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Effect of difference filter media on Recirculating Aquaculture System (RAS) on tilapia (*Oreochromis niloticus*) production performance

Ricky Rahmat Maliki Tanjung[1], Irfan Zidni[2,3,*], Iskandar[3], Junianto[3]

[1]Student of Fisheries Study Program, Universitas Padjadjaran, Jatinangor 45363, West Java, Indonesia

[2]Ciparanje Fish Farming Laboratory, Universitas Padjadjaran, Jatinangor 45363, West Java, Indonesia

[3]Departement of Fisheries, Universitas Padjadjaran, Jatinangor 45363, West Java, Indonesia

*E-mail address: i.zidni@unpad.ac.id

ABSTRACT

This research aims to determine the composition of the best filter media on tilapia (*Oreochromis niloticus*) production performance. The method used in this research is experimental methods use Completely Randomized Design (CRD), which consist of four variables and three replications. The variable used is (A) without media filter (Control); (B) combination of cotton, bio ball and charcoal; (C) combination of cotton bioring and charcoal; (D) combination of cotton, Japanese matt and charcoal. The test fish used 180 tilapia fish with 7-9 cm length size. Tanks that used measured 60 cm x 30 cm x 36 cm as many as 12 pieces. The density during the research was 15 tails per tank. Duration of maintenance is 40 days. The feeding level is given by 5% of fish body weight. Water quality parameters (temperature, dissolved oxygen, pH, ammonia, and nitrate) were observed every 10 days for 40 days. Other parameters are survival rate, absolute length and weight growth, specific growth rate and feed convertion ratio observed every 7 days for 40 days. The results showed that the best composition of filter media for tilapia production performance was combination of cotton, bioball, and charcoal. Tilapia production performance obtained a combination of cotton filter media, bioball, and charcoal with 100% survival rate, length growth 2.17 cm, weight growth of 9.91 g, and specific growth rate of 2.3% and feed conversion ratio of 1.88.

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Keywords: filter media, production, recirculating aquaculture system, tilapia, *Oreochromis niloticus*

1. INTRODUCTION

Tilapia (*Oreochromis niloticus*) is a commodity of freshwater fish that is popular with the community as consumption fish. Tilapia has almost the same nutritional value as other freshwater fish. Tilapia can live in deep and wide waters and in narrow and shallow waters [1].

The problem that often faced in fish farming is the decrease in water quality. Water quality will decline rapidly along with the existence of intensive cultivation. Intensive cultivation is cultivation with a high stocking density system with high feeding intensity. High stocking density and high feed intensity can reduce water quality because the rest of the metabolism of fish and the remaining food that accumulates can cause high ammonia.

The success of aquaculture is very closely related to the optimum environmental conditions for the survival and growth of fish that are maintained [2]. The availability of water and water quality is one of the factors that determine the success in fish farming [1]. Conventional water quality management can be carried out by changing cultivation water regularly, but it is less effective because it requires considerable water and costs.

Water as a living medium for fish must have properties that are suitable for fish life, because water quality can have an influence on the growth of aquatic organisms. Water quality is a limiting factor for the type of biota that is cultivated in waters [3].

Recirculation Aquaculture System (RAS) or often called recirculation system is an innovation culture system that suitable to be applied to limited land and water [4]. The aim is to improve water quality so that water can be used continuously. The movement of water will cause the distribution of environmental factors in the form of temperature, oxygen, pH, and others to be more evenly distributed, even the spread of food is also evenly distributed, besides the impurities and metabolic waste from fish will be carried away by the movement [5].

Recirculating aquaculture systems or recirculation systems combined with filter media can improve water quality [6]. Improving water quality or eliminating the bad influence of dirty water in order to be feasible and healthy for fish life in cultivation can use several ways, namely: aeration, water circulation, heating use [2]. RAS is done by reusing water that has been removed from cultivation activities. Water circulation is usually combined with filter media to process fish-produced waste or leftover feed that is not consumed so it is not toxic to fish. Filters used usually include physical filters, chemical filters, and biofilter. Physical filters function to filter out relatively large coarse impurities such as feces, mucus, leftover feed, etc., for example, dacron. Chemical filters function to filter out particles that cannot be processed by physical filters, for example, charcoal. Biological filters are usually in the form of a bacterial house that functions as a processor of nitrogen compounds in water, for example, bioball, and bioring.

2. MATERIALS AND METHOD

Time and place of research

This research was conducted in August - September 2018 in Aquaculture Laboratory build 4 Faculty of Fisheries and Marine Sciences, Padjadjaran University Jl. Raya Jatinangor KM 21 Sumedang.

Tools and materials

The tools used are aquariums, water pumps, gutters, fiber tubs, water checkers, digital scales, pH meters, and filters. The materials used are tilapia, bioball, bioring, Japanese mat, cotton, charcoal, fish feed, Ammonia test kit, and nitrate test kit.

Research methods

This research will be carried out using the experimental method Complete Random Design (CRD) model. The number of a) treatment in this research were four (4) variables and each variable was repeated three (3) times. The variables are:

a) Treatment A: without filter media (control)
b) Treatment B: Cotton, Bioball, charcoal
c) Treatment C: Cotton, Bioring, Charcoal
d) Treatment D: Cottom, Japanesematt, Charcoal

3. RESEARCH PROCEDURE

Maintenance Container Preparation and Filter Media

The maintenance container in the form of an aquarium measuring 60 cm × 30 cm × 36 cm is cleaned first of the remaining dirt or dust that sticks to the aquarium. Filter media containers such as gutter with a length of 40 cm in the clear, then the filter medium of each variable in place and given the bulkhead each 10 cm. The filter media that has been arranged is then attached to the maintenance container, then filled with 30 cm of water and then flowed towards the filter and grows bacteria.

Fish Acclimatization

Test fish in acclimatization to the maintenance container for 1-2 days in order to adapt to the new environment.

Maintenance of Tilapia

The test fish was kept for 40 days and given a commercial feed with a feeding rate of 5 % of the biomass weight.

Water Quality Check

Water quality checks were carried out at the beginning of the research and every week of maintenance then a final examination was carried out at the end of the research.

Growth Observation

Observation of growth was carried out at the beginning of the research and every week of maintenance then a final examination was carried out at the end of the research.

4. RESULTS AND DISCUSSION

Water quality

Water quality in this research was measured every 10 days during the day. Water quality measured in this research included; temperature, DO, pH, ammonia, and nitrate. Water quality during the research is presented in Table 1.

Table 1. Observation of Water Quality during Research

Parameter	Variable				Standard
	A	B	C	D	
Temperature (ºC)	24.5 - 25.0	24.8 - 25.1	24.6 – 25.1	24.9 - 25.1	25-32 [5]
Dissolved Oxygen (mg/L)	4.6 – 7.2	4.4 – 7.3	4.8 – 7.4	4.8 – 7.3	>3 [5]
pH	7.0 – 7.4	7.1 – 7.3	7.1 – 7.3	7.1 – 7.3	6,5-8,5 [5]
Ammonia (mg/L)	0.6 – 1.1	0.2 – 0.8	0.2 – 1.0	0.3 – 1.1	<0,2 [7]
Nitrate (mg/L)	33.3–50.0	33.3–41.7	33.3 – 41.7	25.0–41.7	≤20 [7]

Temperature

Temperature observations during the 40-day research were shown in Figure 1.

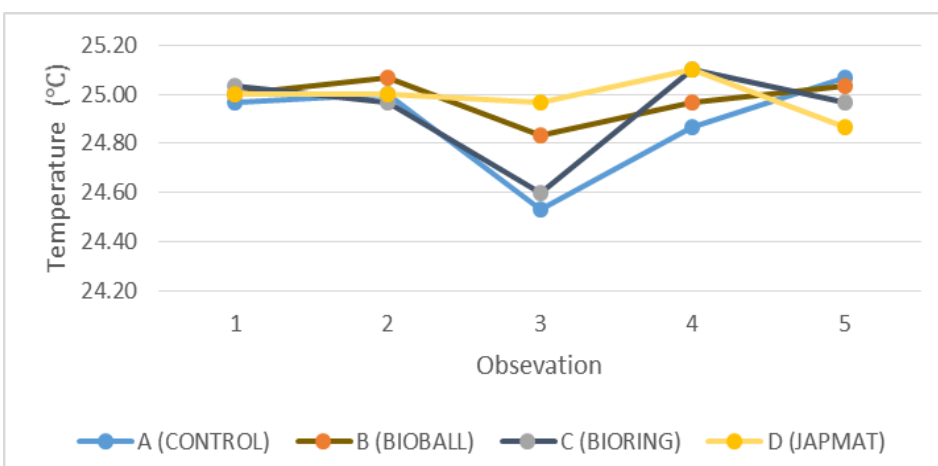

Figure 1. Temperature Charts During Research

The graph shows that the average temperature obtained at the research location is 24.4-25.1 °C. The optimal temperature for tilapia is between 25 - 32 °C, so the temperature during the research can be said to be optimum. The temperature during the research had a condition below 25 °C but the fish remained normal. This condition occurs because the growth of tilapia will usually be disrupted if the habitat temperature is lower than 14 °C or at a high temperature of 38 °C. Tilapia will die at a temperature of 6 °C or 42 °C [7].

Maintenance of tilapia carried out during the research has the optimum temperature so that the fish are not susceptible to disease and have a fairly good appetite. Water temperature affects all activities and life processes of fish such as respiration, reproduction, and growth, in addition, temperature affects appetite, digestion rate and metabolic rate which further influences the rate of fish growth [2].

Dissolved Oxygen

The results of observations of dissolved oxygen during the research carried out for 40 days are shown in Figure 2.

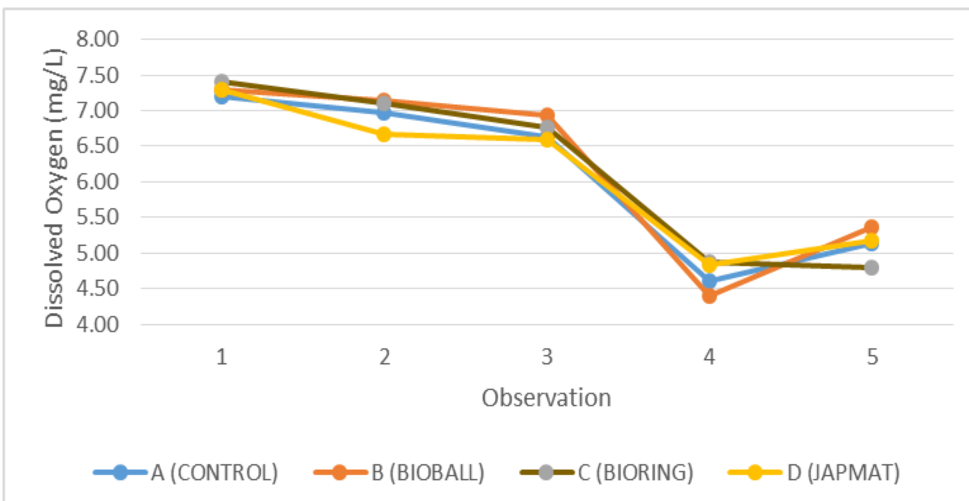

Figure 2. Graph of Dissolved Oxygen (DO) During Research

The graph above shows that dissolved oxygen during the research ranged from 4.4 to 7.4 mg / L. This value can be said to be quite feasible for maintenance of indigo Dissolved oxygen content in the culture medium must be higher than 3.0 mg/L [5]. Dissolved oxygen values decreased in the 4th observation caused by the larger body of the fish causing the dissolved oxygen demand for the metabolic process to increase. Fish requires a minimum dissolved oxygen level of 1 mg/L when resting, but in an active state requires dissolved oxygen of 3 mg/L [5]. The value of dissolved oxygen is obtained through the diffusion of oxygen through water movement and the presence of air (bubble) induction. High dissolved oxygen can stimulate growth in fish, because high oxygen supply causes a high metabolic rate. This is in accordance with [4], stating that with the current the oxygen supply will be evenly distributed and there will be an exchange of oxygen in the air with the toxic content in the water.

Acidity (pH)

The results of observations of acidity (pH) during the research conducted for 40 days are shown in Figure 3.

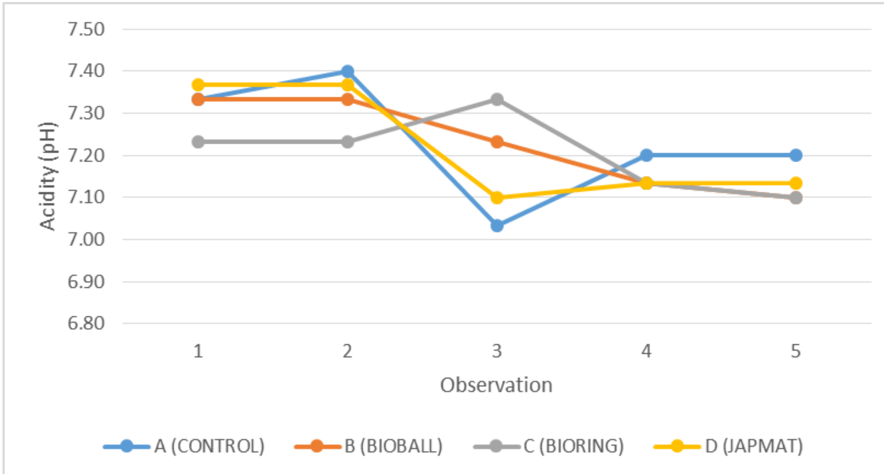

Figure 3. Graph of pH During Research

The above graph shows the pH value during the research. The pH value not showing large fluctuations. The pH value during the research shows the optimal number. This can support the growth of fish because pH values that are not optimal can cause stress, disease, productivity and low growth [9]. pH value fluctuates during the research, the impact of the disease will be on the emergency. In conditions where pH is too alkaline, the bacteria will overgrow while at acidic pH the fungal growth will increase [12].

The pH value also affects the nitrification process during the research. A neutral pH value allows the nitrification process. The pH value greatly influences the biochemical processes of the water, for example in the process of nitrification ending at a low pH. At high pH much ammonia is found that are not ionized and are toxic. This non-ionized ammonia is more easily absorbed into the body of aquatic organisms compared to ammonium [10].

Ammonia

The observation of ammonia during the 40 days of research was shown in Figure 4.

These results show different numbers between variable controls and other variables. The variable that is not given filter media has high ammonia levels with 0.6 - 1.2 mg / L. This figure shows that environmental conditions are not good because it has exceeded the threshold of ammonia in water according to [5]. This can cause death in fish. Fish cannot tolerate the concentration of ammonia which is too high because it can interfere with the process of binding oxygen by blood and ultimately can lead to death [1].

The decrease in ammonia value is caused by the availability of sufficient dissolved oxygen for the nitrification process. Nitrification is ineffective when dissolved oxygen levels in water are insufficient for the continuity of the nitrification process. Nitrification is inhibited when DO is less than 1.2 mg/L [9].

Figures shown by the variable with bioball media show conditions that tend to be better than other variables. This can indicate that the bioball has a larger media surface so that the decomposition of ammonia is better. The more surface area available for bacterial growth it would be better to decompose ammonia. Bioball as a better variable in the decomposition process of ammonia which has a range of ammonia values 0.1 - 0.2. Range ammonia is good and can be tolerated in the maintenance media tilapia is <0.2 mg/L [3].

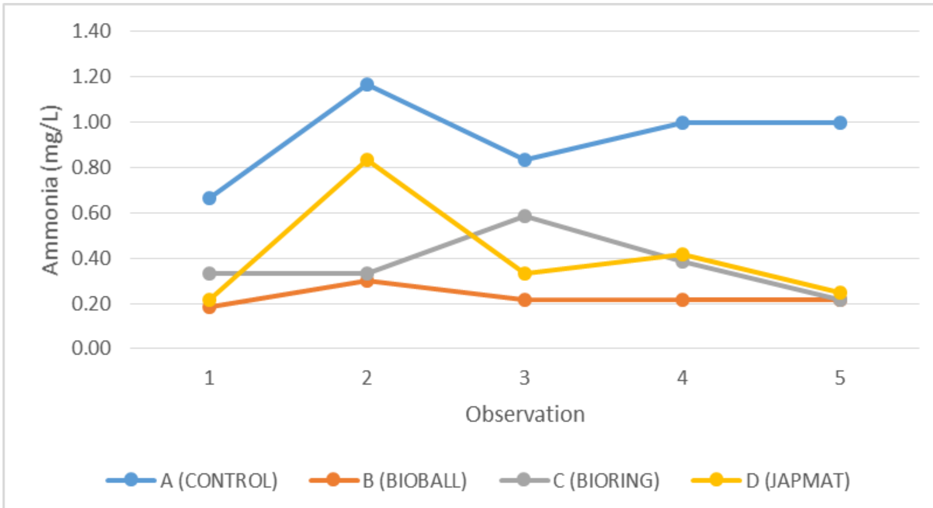

Figure 4. Graph of Ammonia During Research

Nitrate

The results of observations of nitrates during the research conducted for 40 days are shown in Figure 5.

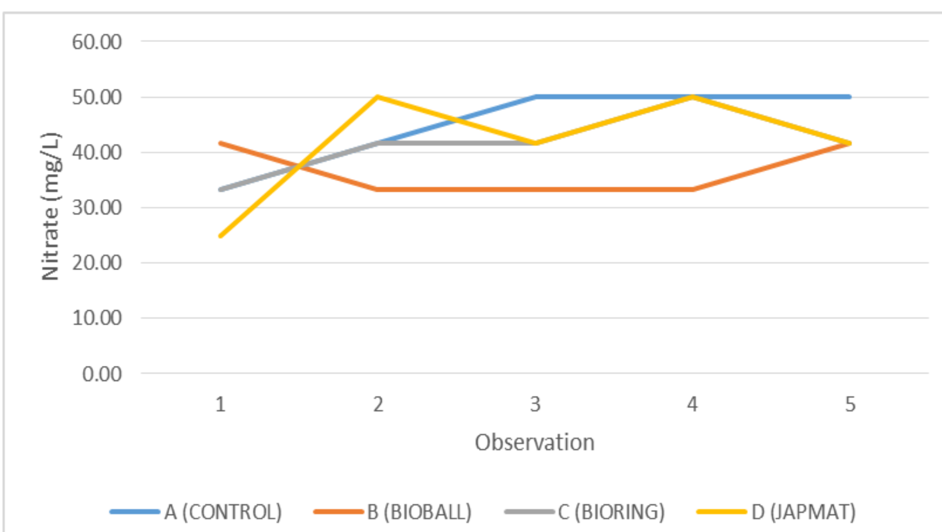

Figure 5. Graph of Nitrate During Research

Nitrate levels measured during the research showed a relatively high number. This is due to the nitrification process that works in the maintenance cycle. The nitrate value during the research was greater than the existing standard, which is <20 mg / L, but nitrate is a harmless compound for fish, and even tends to be good if it can be used by phytoplankton, which then becomes natural food that can be consumed by fish.

Bacteria that grow in the recirculation system combined with filter media will change compounds that are harmful to fish (Ammonia and Nitrite) into compounds that are not harmful to fish (nitrates). Nitrification process that occurs is closely related to the oxygen content dissolved in water during the research. Nitrification more efficient at high oxygen overvoltage conditions, but the conversion of ammonia and nitrite are still ongoing despite the condition of low oxygen tension. The relatively high nitrate value is caused by a lack of utilization of nitrates by aquatic organisms such as phytoplankton or aquatic plants [13]. Nitrate is toxic to aquatic animals and toxicity has been found to increase with concentration and exposure time. [14]

Survival Rate

Survival during research conducted 40 days is shown in Table 2.

Table 2. Survival Rate Every Variable

Number	Variable	Survival Rate (%)
1	A (Control (Without Filter Media))	100
2	B (Cotton, Bioball, Charcoal)	100
3	C (Cotton, Bioring, Charcoal)	100
4	D (Cotton, *Japanesematt*, Charcoal)	100

Survival during the research was 100% due to the absence of death during the research. Death does not occur because of a recirculation system that can ensure the availability of dissolved oxygen during the maintenance period and combined with filter media that can ensure the quality of water that is in accordance with the threshold so that the fish remain alive. The survival values obtained during the research had a better value than the research [11], namely 86.6% with circulation using bioball on the growth of tilapia at the nursery stage I.

Water quality in the variable without filter media during the research was maintained by routine sterilization carried out during the maintenance period. This is done because the recirculation process is carried out only to ensure oxygen availability during the maintenance period is sufficient. Fish that live in optimal environments have a high appetite, so they can grow and develop more and faster [3].

Growth

Growth is a change in size (weight, length or volume) over a period of time. Growth is important to research because growth will determine production because high and low production determines success in fish farming activities [5]. Fish growth is closely related to the availability of protein in feed. This is related to the function of protein as the main energy source, because continuous protein is needed in the feed for growth and repair of damaged tissue [15]. Length growth period of each observation carried out every 7 days is presented in Figure 6.

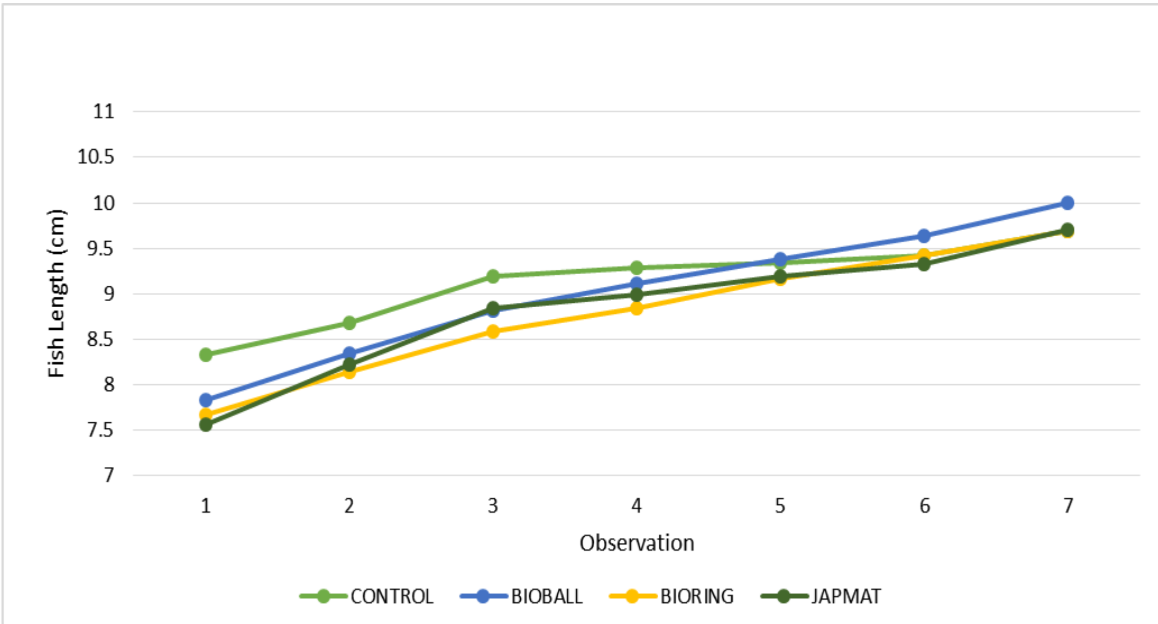

Figure 6. Graph of Length Growth During Research

The average growth length during the research is shown in Table 3.

Table 3. Average Length Growth Tilapia Every Variables

Number	Variable	Length (cm)
1	A (Control (Without filter media)	1.36 ± 0.01^a
2	B (Cotton, Bioball, Charcoal)	2.17 ± 0.43^b
3	C (Cotton, Bioring, Charcoal)	2.02 ± 0.14^b
4	D (Cotton, *Japanesematt*, Charcoal)	2.14 ± 0.45^b

Based on the table above variable A has the lowest length growth. Variety test results show that variable A is significantly different from other variables, which means that there is an influence in the use of filter media in the RAS system. The growth of d to be better than other variables with an average length of 2.17 cm. This is due to the good quality of water caused by the use of effective filter media. The long growth obtained during length between variables B, C, and D did not show a significant difference, but variable B tended the research tended to be good, this refers to the research conducted by [2] namely 7.29 Circulation using coral, gravel, sand and palm fiber for 3 months maintenance of tilapia. Both Length and volume growth at a certain period occur due to muscle cell division [2]. The weight gain is shown in Figure 7.

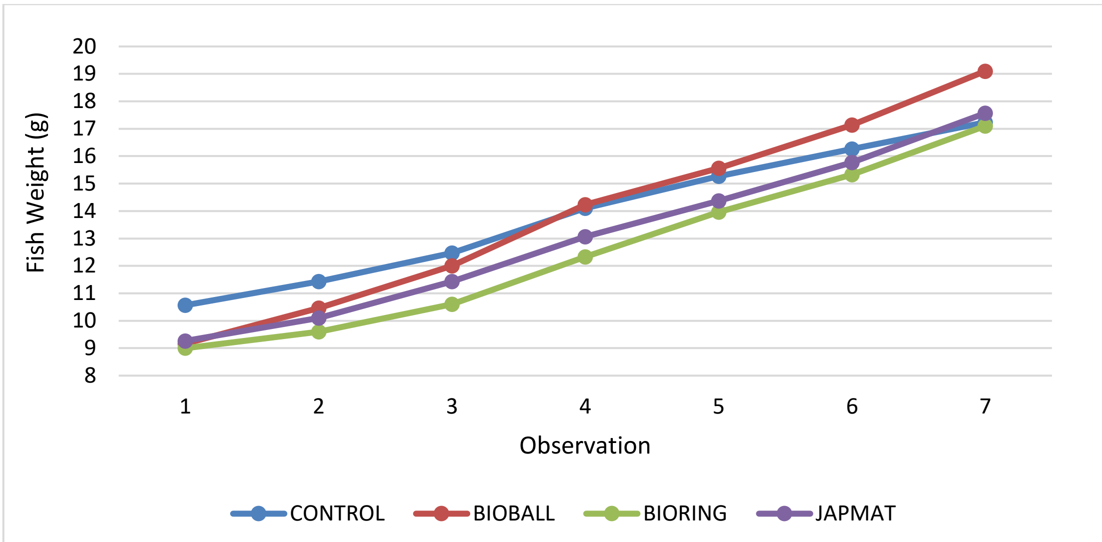

Figure 7. Graph of Weight Growth During Research

The graph above shows the weight growth during the research. The weight growth in the 7th-day observation experienced a significant difference, it was seen that variable B obtained the greatest added value of 1.3 g. This can be caused by the speed of fish adaptation to the new environment is good. The next observation, variable B still has the greatest weight gain value of 1.53 g. Observation on 21st day even though variable B is still the variable that has the highest weight gain value of 2.23 g.

Subsequent observations of the variable which had the greatest weight gain were variable C. Observation on day 35 which had a greater added weight than the others was variable B which was 1.57 g. The last observation shows that variable B is a variable that is greater than the other variables with an added value of 1.97 g. The growth of the average weight of tilapia is shown in Table 4.

Table 4. Average Weight Growth Tilapia Every Variable

Number	Variable	Weight (g)
1	A (Control (Without filter media))	6.67 ± 0.45^{a}
2	B (Cotton, Bioball, Charcoal)	9.93 ± 1.9^{b}
3	C (Cotton, Bioring, Charcoal)	8.1 ± 0.27^{ab}
4	D (Cotton, *Japanesematt*, Charcoal)	8.3 ± 1.15^{ab}

The results of the Duncan test showed that variable A was significantly different from variable B, while variables A and B were not significantly different from variables C and D. This shows that variable B is a better variable compared to other variables in the growth of tilapia weight in RAS. The value of weight gain from this research is better than the results obtained by [2]; namely with a value of 4.5 g weight gain with circulation using coral, gravel, sand and palm fiber.

The addition of this weight value is closely related to the specific growth rate. Fish growth rate is the response of fish which is indicated by the speed of growth at a certain time, both growth length and weight [18]. The specific growth rate during the research is presented in Table 5.

Table 5. Specific growth rate Tilapia Every Variables

Number	Variable	SGR (%)
1	A (Control (Without filter media))	1.31 ± 0.01^{a}
2	B (Cotton, Bioball, Charcoal)	2.34 ± 0.34^{c}
3	C (Cotton, Bioring, Charcoal)	1.98 ± 0.35^{bc}
4	D (Cotton, *Japanesematt*, Charcoal)	1.57 ± 0.31^{ab}

The specific growth rate during this research produces different results. The growth rate in the research of the effect of filter media differences on the RAS system on the performance of tilapia production ranges from 1.31% - 2.34%. Based on the information in the picture shows that the specific growth rate that tends to be greater is shown by variable B with a value of 2.34% then variable C with a value of 1.98% then variable D with a value of 1.57% and variable A with a value of 1.31%.

The Duncan test results showed that variable B was significantly different from variable A and D, whereas it tended to be better than variable C but there were no significant differences. The value of the specific growth rate obtained during the research tends to be good, this refers to the research [11] that is 3.27 with circulation using bioball on the growth of tilapia at the nursery stage I. This shows the optimal filtration process that occurs in the process of improving water quality so that the fish do not stress and have a good appetite. Poor water quality can make fish stress which results in reduced fish appetite and disruption of the metabolic system [2].

The control variable is the lowest variable compared to other variables. This is because the control variable does not use filters which results in a decrease in water quality. A decrease in water quality can cause the immune system of the fish to become weak and the response to the feed given will decrease. The lack of recirculation rates and the high number of inorganic materials in the waters can cause the immune system of the fish to become weak and eventually susceptible to disease [17]. Proteins are the main energy source for fish [18]. Omnivore fish such as tilapia need protein in feed as much as 25-35% [23].

Tilapia during research was given commercial feed in the form of pellets with a protein composition of 31-33% and given with a feed level of 5% of the weight of the fish.

This refers to the statement [17] that "The average amount of daily feed needed is 3-4% of body weight. Feeding as much as 5% is done in order to meet the feed requirements for fish. Suitability of the type of feed given with nutritional needs can affect the growth of fish seeds. Growth can occur if there is an excess energy input of amino acids (proteins) derived from food [18].

Feed Conversion Rate

Feed conversion ratio is a comparison between the amount of feed given and the amount of weight of fish produced [20]. The smaller the value of feed conversion means that the level of efficiency of feed utilization is better, on the contrary, if the feed conversion is large, then the level of efficiency of feed utilization is not good. This feed conversion illustrates the level of efficiency of feed utilization achieved [21]. The average value of feed conversion in each variable during maintenance is shown in Table 6.

Table 6. Feed Convertion Ratio Every Variables

Number	Variable	FCR
1	A (Control (Without filter media))	2.82 ± 0.42^{b}
2	B (Cotton, Bioball, Charcoal)	1.88 ± 0.26^{a}
3	C (Cotton, Bioring, Charcoal)	2.04 ± 0.19^{a}
4	D (Cotton, *Japanesematt*, Charcoal)	2.10 ± 0.28^{a}

The results of the research on feed conversion ratio (FCR) showed that the FCR value was the most efficient at variable B (1.88). The feed conversion value obtained during the research was not significantly different from the results obtained from the research conducted [22]; which is worth 1.86 with the use of zeolite filters. The use of feed can be indicated from total biomass and an increase in the amount of feed given. Feeding showed an increase in the weight of the average individual fish [22].

Table 6 shows that variable A is significantly different from other variables. This is because the FCR value of variable A is the highest compared to other variables. A good FCR value is the value that has the lowest number because it shows how much feed is needed to produce 1 g of fish weight. Variable B is a better variable than other variables, namely 1.88. These results indicate that the variable using filter media is better than the variable that does not use filter media. This is due to the optimal process of energy absorption due to the media that are good for fish growth and the availability of sufficient feed. The availability of energy in the food consumed by fish will be used for growth in good water conditions. Fish growth occurs due to the availability of food in sufficient quantities, which feed consumed is greater than the basic needs for survival [2].

5. CONCLUSION

The results of this research can be concluded that the combination of cotton filter media, and charcoal bioball productivity of tilapia in phase II of the nicest nursery with 100% survival, growth rate is 2.17 cm, the growth of the absolute weight of 9.93 g, specific growth rate 2.3% and 1.88 feed conversion ratio.ate

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