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Use of Filter and Addition of Aeration on Growth of Red Tilapia *(Oreochromis niloticus)*

PENGGUNAAN FILTER DAN PENAMBAHAN AERASI PADA PERTUMBUHANIKAN NILA MERAH *(OREOCHROMIS NILOTICUS)*

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ABSTRACT

This study wants to prove that the combination of using a filter and adding an aerator will get better results when compared to using only an aerator for the growth of red tilapia (Oreochromis niloticus). Factorial Completely Randomized Design (CRD) with two factors and two levels were used, there were consisting of unfiltered and filtered factors and two levels of aerators, one aerator and two aerators. Fish are kept in containers with a capacity of 150 liters of water with a volume of 120 liters of water. Red tilapia weighing 12±0.9 g was reared for 30 days. The variables observed were fish length, height, weight of fish, carcass weight and protein content of fish meat. Environmental factors observed included dissolved oxygen (DO), pH, temperature, ammonia, nitrite and nitrate content. Data analysis was carried out using analysis of variance (ANOVA) carried out using SPSS. Significant differences between treatments were tested by using the Least Significant Difference test (LSD). There is a significant differences for the each parameter (P<0,05) These results indicate that the use of a filter combined with the addition of an aerator increases the supply of dissolved oxygen which can improve water quality thereby increasing the growth and protein content of red tilapia. It can be concluded that the use of a filter combined with the addition of an aerator can be used as an alternative to improve water quality which has a positive impact on red tilapia productivity.
Keywords: Aerators; fish growth; red tilapia; stocking densities

ABSTRAK

Penelitian ini ingin membuktikan bahwa kombinasi penggunaan filter dan penambahan aerator akan mendapatkan hasil yang lebih baik bila dibanding dengan hanya menggunakan aerator pertumbuhan ikan nila merah (Oreochromis niloticus). Faktorial Rancangan Acak Lengkap (RAL) dengan dua faktor dan dua taraf yang digunakan, ada yang terdiri dari faktor tak tersaring dan tersaring serta dua taraf aerator, satu aerator dan dua aerator. Ikan dipelihara dalam wadah berkapasitas 150 liter air dengan volume air 120 liter. Ikan nila merah dengan bobot 12±0,9 g dipelihara selama 30 hari. Peubah yang diamati adalah panjang ikan, tinggi badan, berat ikan, berat karkas dan kandungan protein daging ikan. Faktor lingkungan yang diamati meliputi oksigen terlarut (DO), pH, suhu, kandungan amoniak, nitrit dan nitrat. Analisis data dilakukan dengan menggunakan analysis of variance (ANOVA) yang dilakukan dengan menggunakan SPSS. Perbedaan nyata antar perlakuan diuji dengan menggunakan uji Beda Nyata Terkecil (BNT). Terdapat perbedaan yang signifikan untuk masing-masing parameter (P<0,05) Hasil tersebut menunjukkan bahwa penggunaan filter yang dikombinasikan dengan penambahan aerator meningkatkan suplai oksigen terlarut yang dapat meningkatkan kualitas air sehingga meningkatkan pertumbuhan dan kandungan protein. ikan nila merah. Dapat disimpulkan bahwa penggunaan filter yang dipadukan dengan penambahan aerator dapat menjadi alternatif untuk meningkatkan kualitas air yang berdampak positif terhadap produktivitas ikan nila merah.
Kata kunci: Aerator; pertumbuhan ikan; nila merah; padat tebar

INTRODUCTION

Red tilapia (Oreochromis niloticus) is one of the most widely breed fish in Indonesia. The advantage of red tilapia compared to other cultured fish is that it has good tolerance to changes in the water environment so that it is of interest to fish farmers (Ghozali et al., 2021). Red tilapia is one of the commodities in the fisheries sector developed in Indonesia. The red tilapia commodity is expected to be able to compete in the freshwater fish business at the world level. The strong demand for tilapias causes many people who only care about the results without paying attention to the decline in quality of hatchery (Mahendra, 2018)

The characteristics of red tilapia are, the body of the tilapia is slightly flat, the body color is reddish. Red tilapia is widely developed and cultivated because the taste of the meat is not much different from red snapper (Lutjanus campechanus). This fish is also widely used as an ornamental fish because of its attractive body color (Arifin, 2016).

Bajaj (2017) states that the quality of red tilapia can be good if the quality of the water used is always controlled. Fish production can achieve optimal results if environmental factors such as temperature, pH, and dissolved oxygen are in accordance with the provisions. Zahidah et al. (2018) stated that ammonia can come from food residue that is not eaten by fish, from fish waste, or from urine excreted by fish. According to Mulqan et al. (2017) external factors such as temperature, oxygen, feed, pH, and waste metabolites such as ammonia, nitrite, and nitrate affect the environmental quality of fish which can cause stress in fish and affect their growth.

The recirculation system is a way to maintain optimal water quality during fish rearing (Fauzia and Suseno, 2020). Low water quality can be improved by removing impurities in the water that cause negative impacts. Water quality improvement can be done by means of aeration and water circulation. Water circulation is carried out using a filter to remove impurities caused by fish waste or leftover feed that is not consumed. The filters used usually include physical filters, chemical filters, and biofilters. Physical filters are used to filter out impurities such as feces, mucus, feed residue. Chemical filters are used to eliminate charcoal particles that cannot be processed by physical filters. Biological filters or biofilters are used to eliminate nitrogen components present in water, such as bioballs and biorings (Tanjung et al., 2019).

According to Fauzia and Suseno (2020), pond water filtration technology in fish farming can help maintain water quality as an effort to overcome fish farming problems. The basis for using a filter in an aquarium is the presence of nitrogen compounds such as ammonia, nitrite, nitrate in the waters that can harm fish. The use of filters were aims to minimize the negative impacts caused by these compounds.

Aerators play a role in pumping oxygen to enter the water through the formation of air bubbles as a result of direct contact between air and water (Salim et al., 2016). Aeration is the process of adding oxygen to the water so that the level of dissolved oxygen in the water increases. The principle of aeration is to mix water with air so that the water is in contact with oxygen from the air. The aeration mechanism is more physical, because there are more mechanization elements than biological elements. As oxygen increases, substances that affect taste and smell, such as hydrogen sulfide and methane, are volatile and thereby can be removed. The carbon dioxide level in the water will decrease. Soluble minerals such as iron and manganese are oxidized to form precipitates and can be removed by sedimentation and filtration (Yuniarti and Aziz, 2019). During the biological process, the dissolved oxygen content in the water is sufficient, it will be useful in reducing the concentration of organic compounds in the water (Bary et al., 2013). The effectiveness of the aeration process depends on the surface area of the water that is directly in contact with the air. (Hartini. 2012.)

The addition of aeration is one way to overcome the decline in water quality. Aeration aims to increase the oxygen content in the water. The increase in oxygen will reduce the carbon dioxide content in the water. Dissolved oxygen can also oxidize dissolved minerals (Yuniarti and Azis, 2019). The use of a mechanical aerator will help minimize the risk of dissolved oxygen dropping. (Torrans and Craig, 2018). Tanveer et al. (2018), stated that mechanical aerators will improve water quality and reduce feed residues.

The aim of this study was to analyze the effect of use a filter and adding aerator on the growth of red tilapia. The results of this study are expected to be a source of scientific information regarding the effect of using a filter and adding aerator on the growth of red tilapia.

RESEARCH METHODS

Red tilapia with a weight of 12 ± 0.9 g. were used as experimental animals. The experimental red tilapia seeds were obtained from the Siwarak Fish hatchery Center, Ungaran, Semarang Regency, Central Java. The fish are kept in four containers with a capacity of 150 L containing 120 L of water. Each container contains 20 fish. The stocking density of fish per container refers to the research conducted by Diansari et al. (2013), for rearing tilapia size of 2.28 ± 0.12 g/fish with a stocking density of 1 fish/L. Two containers are equipped with an aerator, one without filter, the other with filter. Two containers are equipped with two aerators, one without filter, the other with filter. Fish were placed in containers according to the randomization unit. The water was changed every week

The air temperature where the fish are kept ranges from 27-31°C. Feeding as much as 3% of body weight is given three times per day. Fishes were kept for 30 days. The Fish feed (Takari®, Takari Kokoh Mandiri, Jakarta Indonesia) with 2 mm in diameter was given during the study. The environmental factors observed were water pH, dissolved oxygen (DO), nitrite, nitrate, ammonia content, and water temperature. The variables observed were fish body weight, carcass weight, body length, height, and the protein content of fish meat.

Dissolved oxygen was measured using a DO meter (DO9100), pH was measured with a pH meter (PH-009(I)A), temperature was measured with a thermometer (HTC-2 type water thermometer). The levels of ammonia, nitrite, nitrate was measured by using a spectrophotometer (DR 3900) in a wavelength of 630 nm. Body weight and carcass weight of fish were measured by using a weighing device (PS-200A micro digital scale) with an accuracy of 0.01 g. The length and height of the fish were measured using a digital caliper with an accuracy of 0.01 mm. Fish protein content was measured using the Kjeldahl method (Michalowski, 2013)

This study used a completely randomized design (CRD) with a 2x2 factorial pattern. The main factor consists of the aerator and filter. The main filter factor consists of two levels, that were without filter and with filter. The main factor of the aerator consists of two levels, that were with one aerator and with two aerators. Each container is filled with 20 tilapia fish. The treatments are structured as follows: NFA1: Unfiltered container with one aerator; NFA2: Unfiltered container with two aerators; FA1: Container with filter and one aerator; and FA2: Container with filter and two aerators

The data obtained were analyzed by using two-way analysis of variance. All data analysis was carried out using SPSS. Every significant difference between treatment groups, was analyzed further by using Least Significant Difference (LSD) test. The significant difference was evaluated at the level of $p<0.05$ (Santoso, 2016).

RESULTS AND DISCUSSION

Environmental factors such as the level of ammonia, nitrite, nitrate, DO, pH, water temperature is presented in Table 1 and Table 2 Ammonia in waste water can affect dissolved oxygen (DO) concentrations and can poison fish. In order to avoid eutrophication, the nitrogen content must be removed from the surface of the water. Ammonia reduction through the nitrification process using the role of bacteria Nitrosomonas sp., and Nitrobacter sp. Nitrosomonas sp., bacteria will convert ammonia into nitrite. Nitrite by Nitrobacter sp., will be converted to nitrate (Bhimantara and Suryo, 2018). According to Wasielesky et al. (2017) nitrite is an intermediate compound before becoming nitrate. Nitrite is a compound product of the denitrification of nitrate. Thereby the content of ammonia, nitrite, nitrate in water has a value that is directly proportional.

Fluctuation level of ammonia in water dependi on water temperature. The high temperature causes the activity of bacteria in the nitrification process to increase. When the environmental temperature decreases, the activity of bacteria in the nitrification process decreases. The ammonia oxidation process will be inhibited at pH 5. The nitrite oxidation process will be severely inhibited at pH 8.5. Another factor that greatly affects the nitrification process besides temperature and pH, is dissolved oxygen. According to Kristiana et al. (2020) the fish can survive with pH values ranging from 6–9. When oxygen levels are insufficient, the nitrification process will be hampered, as a result, ammonia levels will increase (Ambarsari et al., 2020). Nugroho et al. (2013) stated that a good and proper dissolved oxygen content for tilapia cultivation should be higher than 3.0 mg/L. Dissolved oxygen is an important variable and is needed for the survival of fish. Saputri (2014) states that

Table 1. The mean of environmental factors

Treatment	Environmental factors		
	Ammonia (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)
FA2	0.17±0.007[a]	0.03±0.004[a]	0.06±0.004[a]
FA1	0.23±0.015[b]	0.06±0.008[b]	0.09±0.006[b]
NFA1	0.28±0.004[c]	0.12±0.012[c]	0.13±0.004[c]
NFA2	0.22±0.004[c]	0.07±0.007[b]	0.10±0.003[b]

Note: Values are presented as Mean±SD Different superscripts on the number same column shows significantly different (p<0,05).

Tabel 2. The mean of environmental factors

Treatment	Environmental factors		
	DO (mg/L)	pH	Temperature (^{O}C)
FA2	5.47±0.021[a]	8.10±0.11[d]	27.64±0.041[g]
FA1	4.56±0.026[b]	7.81±0.17[e]	28.32±0.062[h]
NFA1	3.12±0.037[c]	6.55±0.10[f]	31.10±0.038[i]
NFA2	4.14±0.054[b]	7.51±0.21[e]	28.23±0.043[h]

Note: Values are presented as Mean±SD Different superscripts on the number same column shows significantly different (p<0,05).

Table 3. The results of data analysis on the increase of body length, height and weight of tilapia after maintained for 30 days

Treatment	Increase body length (cm)	Increase body height (cm)	Increase body weight (g)
FA2	5.77±0.15[a]	2.21±0.06[d]	36.18±1.35[g]
FA1	4.92±0.12[b]	1.89±0.04[e]	30.87±1.14[h]
NFA1	3.93±0.06[c]	1.51±0.03[f]	24.67± 0.68[i]
NFA2	4.81±0.19[b]	1.83±0.01[e]	29.53±0.28[h]

Note: Values are presented as Mean±SD Different superscripts on the number same column shows significantly different (p<0,05).

an increase in temperature will cause the oxygen concentration to decrease and conversely the lower the temperature will increase the higher dissolved oxygen concentration. According to Diantari and Pratiwi (2018) fish that live at temperatures between 25-32ºC can grow well.

Nitrogen in water come from ammonia (NH_3), nitrate (NO_3) and nitrite (NO_2) greatly affects water quality. The nitrogen cycle in water requires a lot of dissolved oxygen compared to other biochemical reactions that occur in water (Dahruji et al., 2017). Ammonia levels can be toxic to cultured fish above 1.5 mg/L. (Wahyuningsih and Gitarama, 2020) According to Putra et al. (2020) the range of nitrite is 0.20-0.43 mg/L. Patty (2015) stated that the concentration of nitrate that is sufficient for the growth of organisms ranges from 0.3 to 0.9 mg/L, if the nitrate concentration exceeds 3.5 mg/L it can be toxic to creatures living in water.

Table 1 show that increasing the number of aerators can inhibit the increase in ammonia, nitrite, and nitrate in the waters. Treatment with two aerators decrease the level of ammonia, nitrite, and nitrate compare with the treatment with one aerator. This is due to the addition of aerator will increase dissolved oxygen. and dissolved oxygen will increase the activity of breaking down nitrites and nitrates by Nitrosomonas sp., and Nitrobacter sp., which are aerobic. The use of filters showed a decrease level of nitrite, nitrate, and ammonia. The combination of treatment with the amount of aerator with the use of a filter showed that the content of ammonia, nitrite, and nitrate in water was significantly different between treatment groups. The use of filters and the addition of aerators can maintain the quality of water or the environment where fish live

The results showed that the environmental conditions indicated by the ammonia content, nitrite content, dissolved oxygen nitrate content, pH and water temperature were in the range in accordance with the maintenance standards of red tilapia SNI 7550:2009 for the life of red tilapia, thereby all environmental conditions in good conditions, the oxidation process of ammonia and nitrite is not hampered. Low oxidation of ammonia and nitrite resulted a low nitrate so that the negative impact due to environmental factors did not occur.

The Table 3 show that increasing the number of aerators can increases body length, height and weight of tilapia after being reared for 30 days. In the treatment with two aerators, the increases of body length, height and weight of tilapia was higher than in the treatment with one aerator. The use of filters showed an increase in the length, height and weight of tilapia. The combination of treatment with the number of aerators and the use of filters showed the increases of body length, height and weight of tilapia were significantly different between treatment groups.

The use of filters and the addition of aerators will increase environmental factors. Improved environmental factors resulted in fish growth as shown by the addition of length, height and weight of fish

Table 4 show that the addition of the aerator can increase the carcass weight and protein content of tilapia meat after being reared for 30 days. In the treatment with two aerators, the carcass weight and protein content of tilapia meat was higher than the treatment with one aerator. The use of filters showed an increase in carcass weight and protein content of tilapia meat. The combination of treatment with the amount of aerator with the use of a filter showed carcass weight and protein content of tilapia meat were significantly different between treatment groups.

Aerator is a device used for aeration in waters. Aeration is the process of adding oxygen in by giving fine bubbles and letting it rise through the water, using an aerator. Aerators in aquaculture are used to maintain water oxygen levels. Aerators create gas bubbles in the water, which will slowly float to the surface causing an increase in oxygen levels in the water (Patang et

Table 4. Results of data analysis on carcass weight and protein content of tilapia meat after being kept for 30 days

Treatment	Carcass weight (g)	Protein (per 100 g)
FA2	26.40±0.53[a]	27.10±0.55[h]
FA1	23.10±0.44[b]	23.55±0.35[i]
NFA1	19.80±0.35[c]	18.61±0.40[j]
NFA2	22.55±0.61[b]	22.48±0.57[i]

Note: Values are presented as Mean±SD Different superscripts on the number same column shows significantly different (p<0,05).

Table 5. Feed consumption during rearing

Feeding time	Amount of food given per container (g)			
	1st week	2nd weeks	3th weeks	4th week
6.00 am	0,7 ± 0,04	0,9 ± 0,05	1,2±0,03	1,6±0,04
12.00 noon	0,7 ± 0,04	0,9 ± 0,05	1,2± 0,03	1,6±0,04
6.00 pm	0,7 ± 0,04	0,9 ± 0,05	1,2± 0,03	1,6±0,04

al., 2019). Torrans and Craig (2018) state that mechanical aeration will help in minimizing the risk of low dissolved oxygen values. Nugroho et al. (2013) stated that the filter is a tool used for filtering unwanted materials for aquaculture activities such as ammonia, organic residues, solids, and other unwanted chemicals.

The results showed that fish growth (indicated by the increase in length, height, and body weight of fish) and carcass weight also increased with the use of filters. The treatment with filter on the container was significantly different from the treatment without filter. In the treatment without the addition of an aerator, fish growth was slower, so the carcass weight also decreased. Thereby the use of filters makes the waters cleaner causing the fish growth to increase and the carcass weight of the fish become heavier. This is in line with the statement of Nugroho et al. (2013) which states that the use of filters can remove ammonia around 9-98%. Norjanna et al. (2015) added that the use of filters in the recirculation system has a significant effect on reducing ammonia levels.

Protein in the body of fish is the highest compound after water. Protein has an important role in the structure and function of the body, such as growth and reproduction. Fish cannot synthesize protein, amino acids from inorganic nitrogen compounds, protein was occupied by the food (Ramlah et al., 2016) Protein is used for catabolic functions, such as to movement. Amino acid deficiency results in abnormal vertebrate growth (Rodwell, et al., 2018). Carcass in fish is used to determine the amount of meat that can be consumed (Hasan et al., 2016). Sahu et al. (2017) showed the percentage of carcass in tilapia reached 53%.

Catabolism is a metabolic step that breaks down organic nutrient molecules such as proteins from the cell's own food reserves, breaking down through reactions into smaller and simpler end products, such as lactic acid, CO_2 and ammonia. Catabolism is followed by the release of energy stored in these larger complex organic molecules. Anabolism or biosynthesis is the stage of formation or synthesis of smaller molecules arranged into large macromolecules which are cell components (Putra, 2015). Thereby the formation (biosynthesis) of protein contained in fish meat is influenced by the value of dissolved oxygen. Dissolved oxygen is the most important factor in determining fish survival (Firman et al., 2019). Table 4 show that the protein content in fish meat increased with the addition of an aerator. Dissolved oxygen is needed in the respiration process to break down Adenosine Tri Phosphate (ATP) into free energy which is needed in the anabolism process Rodwell et al., (2018). One of the anabolic processes is the formation of proteins. Based on the statement can be understood if the increase in dissolved oxygen ultimately increases the protein content of fish meat. Proteins have amino acid chains that are important in the anabolic process, such as for growth (Rodwell, et al., 2018) The use of filters in fish habitats leads to improved water quality which causes an increase in dissolved oxygen. The use of filters and the addition of aerators will improve water quality. This causes an increase in protein anabolism which results in increased meat protein. According to Zaidy and Tatty (2021) the quality of water and feed consumtion. can affect the quality of fish meat. Carcass composition, color, ratio and growth are determinants of good or bad quality of fish meat produced. Feed consumtion can be seen in table 5.

In the treatment using one aerator with no filter, it was significantly different compare the treatment using two aerators without a filter. This can be seen in the results of observations of the increase in length, height and weight of fish in table 3. The results of observations of carcass weight and protein content in table 4 also show the same thing.

The data shows that the use of filters and the addition of aerators improve environmental factors. This can be seen by increasing dissolved oxygen, pH and decreasing temperature. The content of nitrite, nitrate, and ammonia in the water decreases, thereby the use of dissolved oxygen filters increases and the water temperature decreases. The cleaner waters because of the filtration of metabolic waste that form of ammonia decreases. Ammonia decreases resulting in nitrite, nitrate down.

These results indicate that the use of a filter combined with the addition of an aerator increases the supply of dissolved oxygen which can improve water quality thereby increasing the growth and protein content of red tilapia meat

CONCLUSION

Use of a filter combined with use of two aerators can be an alternative to improve water quality which has a positive impact on the productivity of red tilapia (Oreochromis niloticus).

SUGESTION

It needs to be done further by adding water salinity treatment

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