oxygen concentrations in the red tilapia-rearing media showed that dissolved oxygen was at the optimal limit for red tilapia growth. The measured oxygen concentration was in the range of 5.16-5.30 mg/L. For fish, oxygen should not be less than 3 mg/L[3].

The oxygen level required for oxidizing organic matter is around 4-5 ppm[13]. The high oxygen concentration in each treatment was due to the continuous aeration provided. The characteristics of the biofloc system are high oxygen demand and high bacterial biomass production rate.

Therefore, in this system, strong aeration and stirring are required to ensure the oxygen demand of both cultured organisms and bacterial biomass and that bioflocs remain suspended in water and do not settle.

Intensive high-density aquaculture will cause water quality to decline rapidly if not managed properly. The accumulation of ammonia (NH_3-N) in aquaculture causes water quality degradation that can fail in fish farming production. Feeding in large quantities in fish farming will cause high waste generation due to the remaining feed that dissolves in water and feces, which results in fish metabolic activity. In aquaculture systems without water changes, the concentration of aquaculture waste such as ammonia (NH_3), nitrite (NO_2), and CO_2 will increase very quickly and is toxic to aquaculture organisms[6].

Fish farming waste resulting from metabolic activity contains much ammonia. Fish excrete 80-90% of ammonia (inorganic N) through osmoregulation, while from feces and urine, about 10-20% of total nitrogen[7]. Ammonia accumulation in aquaculture media is one of the causes of water quality degradation that can fail in fish farming production. The treatment with bio floc technology showed that the ammonia concentration until day 40 remained stable, where the ammonia concentration ranged from 0.003-0.13 mg/L.

Sources of ammonia in red tilapia rearing come from feed residue, feces, urine, and nitrogen excretion through fish gills. If not reduced in the rearing medium, ammonia will be toxic to red tilapia. The remains of feed and feces decompose into nitrogen in the form of dissolved NH_3. NH_3 levels of 0.2-2.0 mg/L in a short time are toxic to fish, and NH_3 is already dangerous at a concentration of 0.04 mg/L because it can reduce the capacity of blood to carry oxygen, so tissues will lack oxygen. When the ammonia concentration in the environment increases, ammonia excretion in fish decreases, so ammonia levels in the blood and tissues of fish will increase. In line with experiments conducted in several laboratories, NH_3 is harmful to fish and deadly with levels of 0.2 - 2.0 mg/L NH_3. Meanwhile, the ammonia (NH_3) concentration allowed for tilapia aquaculture and should not be more than 0.06 mg/L[14].

Applying bioflocs in red tilapia rearing with probiotics can reduce ammonia concentrations in fish rearing media. Bacteria will utilize ammonia if carbon is in sufficient quantities. The ability of bioflocs to control ammonia concentration in aquaculture systems theoretically and in application has been proven to be very high. Theoretically, Ebeling et al.[14] stated that ammonia immobilization by heterotrophic bacteria is 40 times faster than by nitrifying bacteria.

In zero water exchange aquaculture systems such as still water ponds, concentrations of aquaculture effluents such as ammonia (NH_3^-), nitrite (NO_2^-), and CO_2 will rapidly increase and are toxic to aquaculture organisms. Water quality management is very important in aquaculture systems. Water quality management is intended for the optimum needs of cultured organisms[5]. The process of biofloc formation begins with feeding in fish farming. The fish body cannot entirely assimilate the feed given. Only some can be assimilated into the body, while the rest is wasted in the water as residual feed and metabolite waste. This residual feed and metabolite waste become a problem in fish farming because the dissolved protein elements will immediately form ammonia, which is very dangerous for aquatic organisms. Developing biofloc technology aims to improve and control aquaculture water quality biosecurity, limit water use, and feed use efficiency[9].

Growth

Growth measurements include absolute weight, absolute length, specific growth rate, and survival rate. Tilapia absolute weight growth data during maintenance can be seen in Table 2.

The research results show an increase in absolute weight of 8,20-14.70 g, absolute length of 4.03 - 6.70, specific growth rate of 3.11-3.87%/day, and survival rate of 95-100%. The best results were obtained in treatment C, and the results of the analysis of variance showed that the provision of probiotics into feed with different doses in tilapia culture had a significant effect ($p<0.05$) on the growth of absolute weight, absolute length, specific growth rate and survival of tilapia.

Table 2. Absolute weight gain, absolute length, specific growth rate, and survival rate of tilapia

Parameter	Satuan	Treatment			
		A	B	C	D
Absolute weight	g	8,20±0,10^{a}	10,70±0,00^{b}	14,70±0,10^{d}	13,60±0,010^{c}
Absolute length	cm	4,03±0,50^{a}	4,56±0,23^{b}	6,70±0,10^{d}	5,66±0,05^{c}
SGR	%/day	3,11±0,02^{a}	3,49±0,09^{b}	3,87±0,01^{c}	3,78±0,06^{c}
Survival rate	%	96,66±2,88^{a}	95±0,00^{a}	100±0,00^{b}	95±0,00^{a}

Note: Different superscripts in the same column indicate significantly different treatments ($p < 0.05$).

Growth is influenced by two factors, namely internal factors, including heredity and age, while external factors are the aquatic environment, feed, and disease[15]. Also, according to Effendi[16], good water quality conditions will cause the physiological functions of the fish body to run smoothly. In poor water quality conditions, much energy is used for the physiological adaptation of the fish body to the environment, resulting in less energy stored in the body.

In addition, disturbed physiological conditions cause a decrease in fish feed consumption to minimize the energy used so that the fulfillment of the energy needed comes from nutrient reserves stored in the fish body. Feeding according to nutritional needs, mouth openings, and eating habits will increase fish growth[17]. Feed that suits the needs of fish will be characterized by increased growth.

The high value of the daily growth rate of tilapia in this study is because the fish can utilize feed added with probiotics, and bacteria help break down proteins into simpler (fermentation) wells to grow. Fermentation can cause the feed to be more easily digested in the digestive tract. It will greatly help the food absorption of food in the digestive tract and absorption of nutrients so that the utilization of feed by fish is more efficient[18].

Fermentation can also increase the nutritional value of feed, and the rate of the presence of probiotic bacteria can also increase fish digestibility when additional feed is given. Sari[19] identified the presence of *Bacillus* sp. bacteria in the gut of fish reared with a biofloc system. This indicates that tilapia with biofloc system treatment utilizes the floc formed as natural food. This can also be seen from the feed conversion ratio (FCR) between treatments, which is almost the same, ranging from 1.07 to 1.34.

The results showed that the survival rate was in the range of 95%-100%. In some studies, the SR value of fish rearing with the biofloc system is relatively above 90%. Hermawan et al.[20] obtained an average SR above 91% in their research. The results showed a positive role of probiotics on fish growth. This is following the research of Noviana et al.[21] that the provision of probiotics at 10 g/kg feed resulted in a relative growth rate of 3.20% per day, feed consumption rate of 83.86 g, feed utilization efficiency of 77.23%, protein efficiency ratio of 2.17% and tilapia seed survival of 90%.

The high absolute growth in the test fish is thought to be due to the contribution of digestive enzymes by probiotic bacteria in feed and in the maintenance media to improve the digestive process of tilapia. This statement follows Praditia's[22] opinion that probiotics in the digestive tract can increase enzyme activity and maximize the digestive process. In addition, the increase in absolute growth of test fish is thought to be due to an increase in feed nutrition, especially protein content.

4. CONCLUSION

Based on the study results, it is concluded that the maintenance of red tilapia with the addition of probiotics in feed reared in biofloc technology can affect water quality parameters and growth of red tilapia. The results showed a significant effect on tilapia's growth and survival rate. The best treatment is probiotic supplementation in feed at a dose of 15 mL/kg feed. The results of each parameter are as follows: absolute weight 14.70 ± 0.10^{d}, absolute length 6.70 ± 0.10^{d}, specific growth rate: 3.87 ± 0.01^{c}, and survival rate: $100\pm0{,}00^{b}$. Water quality parameters were temperature 26.96-27.30°C, pH 6.6-6.7, dissolved oxygen 5.16-5.30 mg/L, and NH_3-N 0.003-0.13 mg/L.

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