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THE PRODUCTIVITY OF NILE TILAPIA (OREOCHROMIS NILOTICUS) AND WATER QUALITY CONDITION IN DIFFERENT FILTERS IN AQUAPONICS SYSTEM

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Oreochromis niloticus, Absolute Growth, filters, aquaponic, water quality

ABSTRACT

This study aims to determine the effectiveness of filters in the cultivation of nile tilapia (*Oreochromis niloticus*) in aquaponic system. The study was conducted from July to August 2017 at Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Jatinangor. The research method was Completely Randomized Design (CRD) with four treatments and three replications, namely treatment A: circulation using bioball filter media, B: Circulation using water spinach filter media, C: Circulation using bioball filter media and water spinach plants and D: Circulation using media sponge (control).The container used for the maintenance of a fiber tub with the size of 70 cm x 70 cm x 70 cm filled with water as much as 257 L with a density of 15 fish/fiber. The parameters observed were absolute fish growth, survival rate and water quality, including pH, dissolved oxygen and ammonia. The results showed that there were significant differences in the growth of nile tilapia fry with a biological filter of water spinach plants with survival rate of 100% and absolute growth 98.32 gr ± 15.6 gr.

INTRODUCTION

Nile tilapia (*Oreochromis niloticus*) is a type of commercialized fish that is popular among Indonesians. The production rate of nile tilapia increases from 2010 to 2013, with an increase in the average as much as 34,85%. One of the technologies used in nile tilapia breeding is by using aquaponics system. Aquaponics is a biointegration between aquaculture activities and hydroponic plants or vegetables that can be applied in a condition where land and water resource are limited, including in urban areas (Hermawan, 2015). Density and high frequency of feeding in aquaponics system pose a problem for the water quality, because not every feed is being eaten, while feed that is eaten will be excreted as metabolic waste in breeding media. The solution that can be taken to solve this problem is by applying recirculation system.

Recirculation system is using the principle of reusing the water that is already excreted from the breeding process (Putra & Setiyanto, 2011). Filtration is filtering the water that is full of fish's wastes by using filter, so that the water is clean again and is suitable to be reused. Filtering media can be a biological, physical, or chemical filters (Satyani et al., 2008).

Biological filter is a mineralisation process of organic nitrite substances, by nitrification and denitrification by the bacteria inside the water and those that is sticking to the filtration stones. One of the media that can be used as biological filter in recirculation system is bioball. Bioball functions as a biological filter which is a growing medium for bacteria that can remove ammonia contained in the water. Bioball is made light, has a lot of cavities, floats in water and most popular biological filter (Alfia et al. 2013).

Other than bioball, biological filter media that can be used in fish breeding is including plants. Another function of plants that is used as bio filter is that plants can also supply oxygen to the water that is used for fish breeding. Biological filtration by plants can also absorb nitrogen and carbon dioxide (CO_2) which are the by-products of fish breeding. Fish excreted 80%-90% of Ammonia from osmoregulation process, and about a total of 10-20% of Ammonia-Nitrogen from urine and faeces (Van Rijn et al., 2006). Aim of this study is to find out about the most suitable filter used in breeding of Nile tilapia in aquaponics system using water spinach.

METHODS

Tools and Materials

The tools used in this study included: 12 fiber tubs, pumps, heaters, 4 inch and ½ inch PVC pipes, sponges, plastic pots, bioball, UTE Digital Counting Balance, measuring boards, thermometers, DO meter, pH meter, Spectrophotometer. While the ingredients used included: tilapia fingerlings measuring 5-8 cm, water spinach of 1-2 weeks of age as a result of seeding, Rockwool, and commercial pellet meal with a crude protein content of 35%.

Research Methods

The method used in this study is the experimental method using a Completely Randomized Design (CRD) of four treatments and three replications. The treatments used in this study are as follows:
A: Circulation using bioball filter media
B: Circulation using water spinach plant filter media
C: Circulation using bioball filter media and water spinach plants
D: Circulation using sponge media (control)

Research procedure

Preparation phase

Preparation of Recirculation and Filter Systems

Fibre tubs are arranged randomly according to treatment and placed on a shelf in a greenhouse. Water pumps and water pipes that have been prepared were installed in the tub and directed into a water reservoir pipe, each tank is given a water pump. The water was then left for one week so that dissolved oxygen (DO) and pH are stable, and also to grow nitrifying bacteria. One week later, the fingerlings were inserted into the fiber tubs and the test plants which had been previously familiarized with the water stagnant conditions for three days, were planted on rockwool.

Fry and Plant Seed Preparation

Before the seeds were disseminated, the initial length and weight of fry were measured. The dissemination is carried out after 3 days of stabilization of the recirculation system. The number of fingerlings put inside the cultivation container is 40 fish/ m^2. The plants used are ground water spinach seeds that were sown for 1-2 weeks. Water spinach seeds sown into rockwool soaked in water. After the roots had come out, the plants are sorted into plastic cups and implanted into the pipe holes.

Implementation of Research

Fish are kept for 30 days in a cultivation container. Fish are fed with pellets with a size fit to the opening of the fish fry's mouth. The amount of feed given is 3% of biomass with a frequency of 2 times a day, at 09.00 and 15.00 WIB. Fish weight sampling is carried out every 7 days in the morning, and amount of feed is also adjusted along the growth of fish. Water outlet and cultivation media cleaning is carried out every day. Water quality measurements are carried out once a week, which includes measuring the level of dissolved oxygen, pH and ammonia.

Parameters Observed

Survival Rate

Survival (SR) is calculated using the formula from Goddard (1996):

$$SR = (Nt/No) \times 100\%$$

Description:
SR = Survival Rate (%)
Nt = Number of live fish at the end of cultivation
No = Number of fish at the beginning of cultivation

Absolute Growth

Absolute growth is calculated using the following formula (Ogunji et al. 2008):

$$AB = W2 - W1$$

Description:
AB = Absolute growth (gram)
W1 = Initial weight of fish (g)
W2 = Final weight of fish (g)

Water quality

Observation of water quality includes dissolved oxygen (DO), pH and ammonia.

Data analysis

Data analysis was carried out by conducting ANOVA test followed by Duncan's Multiple Range Test with a confidence level of 95% to compare values between treatments. Data on water quality was analysed descriptively.

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Results and Discussion

Survival Rate

Survival rates for tilapia fingerling did not significantly different between treatments, with values ranging from 74.04% - 100% (Figure 1). The use of water spinach as a filter in treatment B has the highest value of 100%, followed by treatment C (Bioball and Plants) 96.30%, treatment A (Bioball) 88.89%, and the lowest is treatment D (control) of 74.07% .

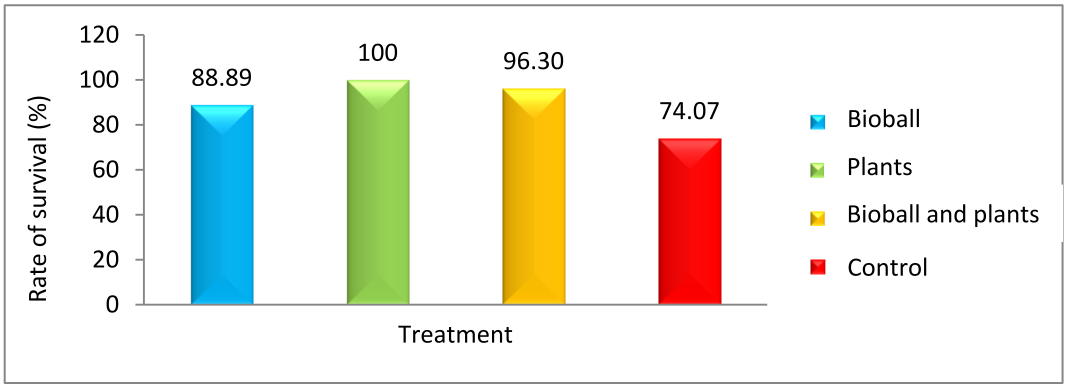

Figure 1. Survival of Tilapia Fingerling During Research

The survival value of tilapia fingerling in treatment B (Plants) and treatment C (Bioball & Plants) in this study is better than that of Mulqan (2017), where the highest survival rate of nile tilapia fingerling for 30 days of cultivation in aquaponics using water spinach is equal to 95%. However, overall survival of tilapia in this study is still quite high, because it is still above 80% (SNI 2009).

The results of the calculation of variance analysis show that the different recirculation systems with filter media have no significant effect (Fcount <Ftable) on the Duncan test on the survival of tilapia fingerling (Table 1).

Table 1. Average Survival of Tilapia Seeds

	Treatment			
Parameter	A (*Bioball*)	B (Plant)	C (*Bioball* & Plant)	D (Control)
SR (%)	88,9±14,7 a	100±0 a	96,3±3,2 a	74± 25,7 a

Absolute Growth

The absolute growth of cultivated tilapia fingerling in the recirculation system has also increased for each treatment. The average weight of each tilapia fingerling at the time of dissemination was 14.43 gr, after being cultivated for 30 days it increased to 21.59 gr, with a weight gain of 7.16 gr. It can be seen in Figure 2 that the average daily weight gain of Tilapia fingerlings is about 0.23 gr.

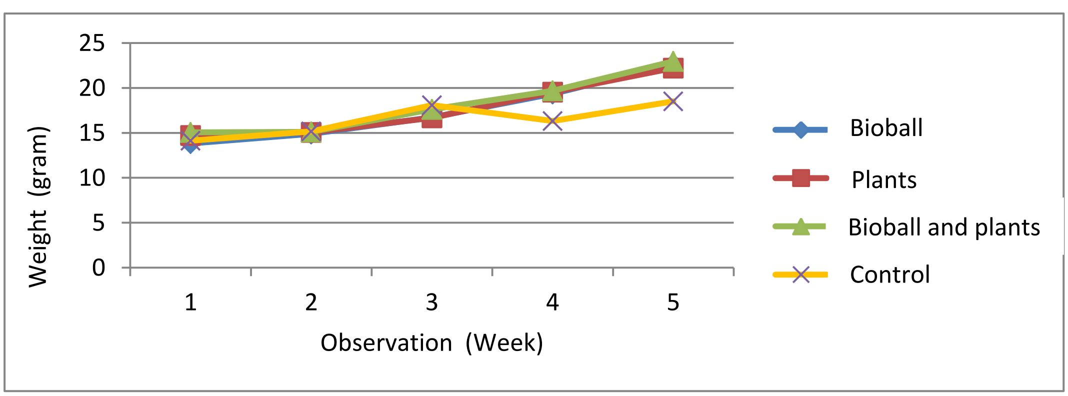

Figure 2. Absolute Weight Growth of Tilapia Fingerling

The results of weight gain of tilapia fingerlings between treatments were not significantly different. The highest average value of absolute weights in treatment A (Bioball) is 8.83 gr, followed by treatment C (Bioball & Plant) 7.90 gr, then treatment B (Plant) 7.51 gr, and the lowest is found in treatment D (Control) 4.38 gr. The value of weight gained in treatment B and C in this study produced a better value compared to Mulqan's research (2017), that stated the weight gain of a nile tilapia fingerlings cultivated in aquaponics system using water spinach was 7.16 gr.

The variance test results showed that there was no significant effect of the recirculation system with different media filters (Fhit <Ftable) on the Duncan test level of 5% on the growth of absolute weight of tilapia fingerling (Table 2).

Table 2. Average Absolute Growth of Tilapia Fingerling

	Treatment			
Parameter	A (*Bioball*)	B (Plant)	C (*Bioball* & Plant)	D (Control)
AG (Gram)	159±51,2 a	135,2±7,5 a	142,2±28 a	159,5±22,8 a

Water quality

Dissolved Oxygen (DO)

Oxygen plays an important role as an indicator of water quality, because dissolved oxygen plays a role in the process of oxidation and reduction of organic and inorganic compounds. The measurement results of dissolved oxygen during the study fluctuated, ranging from 5.2 to 7.7 mg / L. This condition is still within tolerance for the growth of pangasius catfish fry. Boyd (1982) stated that the optimal dissolved oxygen level for fish growth process, must be more than 5 mg / L. Fluctuations in dissolved oxygen concentration during the study can be seen in Figure 3.

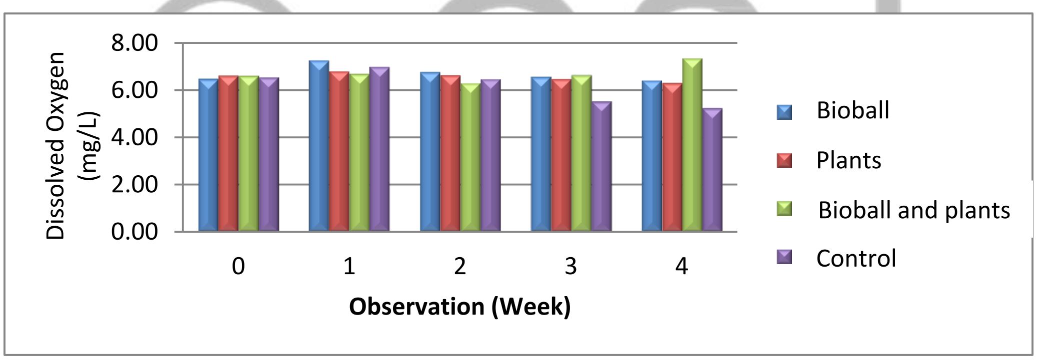

Figure 3. Dissolved Oxygen Fluctuation During The Study

Dissolved Oxygen levels in water in the recirculation system which combines bioball and water spinach plants had higher average values than other treatments. Andriani et al (2018), states that the oxygen is produced by photosynthesis of water spinach and phytoplankton plants during the day.

Decreased dissolved oxygen levels are caused by the use of oxygen by fish, plants, and bacteria. According to Kordi (2005), nitrifying bacteria require a lot of oxygen in the process of nitrification. Therefore, there is a high probability of competition between fish and bacteria to obtain oxygen.

Degree of Acidity (pH)

pH value (Power of Hydrogen) is the value of hydrogen ions (H +) in water. Water with a lot of H+ ions will be acidic, and water with little of H+ ion presents will be alkaline (Alkali). Measurements of water pH indicate a range between 7.47 - 8.57 (Figure 4). The decrease in pH occurs due to water quality degradation caused by residual feed, feces, algal respiration and reduced CO2 in water (Molleda 2007). The nitrification process is a process that produces acid, which affects the pH of the water. According to Le et al (2018), the process of nitrification is a process that produces acid, which affects the pH of water.

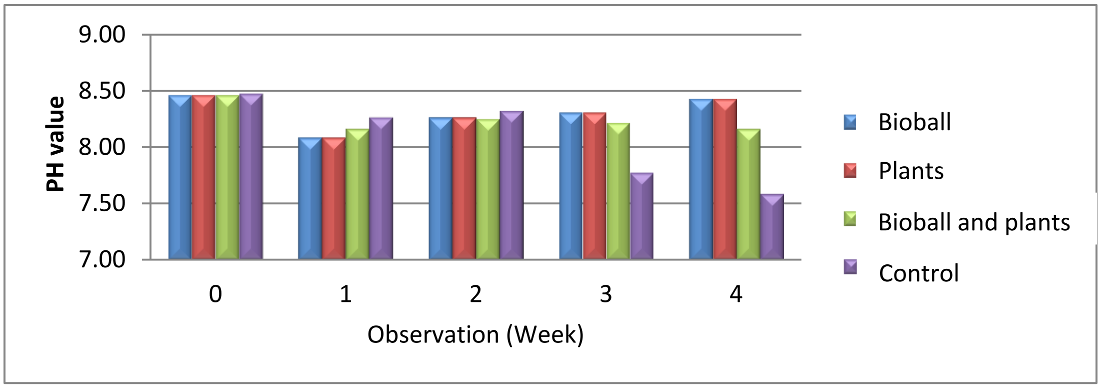

Figure 4. pH fluctuations during the study

Ammonia

Ammonia is the main end product of protein breakdown in fish. Fish can digest protein from feed and excrete ammonia through gills and urine. Ammonia in the aquaculture environment also originates from the process of decomposition of organic matter such as food waste, dead algae, and aquatic plants (Duborrow et al., 1997). The measurement results of ammonia concentrations during the study fluctuated, ranging from 0.0025-0.125 mg / L (Figure 5). Freshwater fish have a tolerance to total ammonia up to 1.0 mg / L (Molleda, 2007).

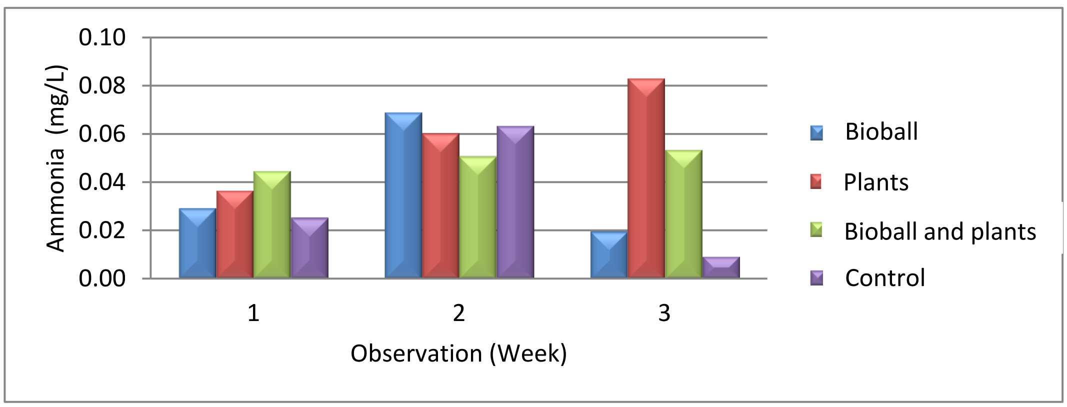

Figure 5. Ammonia Fluctuation Graph in Inlet Tubes

Ammonia concentration fluctuates during the study. This is influenced by the nitrification process that occurs in the cultivation medium. According to Boyd (1982), through the process of nitrification, ammonia will be oxidized by bacteria into nitrites and nitrates. The increase in ammonia concentration over the time of the study is maybe due to increased feeding along with the growth of tilapia fry, and also due to limited absorption of nutrients by water spinach, resulting in increased fish excretion. This is in line with the statement of Effendi (2003), that an increase in feed requirements by fish can cause metabolite emissions to increase and fecal build up occurs.

The increasing size of the fish was in imbalanced with the ability of water spinach roots to absorb nutrients. This was seen in the 4th week, where there was a quite high increase in the concentration of ammonia in treatment A. This happened because the roots of plants were not able to absorb nutrients anymore, and the volume of the roots became denser and clogged the water outlets. The blockage causes the results of fish metabolism and food waste to accumulate inside the pond and plant cultivation media.

Conclusion

Based on the results of the study it can be concluded that the use of water spinach plants as a biological filter media produces the best growth and survival rate of cultivated nile tilapia in aquaponic systems. The highest survival of 100%, absolute growth of 135.2 grams, while the condition of water quality in the range of values that can still be tolerated for fish farming.

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