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Research Article

Effectiveness of Filter Media Compositions on Water Quality, Growth and Survival Rate of Tilapia (*Oreochromis niloticus*) Cultured in Recirculation System

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ABSTRACT

Market demand for tilapia (*Oreochromis niloticus*) is increasing every year. This has encouraged aquaculture companies to apply intensive cultivation systems. However, these applications run the risk of increasing waste and decreasing water quality. One strategy to overcome those problems of water quality is to use recirculation aquaculture system. This study aimed to determine the effectiveness of filter media composition on water quality, survival rate, and tilapia growth. The average body weight of the fish used was 3.84 ± 0.05 g per individual. A completely random experiment design with three treatments and three replications were applied. The treatments were combination of several filter media with different compositions, namely A (Dacron + 75% nets + 25% sand), B (Dacron + 50% nets + 50% sand) and C (Dacron + 25% nets + 75% sand).The water quality variables measured were pH, DO, temperature, ammonia, and VTR (Volumetric TAN Removal). The survival rate (SR), relative growth rate (RGR). and total amount feed fed (TFF) of fish were also measured. The results showed that the composition of the filter had a significant effect *(P<0.05)* between treatment*.* The best VTR was showed in Treatment C with value 54.65 $gm^{-3}d^{-1}$

Keywords: Tilapia, recirculation, dacron, nets, sand

ABSTRAK

Permintaan pasar ikan nila (*Oreochromis niloticus*) *semakin meningkat setiap tahunnya. Hal ini mendorong perusahaan budidaya untuk menerapkan sistem budidaya intensif. Namun, hal ini berisiko meningkatkan limbah dan menurunkan kualitas air. Salah satu strategi untuk mengatasi permasalahan kualitas air tersebut adalah dengan menggunakan sistem akuakultur resirkulasi. Penelitian ini bertujuan untuk mengetahui efektivitas komposisi media filter terhadap kualitas air, kelangsungan hidup, dan pertumbuhan ikan nila. Rata-rata berat badan ikan yang digunakan adalah 3,84 ± 0,05 g/ekor. Riset ini mengaplikasikan desain eksperimen acak lengkap dengan tiga perlakuan dan tiga ulangan. Perlakuan berupa kombinasi beberapa media filter dengan komposisi yang berbeda yaitu A (Dakron + 75% jaring + 25% pasir), B (Dakron + 50% jaring + 50% pasir) dan C (Dakron + 25% jaring + 75% pasir).).Variabel kualitas air yang diukur adalah pH, DO, suhu, amonia, dan VTR (pembuangan TAN volumetrik). Tingkat kelangsungan hidup (SR), tingkat pertumbuhan relatif (RGR) dan total pakan termakan (TFF) dari ikan juga diukur. Hasil penelitian menunjukkan bahwa komposisi filter berpengaruh nyata (P<0,05) antar perlakuan. Nilai VTR terbaik ditunjukkan pada Perlakuan C dengan nilai 54,65 $g.m^{-}3.h^{-1}$*

Kata kunci: tilapia, resirkulasi, dakron, jaring, pasir

1. Introduction

Tilapia (*Oreochromis niloticus*) is one of the most popular freshwater fish cultivated in Indonesia (Tanjung *et al.,* 2019). Indonesian tilapia products increase by up to 14% each year, generating up to IDR 162 million in revenue (Ministry of Marine and Fisheries, 2018). This shows a positive trend towards the development of tilapia aquaculture, especially in areas with high quality freshwater resources. Therefore, this condition encouraged fish farmers to continue to increase production and indirectly forced fish

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farmers to maintain good tilapia production in order to earn more income.

The intensive aquaculture system is a system that produces a large amount of fish over a period of time (Cao *et al.,* 2019; Leal *et al.,* 2018). This intensive aquaculture system increased the density of fish in the pond and responded to the increased yield (Bao *et al.,* 2018). However, the intensive aquaculture system requires high densities and intensive feeding rates.This leads to the accumulation of fecal and leftover fish metabolism (Tanjung *et al.,* 2019). Accumulation produces toxic substances (Chun *et al.,* 2018), and reduces water quality (Suantika *et al.,* 2018). Furthermore, low water quality accelerates pathogen growth (Shefat and Karim, 2018). The rapid growth of pathogens in water is certain to attack fish in terms of growth, health, and viability. One way to overcome the decline in water quality is to reduce toxic substances in the water by implementing a recirculating aquaculture system (RAS) (Harwanto and Jo, 2010; Lebel *et al.,* 2018; Ahmed and Turchini, 2021).

The RAS is a cultivation system that is able to improve water quality by operating a filtration system to treat water that has been used in the cultivation process so that the water can be reused (Ngoc *et al.*, 2016; Hisano *et al.*, 2021; Azevedo *et al.*, 2018). The principle of RAS is to reuse water from cultivation activities so as to save water consumption (Lindholm-Lehto and Vielma, 2019). Processes carried out at RAS can also help reduce pollutant content through aquaculture wastewater treatment with installed filters (Bhargava, 2018).

The filters in RAS are mechanical, biological, and chemical filters. Some examples of materials used as filter media include dacron, sand, bio-balls, zeolite stones and activated carbon. The expected result is to be able to treat water after production of aquaculture activities to support fish growth (Lepine *et al.,* 2018). A good filter media is a material that can absorb ammonia and waste from fish metabolism, does not decompose, and does not clog the water flow (Majdi *et al.*, 2019). Filter is the main component used in RAS because it is a means to reduce the ammonia content of water. Ammonia in tilapia aquaculture comes from the fish itself, 80-90% mainly comes from fish osmoregulation processes, and 10-20% from tilapia feces and urine (Setijaningsih and Suryaningrum, 2015).

Lindholm-Lehto *et al.* (2021) proved that sand is the best material for filtering waste with RAS and has achieved 98% of nitrate removal. This condition occurs due to sand is one of the most effective and efficient biological filter medium both in freshwater (Harwanto *et al.,* 2011a) or seawater recirculating aquaculture system (Harwanto *et al.,* 2011b). Dacron can also act as a filter and aggregator for large particles in wastewater (Muhtaliefa *et al.*, 2019), nets also have the potential to filter wastewater through their porosity (Razavi *et al.*, 2018). However, research on the function of nets as filter media has not been studied much.

The combination of filters used in the RAS able to filter waste in aquaculture water, affecting water quality, saving water consumption and potentially attracting bacteria nitrification (Yanti *et al.,* 2018; Muhtaliefa *et al.*, 2019; Oktavia *et al.*, 2021). These bacteria help maintain water quality by performing a nutrient cycle and breaking down organic matter in the water (Hassan *et al.,* 2018; Azevedo *et al.,* 2018). The purposes of this study were to investigate the effectiveness of the filter media composition on water quality, survival and growth of tilapia (*O. niloticus*) culture in the recirculation system.

2. Materials and Methods

2.1. System Design

The test fish used was tilapia seeds with an average body weight of 3.84 ± 0.05 g per fish. The density of fish was 6.07 g L^{-1}, that is equivalent to 2 fish per liter (Cao, *et al.,* 2019). The feed used was an artificial feed with a protein content of approximately 30%, given at satiation (Obirikorang *et al.,* 2019). The frequency of feeding three times a day i. e. 8:00, 13:00, and 18:00.

The container used in this study was an aquarium measuring LxWxH= 35 x 30 x 25 cm which was filled with water up to 75% or 19L and placed on a multilevel shelf. There were 9 aquariums used for 3 treatments and 3 repetitions. Each aquarium is filled with 30 fish and is equipped with a pump that is used to pump water and to supply oxygen during maintenance. A filter container with a capacity of 10 L is placed on the aquarium shelf filled with filter media then filled with 7 L of water. In this study, a recirculation system was used by placing the filter media separately from the fish rearing container.

The method used in this study was an experiment with a completely randomized design. Three different filter media compositions as treatments were applied. Each treatment has three replicates. Treatment A consisted of Dacron (1 sheet), 75% net, and 25% sand. Treatment B consisted of Dacron (1 sheet), 50% net and 50% sand. Treatment C consisted of Dacron (1 sheet), 25% net, 75% sand. The design of the water circulation system is shown in Figure 1. The water that has been used for the cultivation process is pumped from the aquarium to a filter container containing filter media. The placement of the filter media from the bottom up is sand, nets and dacron. Thus, Dacron is able to pre-filter impurities and waste from the culture water.The RAS system is operated for several days before the fish seeds are added to the aquarium. The research was conducted for 30 days.

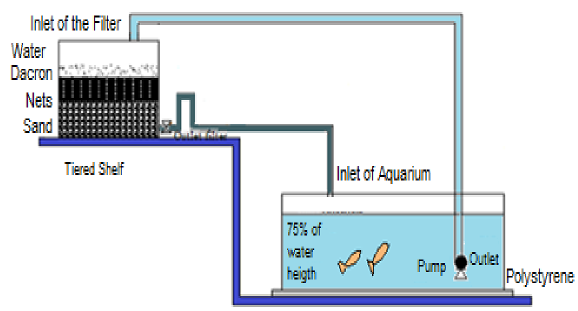

Figure 1. System Design of RAS

2.2. Water quality

Water quality was measured daily during the study using alcohol thermometers for temperature, Water Quality Control for dissolved oxygen (DO) and pH papers for pH. The ammonia concentration was measured by spectrophotometer on day 10th, 20th, and 30th from outlet aquarium and outlet filter.

The TAN percentage was calculated at the end of the study. The calculation based on the formula used by previous studies (Oktaviola *et al.*, 2021; Pierrenia *et al.*, 2021) as follows:

$$\text{Percentage of TAN} = \left(\frac{\text{TAN Inlet} - \text{TAN Outlet}}{\text{TAN Inlet}}\right) \times 100\%$$

where:

TAN Inlet = TAN from inlet or water that enter to filter media (mg L^{-1})
TAN Outlet = TAN from outlet or water that out from filter media (mg L^{-1})

The VTR is calculated every 10 days using the formula used in previous studies (Pfeiffer and Paul, 2011; Harwanto *et al*, 2011a,b), as follows:

$$VTR = \frac{K_c \times TAN_{in} - TAN_{out} \times Q}{V_{media}}$$

where:

VTR = volumetric total ammonia nitrogen removal (g m^{-3} d^{-1})
Kc = conversion factor; 1.44
TAN_{in} = concentration of total ammonia inlet (mg L^{-1})
TAN_{out} = concentration of total ammonia outlet (mg L^{-1})
Q = water flow rate (m^3 d^{-1})
V = volume of filter media (m^3)

2.3. The Survival Rate (SR)

Survival rate measured using the formula by Zonneveld *et al.* (1991), as follows:

$$SR = \frac{Nt}{No} \times 100$$

where:

SR = survival rate (%)
N_t = number of fish at the end of the study (individual)
N_o = number of fish at the beginning of the study (individual)

2.4. The Total Amount Feed Fed (TFF)

The total amount feed fed is obtained from the total amount of feed consumed by fish minus the amount of remaining feed not consumed by fish, calculated from the total amount of feed provided during maintenance (Dauda *et al.*, 2018).

2.5. The Relative Growth Rate (RGR)

The relative growth rate is calculated by the formula used in the study of Ferosekhan *et al.* (2019) as follows:

RGR = (Wt-W0)/(W0 x t) x 100%

where:

RGR = relative growth rate (% day^{-1})
Wt = fish weight at the end of the study (g)
Wo = fish weight at the initial of the study (g)
t = duration of study (day)

2.6. Data analysis

Water quality data pH, DO, temperature, and ammonia were analyzed descriptively. The data analyzed statistically were the percentage of TAN, VTR, SR, TFF, and RGR. The ANOVA was used to analyze the data to determine the impact of the treatments tested on growth and survival. Prior to data analysis, the varieties were first tested for normality, homogeneity and additivity. If the results of the three tests showed that the data was successfully, evenly, and effectively distributed, we performed a variety of analyses. If there was a real difference, the Duncan Double Face Test was applied to find the difference in treatment averages for the best treatment results

3. Results

3.1. Water Quality

The results of water quality measurements during research activities can be seen in Table 1. The temperatures of all treatments showed the same range, namely 24-27°C. Relatively high pH values were found in treatment A. The DO values with the highest range were found in Treatment C (3.6-9.6 mgL^{-1}). The lowest ammonia concentration was found in treatment C (0.002 mgL-1) while the highest was in Treatment A (0.229 mgL^{-1}).

In Figure 2, it can be seen that the value of ammonia inlet filter (aquarium outlet) from all treatments were decreased over time as the study progressed. The ammonia values obtained from the 10th, 20th and 30th days showed that treatment C was the lowest, namely 0.075; 0.062 and 0.057 mgL^{-1}, respectively, while the highest was treatment A, namely 0.0229; 0.221; and 0.219 mgL^{-1} respectively.

Likewise for the ammonia value at the filter outlet (Figure 3), where Treatment C had the lowest ammonia value (0.031; 0.016; and 0.002 mgL^{-1}) and Treatment A had the highest (0.217; 0.203; and 0.187 mgL^{-1}).

3.2. The Filter Effectiveness

The result of the calculation of the percentage of TAN will indicate how much ammonia can be oxidized during the study. Until the end of the study, the highest value of ammonia removal was shown by treatment C which was 96.49%, while the lowest was in treatment A which was 11.79%. These results are presented in Figure 4.

3.3. The Volumetric TAN Removal (VTR)

Treatment C showed the highest VTR values, namely 43.82; 45.71; and 54.65 g.m^{-3}.d^{-1} on days 10, 20, and 30, respectively. While treatment A showed the lowest VTR value, namely 12.02; 17.88; and 24.85 g.m^{-3}.d^{-1}, respectively. Complete VTR data shows in Figure 5.

3.4. Survival Rate (SR)

The survival rate values of *O. niloticus* during observation are presented in Figure 6. The

Table 1. Water Quality Measurement Results (A: dacron + 75% net + 25% sand; B: dacron + 50% net + 50% sand; C: dacron + 25% net + 75% sand).

Parameter	Treatment of Filter Media Composition		
	A	B	C
Temperature (°C)			
08.00	24-27	24-27	24-27
16.00	26-28	26-28	26-28
pH	7-8	7	7
DO (mg L^{-1})	3.6-5.6	4.4-7.8	3.6-9.6
Ammonia (mg L^{-1})	0.187-0.229	0.066-0.120	0.002-0.075

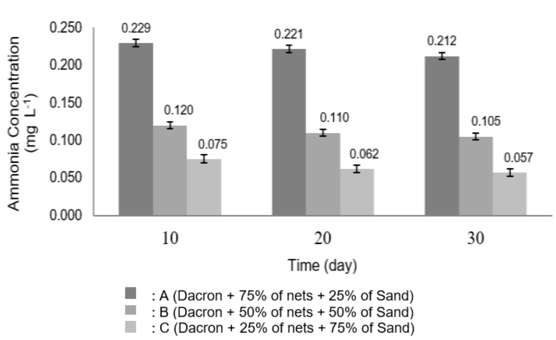

Figure 2. Amount of Ammonia Concentration in the Inlet Filter

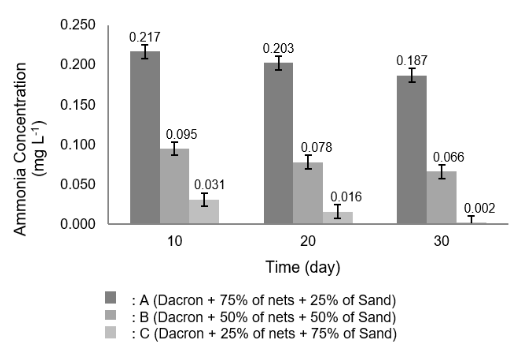

Figure 3. Amount of Ammonia Concentration in the Outlet Filter

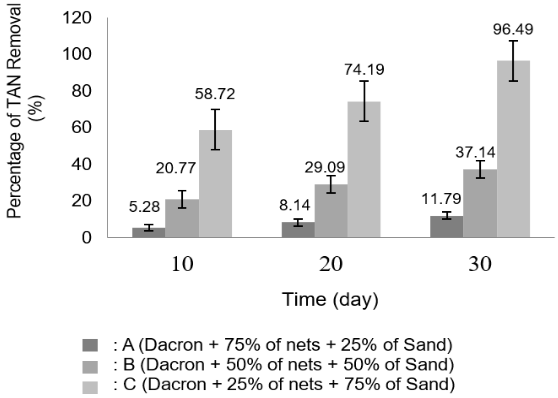

Figure 4. Percentage of TAN removal in RAS of *O. niloticus*

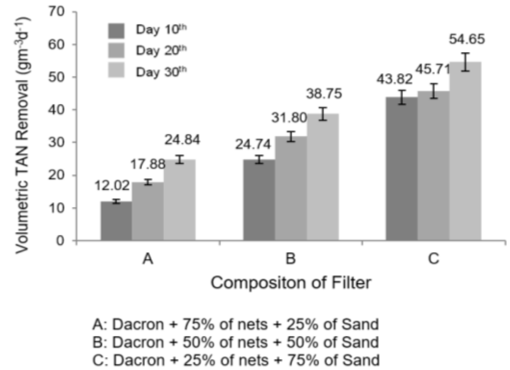

Figure 5. Values of VTR in RAS of *O. niloticus*

highest survival rate showed in treatment B (94.44%) and C (96.67%), while in treatment A showed the lowest (85.56%).

3.5. The Total Amount Feed Fed (TFF)

The total amount feed fed (TFF) obtained during study is presented on Figure 7. The highest TFF was found in treatment C (206.38 g), while the lowest was in Treatment A (198.60 g) and B (201.85 g).

3.6. Relative Growth Rate (RGR)

The RGR of all treatment is presented in Figure 8. Treatment C showed the highest value, i.e. 3.27%.d^{-1}, while treatment A showed the lowest, i.e. 2.74 %.d^{-1}.

4. Discussion

4.1. Water Quality

Maintaining water quality is very important in aquaculture circulation systems. This is due to water quality is directly related to the stability of the aquaculture system. When stability is compromised, the cultivation system is also disturbed. There are two factors directly related to water quality in the stability of aquaculture systems, namely the ability of the system to cope with fluctuations in water quality conditions and the rate of the system to improve as water quality deteriorates. Water quality must be maintained as it is one of the factors affecting tilapia growth and survival (Trang *et al.,* 2017) and a limiting factor for aquaculture (Laghari *et al.,* 2018).

According to this study, the temperature of the water in the tank was in the range of 24-28°C. These results showed the feasibility of water temperature parameters for tilapia to grow optimally. Based on Indonesian National Standard (SNI 7471, 1999), the ideal temperature for *O. niloticus* is in the range of 27-32°C. This result is similar from the study of Tanjung *et al.* (2019) which reported that temperature value of 24.4-25.1°C was suitable to the breeding of tilapia in recirculation system with filter media composition of cotton, bio-balls and charcoal. Temperature has a significant effect on tilapia metabolic processes, such as the respiration

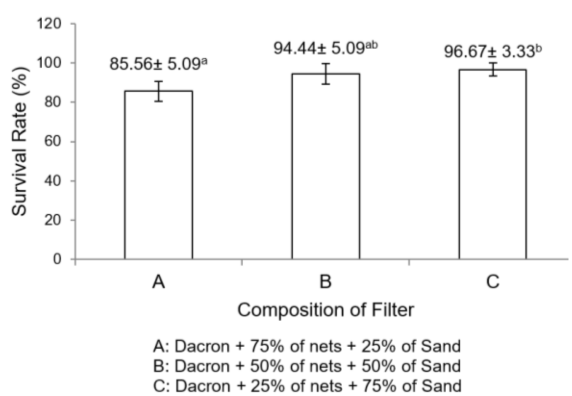

Figure 6. Survival Rate of *O. niloticus*

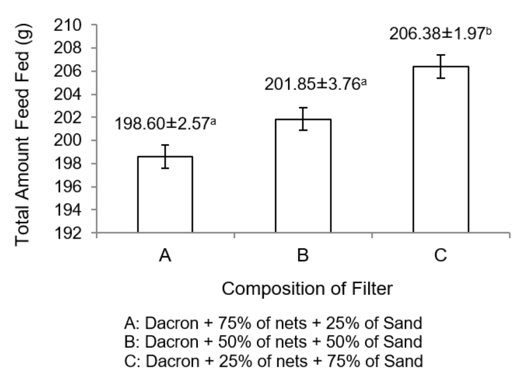

Figure 7. The Total Amount Feed Fed of *O. niloticus*

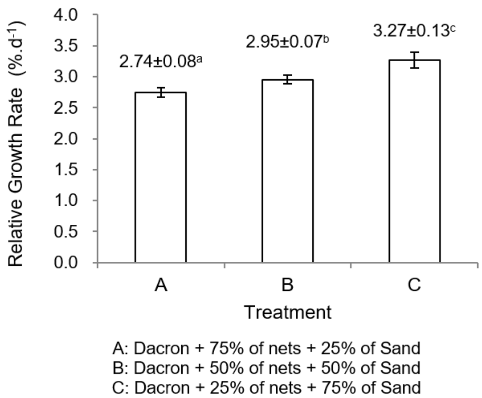

Figure 8. Relative Growth Rate of *O. niloticus*

process of fish. When the temperature drops, the metabolic rate and oxygen demand will also decrease.Additionally, changes in water temperature itself can be influenced by several factors such as time, weather, water depth, and water flow (Alfonso *et al.,* 2020). Temperature can affect the physical and chemical properties of water and accelerate the biochemical process of fish (Li and Convertino, 2021). Temperatures below 14°C and above 38°C can impede tilapia growth and even lead to death (Tanjung *et al.,* 2019).

In present study, the highest DO was in Treatment C (3.6-9.6 mg L^{-1}), following by Treatment B (4.4-7.8 mg L^{-1}), and the lowest was in Treatment A (3.6-5.6 mg L^{-1}). Eventhough the best DO was in treatment C with a composition of Dacron filter media + 25% net + 75% sand, but those values are also suitable for tilapia cultivation since all of those are above 3.0 mg/L (SNI 01-6141, 1999) The DO for this study was also in line with study of Tanjung *et al.* (2019), that achieving DO values in the range of 4.8-7.4 mg L^{-1}. The composition of the filter medium allows the water medium to be filtered well, allowing proper filtration of unwanted organic particles such as feces and remaining feed to reduce turbidity (Mahmud *et al.,* 2016). The DO is the most important water quality parameter and a limiting factor for controlling fish growth and survival (Laghari *et al.,* 2018). If the DO value is less optimum, this leads to a loss of appetite in the fish.

The pH value ranges from 7-8 in this research. Those values are in accordance with Indonesian National Standard which states that the pH tolerance value for tilapia cultivation is 6.5-9.0 (SNI 01-6141, 1999). If the pH value is outside this range, it will have an impact on decreasing fish reproduction. Tanjung *et al.* (2019) reported that the best pH for tilapia was 7.0-7.4. The pH values for each treatment in this study were also suitable for the nitrification process (Trang *et al.*, 2017; Babatunde *et al.*, 2019). Wambua *et al.* (2018) stated that the pH value of water is directly proportional to the temperature and the toxicity level of ammonia in the water. Therefore, if the pH value is high, the toxicity ammonia will increase sharply, and this increase can cause the water to become toxic (Suryadi *et al.*, 2019). Additionally, they explained that the pH value was stimulated by the stocking density of fish in one rearing container, the value of carbon dioxide, temperature and alkalinity.

The ammonia concentration in treatment A, with filter media composition of dacron + 75% net + 25% sand, confirmed the highest, namely 0.187-0.229 mg NH_3 L^{-1}. Following by those in treatment B, with ranged of 0.066-0.120 mg NH_3 L^{-1}. The lowest ammonia concentration was in C (dacron + 25% net + 75% sand), with the range of 0.002-0.075 mg NH_3 L^{-1}. In the study of Mota *et al.* (2015), the concentration of ammonia in aquaculture recirculation system ranged from 0.001-0.002 mg NH_3 L^{-1}. Then the research of Trang *et al.* (2017) confirmed that the ammonia concentration of 0.71 mg NH_3 L^{-1} can cause death in tilapia, and can harm the tissues in the fish body. Ammonia in the water is acquired from the metabolism of fish and the end result of mineralization of natural nitrogen from different natural materials, fish feces, and uneaten feed (Engler *et al.,* 2018).

4.2. The Filter Effectiveness

The effectiveness of ammonia removal in the treatment C (dacron + 25% net+75% sand) was the highest, compared to others two treatments. The results was 58.72-96.49% of ammonia concentration that filtered. In treatment C, the composition of sand is higher than composition of the nets and the dacron. This condition affects the effectiveness of the filter media, as the composition of the filter media can reduce the chemical composition of the waste (Majdi *et al.,* 2019). Since sand has the property of being less saturated, it has the best absorption. In that case, sand has a larger SSA (specific surface area) than the nets. The range of SSA promotes bacterial growth (Ridha and Cruz, 2001). Sand with a relatively very high SSA allows nitrifying bacteria to stick to and grow more (Harwanto *et al,* 2011a,b; Pierrenia *et al*, 2021). Sand can also serve as a dual role as a chemical and biological filter. Sand as a chemical filter can absorb ions and reduce the total amount of ammonia, nitrite and nitrate. Then the sand provides a place for bacteria to act as a biological filter and acts as a biofilter.

Treatment A with a composition of Dacron + 75% nets + 25% sand showed inadequate results due to the composition of this filter medium. During the study, the ammonia concentration could only be reduced by 5.28-11.79%. In treatment B, the percentage of TAN obtained was in the range of 20.77-37.14% of ammonia concentration, that decreased during the study. This is probably due to the configuration of the nets larger than the sand. The net filters large debris such as tilapia feces and leftover food. Sand, on the other hand, can filter waste with smaller particle sizes. If there is more nets than sand, excess debris can build up in the nets, creating gaps in the filtering system. Sand is expected to be less effective than nets in decomposing small amounts of toxic substances in the water. These conditions can put a double burden on the sand treatment system through the sand, that requires the sand to break down toxic substances and filter the waste produced by the nets.

The calculation of the TAN percentage in this study was 5.28-96.49% higher than the calculated TAN percentage in Savin *et al.* (2012) that gained value ranging from 2.7-55.45%. In their study, the average body of rearing tilapia was 8 g per individual, and the filtration was from bioballs, foam and charcoal. A study by Al-Hafedh and Alam (2007) utilized different types of filters. The result of TAN percentage when breeding tilapia utilized the biofilter in the form of a piece of PVC pipe was 21.05-31.45%. When using a rotary biological external filter, the TAN percentage was 74-82%, and when using a sand bed filter, the TAN percentage was 8-32%. These differences in TAN percentage results due to the applied filter and the difference in pH and temperature values that affect the TAN percentage. The TAN is one of the key values for water quality parameters. TAN is composed of two compounds, non-ionized ammonia (NH_3) and ionized ammonia (NH^{4+}) (Tanjung *et al.,* 2019). The two ammonia types (NH_3^- and NH_4^+) always have a balanced TAN content in the water (Zeitoun *et al.,* 2016). Unionized ammonia is a source of toxic in aquaculture water. The upper limit of TAN concentration in water is 1 mg L^{-1} (Al-Hafedh and Alam, 2007; Harwanto *et al.*, 2011a, b) with pH 7.

4.3. The Volumetric TAN Removal

The VTR results are directly proportional to the effectiveness of the filter media. Filter media are effective when they are in good condition, for instance not easily damaged, not brittle, and has no potential to clog. Filter media needs to be adapted to the system. A RAS system is ready for use if the filter can function stably. However, this filter media has a lifespan and may need to be repaired or replaced. Conditions of filter media that are not good can reduce the effectiveness of the filter. The stability of the reduced ammonia from the filter media can also be affected by water temperature, ammonia loading rate, and suspended solids (Harwanto and Jo, 2010). The concentration of ammonia in the water itself can be affected by the outflow or flow of water in the water body. This overflow water helps the movement of water through the filter where filtration or nitrification processes occur and has a low concentration of ammonia (Wambua *et al.,* 2018).

The VTR results obtained in this study range from 12.02-54.65 $g.m^{-3}.d^{-1}$. This range is much lower then VTR results in study of Savin *et al.* (2012) i.e. 4-3.865 $g.m^{-3}.d^{-1}$ with a median value of 1.353 $g.m^{-3}.d^{-1}$. They used a recirculation system with three types of filters, namely a biological filter in the form of a bio-balls, a mechanical filter in the form of bubbles, and a chemical filter in the form of charcoal.

4.4. The Survival Rate (SR)

The SR of tilapia from the highest was 96.67±3.33% in treatment C, 94.44±5.09% in treatment B, and 85.56±5.09% in treatment A. These results are good based on Indonesian National Standard (SNI 01-6141, 1999) due to tilapia has a good SR of over 80%. Fish survival is affected by abiotic and biological factors. Abiotic factors are food and water quality such as temperature, pH, dissolved oxygen, and ammonia, while biological factors are parasites the population density of fish, age and the ability of fish to adapt to the environment (Shofura *et al.,* 2018; Huda *et al.,* 2018; Dragomir *et al.,* 2020),

The SR in treatment C had the highest result. This result was probably due to treatment C had better environmental conditions for cultivation, in terms of ammonia concentration. The concentration of ammonia in treatment C was at the lowest level, with a range of 0.002-0.075 mg L^{-1}, so that it made the fish comfortable and had a good appetite (Suminto *et al.,* 2019). The low concentration of ammonia in treatment C probably because the filter used works optimally and the composition is more effective than the composition in other treatments.

The SR in this study is higher than the research by Andriani *et al.,* (2019) that obtained a SR during the study was 88.89 ± 14.7% utilizing a recirculation system with a bio-balls filter on tilapia fry. The SR result in the research by Cao *et al.* (2019), was 96.90±2.23%, with an average ammonia value of 1.56±0.76 mg L^{-1} and the composition of the filter media used consisted of a biological filters and a mechanical filter.

Based on the results of the SR, it was possible to show that the difference in the composition of the filter media had a significant effect (*P <0.05*). It is suspected that the composition of the various filter media affects the end result of water quality conditions. Fish survival is one of the aquaculture parameters affected by external water quality conditions (Huicab-Pech *et al.,* 2017). This external factor affected by water quality. The best water quality value gained when the composition of the sand is higher then nets and dacron. This condition occur due to the sand has a dualfunctions, as a biological filter and a mechanical filter and the sand easily adapts to the shape of the filter container used (Kapgate *et al.,* 2018).

4.5. The Total Amount Feed Fed (TFF)

The TFF obtained in all treatments showed significant results. The best TFF were found in Treatment C with a value of 206.38±1.97 g, followed by TFF in treatment B, i.e. 201.85±3.76 g. Treatment C had the lowest TFF, that was 198.60±2.57 g. The difference in TFF value for each treatment is believed due to the fact that the water quality conditions are not the same, such as temperature, ammonia and DO.

Different composition of filter media are impacted to the water quality condition that the most important elements of TFF. With optimal water qualty, fish can optimally swim, find food, and breed (Yustiati *et al.,* 2018). The better the quality of the cultivated water, the less energy is used to survive and the more energy is used to grow. Hence, the composition of the filter media has great influence on TFF.

Treatment C showed better water quality conditions than the other two treatments. The pH, water temperature, and DO conditions are within the suitable range for tilapia aquaculture activities according to SNI 01-6141 (1999). Good water quality maintains the stability tilapia's metabolism. Then, due to the tilapia metabolism is functioning well, fish can better process the feed consumed (Pulido-Rodriguez *et al.,* 2021).

The TTF value is also influenced by the appetite and behavior of the fish. If the fish are actively moving while feeding, more food will be consumed. This is related to the process of feeding fish which begins with a response to the feed stimulus given and then catches the feed (Noviana *et al.*, 2014). Fish that were actively moving during the study were caused by good environmental conditions.

4.6. Relative Growth Rate (RGR)

The relative growth rate is a value that determines daily fish growth. Growth can occur when specific energy is obtained from the feed (Selpiana *et al.,* 2013). Fish growth is influenced by internal and external factors. Internal factors are factors related to the fish itself, such as genetics or heredity (Ariyanto *et al.,* 2016), age (Pratiwi, 2019), sex type (male or female) (Dediu *et al.,* 2021), fish's ability to digest the feed (Wan-Mohtar *et al.*, 2020) and disease resistance (Wang *et al.,* 2020). The external factors are those that are influenced by the environment in which the fish live and the feed they consume (Diansyah *et al.,* 2018). The TFF plays an important role in fish growth. In particular, the protein in feed, which plays as a source of energy for fish life (Umasugi *et al.,* 2018).

Present study shown that the difference in the composition of the filter media during tilapia cultivation had a significant effect (*P <0.05*). The highest RGR values of tilapia was observed in treatment C (3.27±0.13%.d^{-1}), following treatment B (2.95±0.07%.d^{-1}) and treatment A (2.74±0.08%.d^{-1}). The value of the RGR of tilapia treated with filter media composition of dacron + 25% net + 75% sand showed significant results compared to other filter media compositions. This is probably due to the good water quality. One of the parameters that indicates good water quality condition is the ammonia concentration of the water and this ammonia condition affected pH, temperature (An and Jin, 2021), DO (Effendi, *et.al.,* 2020) and finally fish growth (Sarkheil *et al.,* 2021). The application of different filter media compositions in RAS has been shown to contribute to varying water quality values (Yanti *et al.,* 2018; Muhtaliefa *et al.*, 2019; Oktavia *et al.*, 2021).

The results of the growth rate obtained in this study were higher than RGR in the study by Seemann *et al.* (2019) that the RGR result was 1.22% per day. However, the results of this relative growth rate were lower than the study by Hisano *et al.* (2019) that obtained a growth rate value was 3.33±0.08% per day in rearing tilapia with a recirculation system using an air-lift biofilter.

5. Conclusions

The composition of the filter media in the maintenance of tilapia fish with a recirculation system has a significant effect on consumption rate and relative growth rate but has no significant effect on survival rate. The best filter media composition was showed by treatment C, with RGR value was 3.27±0.13% per day; total amount feed fed was 206.38±1.97 g; and the SR value of 96.67± 3.33%, also the VTR in the final week was 54.65 g $m^{-3}day^{-1}$. Media filter composition with a higher sand ratio is proven to be able to give the best results. This is probably in accordance with the character of sand which has a high SSA so that it provides more space for nitrifying bacteria to grow. The composition of the Dacron + 25% net + 75% sand can be recommended as a good filter media composition in tilapia cultured with recirculation system.

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