

# Medium and filter from activated carbon in aquaponics system (*Oryza sativa* and *Oreochromis niloticus*) to improve water quality

Fara Nadilla<sup>1</sup>, Nurul Wahyuni<sup>1</sup>, Sandri Maulizar<sup>1</sup>, Fitriani<sup>1,\*</sup>, Yulida Amri<sup>2</sup>

<sup>1</sup>Department of Biology, Fakultas of Engineering, Samudra University, Kampus Unsam Meurandeh, Langsa 24415 Indonesia

<sup>2</sup>Department of Chemistry, Fakultas of Engineering, Samudra University, Kampus Unsam Meurandeh, Langsa 24415 Indonesia

\*fitriani@unsam.ac.id

**Abstract.** In this study aquaponics system (*Oryza sativa* and *Oreochromis niloticus*) from activated carbon has been carried out. Activated carbon acts as absorbent, catalyst and filters in water purification, and is able to absorb anions, cations, and molecules of organic and inorganic compounds in the form of solution or gas. The purpose of this study was to determine the effect of activated carbon thickness from organic waste on decreasing the toxicity of water in the aquaponics system. Water quality parameters such as temperature, dissolved oxygen (DO), pH and ammonia content were measured at 20, 40 and 60 days after maintenance. The variation of treatments are P0 (as control), P1=1,5 cm activated carbon, P2=3 cm activated carbon, P3 = 4.5 cm activated carbon and P4=6 cm activated carbon. Based on the results of the study found that the use of activated carbon as medium and filter in an aquaponics system (rice-fish) can maintain water quality for 60 days of maintenance. The optimum water quality for the growth of fish and rice was in treatment P3 (4.5 cm thickness of activated carbon) and P4 (6 cm thickness of activated carbon). The thicker the activated carbon used, the more optimal the water quality.

## 1. Introduction

Rice is a functional food crop that needs continue to increase along with the increase of population each year [1]. However, lately rice productivity has decreased due to the conversion of agricultural land into residential areas which has an effect on food productivity [2]. In addition, the tightness of agricultural land and land dispute issues are also a considerable problem in developing food production so that in 2030 Indonesia is predicted to experience a food crisis. Therefore, to overcome this problem an alternative effort is needed, namely by using an aquaponics system [3].

Aquaponics is a sustainable farming system that combines aquaculture and hydroponics in a symbiotic environment. Aquaponics technology can optimize the use of agricultural land so that it can increase crop productivity [4]. In aquaculture, generally the results of fish and feed excretion will accumulate in water so that it can increase water toxicity. However, in the aquaponics system the remainder of the feed and the results of fish excretion will be used as fertilizer for plants (zero waste) [5]. The results of fish extraction accumulated in water will be filtered using activated carbon from organic waste so reduce the level of toxicity of water that can be reused for the survival of fish [6].

Activated carbon is a carbon that is able to absorb anions, cations, and molecules of organic and inorganic compounds in the form of solutions or gases [7]. In addition, activated carbon can also be used as an absorbent, catalyst and filter in water purification and can eliminate the color and smell of water [8]. The advantages of activated carbon as a planting medium are that it has good absorption capacity for anions, cations, and molecules in the form of organic and inorganic compounds, both in solution and gas. In addition, activated carbon can also absorb pesticide residues in water and soil, and increase soil fertility and prevent the occurrence of root decay caused by microorganisms [9]. The active carbon used comes from organic waste, because remembering the problem of organic waste to date is still an unsolved problem in most cities in Indonesia. Only a small amount of organic waste can be processed into compost and the rest is burned with an incinerator so that causing air pollution. Therefore, to reduce air pollution, solid organic waste can be converted into activated carbon by activating it so that it can be used as a medium for rice plants and water filters for the survival of tilapia.

## 2. Material and Methods

### 2.1 Material

The main material was rice local varieties Aceh from Meulaboh, Aceh, Indonesia. All chemical used for study were analytical grade and obtained from C.V Multikreasi Medan.

### 2.2 Methode

#### 2.2.1 Making Active Carbon from Organic Waste

100 grams of organic waste that has been prepared and put into 250 mL of 0.1 N  $\text{ZnCl}_2$  solutions stirred and left to stand for 24 hours at room temperature. Carbon from organic waste was filtered and washed with water until neutral. The produced carbon dried at 100 °C for 1 hour. Then the activated carbon was heated in the oven for removing water and stored in a closed container. After that the activated carbon is ready for use [10].

#### 2.2.2. Preparation of Aquaponic Medium

Aquaponics was designed using tidal system by placing the plant container on top of the fish pond. Container biofilter equipped with activated carbon from organic waste with varying thickness according to treatment. Furthermore, the ends of the pipe that are in the pool is connected with a pump to suck the water up to the plant maintenance container. Water was flowed by the principle of recirculation, so that waste water from the process of fish cultivation went into the maintenance container of rice plants and was reused as a source of water in the fish cultivation process [5].

#### 2.2.3 Transfer of Rice Seed to Aquaponics Medium

Seed seeding was done by using a seeding box with the ground first smoothed, then the seeds were spread evenly on the prepared nursery box. After 7 days the rice seedlings were transferred from the seedling media to the prepared aquaponics medium. For aquaponics medium with a size of 50 x 50 cm, 25 rice seedlings were planted.

#### 2.2.4 Transfer of Tilapia to Aquaponics Medium

The Fish used was tilapia with a weight of 10-15 grams / head with a density of 50 tails / m<sup>2</sup>. The tilapia was adapted for 2 weeks before being integrated with plants. The tilapia fish used came from fish seed hatchery located in Kuala Langsa Aceh, Indonesia.

#### 2.2.5 Plant and Fish Maintenance

The maintenance period for fish and rice lasted 90 days, so that in one cycle of fish maintenance was obtained one cycle of rice maintenance. Fish feeding was done twice a day. The feed given was in the form of pellets with a protein content of around 30%. There was no special treatment during the maintenance of rice plants, only routine monitoring was carried out so that rice plants avoid pests and predators.

#### 2.2.6 Treatments

Five (5) variations of treatment were applied in this study. The variation of treatments were P0 (as control), P1=1,5 cm activated carbon , P2=3 cm activated carbon, P3=4.5 cm activated carbon and P4=6 cm activated carbon.

#### 2.2.7 Observation

Water quality such as temperature, dissolved oxygen (DO), and pH was measured using Water Quality Checker. Ammonia Test Kit was used for measuring ammonia content[11].

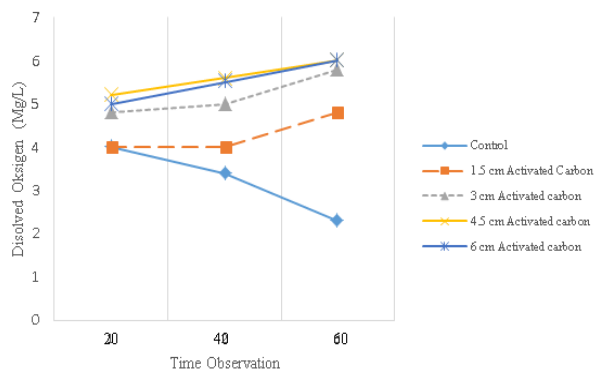
### 3. Result and Discussions

The water quality parameters values for tilapia maintenance with an aquaponics system using activated carbon filters for 60 days of maintenance are shown in table 4 below:

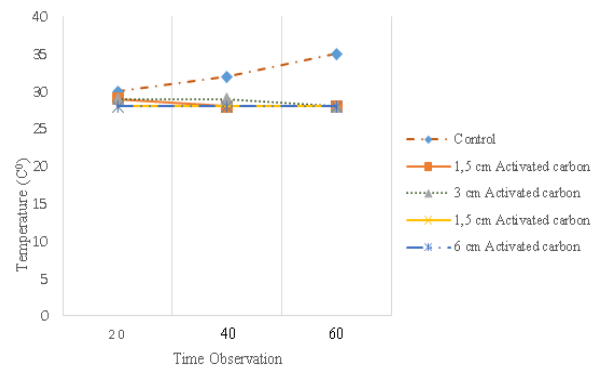
**Table 1.**The Average Values of Water Quality Parameters

Parameters	Unit	Treatments					Maximum content based on literature	
		P0	P1	P2	P3	P4		
1 DO	Mg/L	3,8	4,3	4,8	5,6	5,6	≥4 Mg/L	Badan Standarisasi Nasional (2009)
2 Temperature	C <sup>0</sup>	32,3	28,3	28,7	28	28	25-32C <sup>0</sup>	
3 pH	pH	5,7	6,5	6,8	7,1	7.0	6,5-8,5	
4 Ammonia	ppm	1,5	0.7	0.6	0.6	0,5	< 1 ppm	

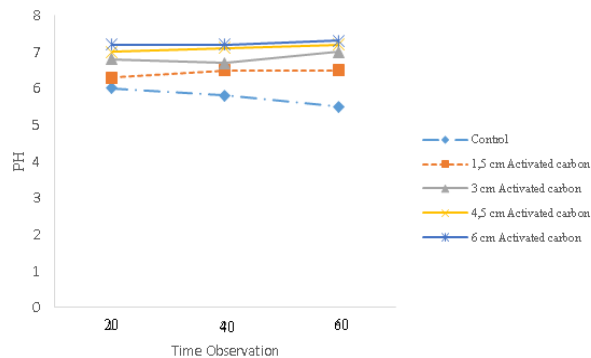
The results of the measurement indicated that the water quality parameters during maintenance tended to be in a condition suitable for the growth of tilapia. Measured water quality parameters at age 20, 40 and 60 days can be seen in Figures 1, 2, 3, 4 below:



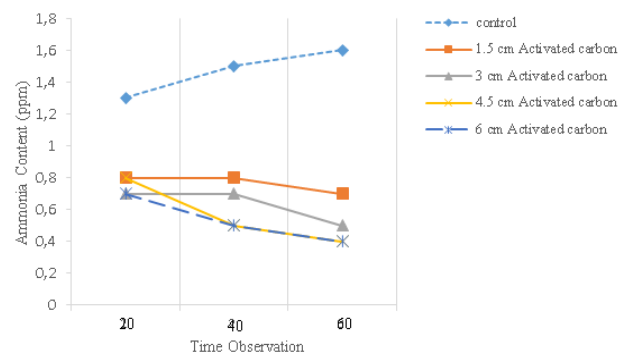
**Figure 1.** Dynamics of dissolved oxygen at 20, 40, and 60 of tilapia maintenance



**Figure 2.** Dynamics of temperature at 20, 40, and 60 of tilapia maintenance



**Figure 3.** Dynamics of pH at 20, 40, and 60 of tilapia maintenance



**Figure 4.** Dynamics of ammonia content at 20, 40, and 60 of tilapia maintenance

The figures showed that the treatment P1, P2, P3 and P4 tended to be in the optimal range for growth of tilapia compared to controls in aquaponics system using activated carbon filters. It caused by activated carbon that has extensive pores on its surface so that it functions effectively in the process of absorption of compounds that cause turbidity (suspended organic matter and small particles). Activated carbon consists mainly of free carbon which has good absorption capacity so that it could maintain the water quality.

Figure 1 showed that the dissolved oxygen content continues to increase in treatments P1, P2, P3 and P4 compared to controls. This is caused by the fact that activated carbon acts as a filter that can increase the diffusion of oxygen so that it can increase the oxygen content dissolved in water. In this case, recirculation using bio-filter as its substrate can function as a place for diffusion of oxygen and water. It also has space or pores that can increase oxygen in water with DO levels obtained that is 6.5- 8.5 mg. L-1 [12]. Besides that it is also influenced by temperature, the lower the temperature (Figure 2), the oxygen consumption by tilapia decreases, so that the dissolved oxygen level in the water increases.

Figure 2 showed that the use of activated carbon as a filter medium for water quality in the aquaponics system caused the water temperature to be in the optimal range for the growth of tilapia, 28-30 °C. This resulted in increasing the fish feeding activities so that the growth of tilapia was faster. The National Standardization Agency (2009) said that the optimal temperature conditions for tilapia growth were in the range of 25-32 °C.

Figure 3 showed that the pH of water in treatments P3 and P4 tended to not fluctuate. But in treatment P0 (control) the pH of water has decreased during tilapia maintenance. Decreasing water pH levels was influenced by the ammonia content, the higher the ammonia content, the lower the pH of the water. Activated carbon is a carbon that is able to absorb anions, cations, and molecules of organic and inorganic compounds in the form of solutions or gases [7]. In addition, activated carbon can also be used as an absorbent, catalyst and filter in water purification. It can remove the color and smell of water and neutralize the pH of water.

Figure 4 showed that ammonia content in treatments P0, P1 and P2 continue to increase due to the accumulation of organic matter (residual feed and increased residual tilapia metabolism). While the treatment of P3 and P4 the content of ammonia did not experience the fluctuations. This is because activated carbon is able to bind to the dissolved materials by cleaning up the dissolved organic molecules through oxidation or absorption directly from the pores [13].

#### 4. Conclusion

The results of this study found that the use of activated carbon in an aquaponics system (rice-fish) can maintain water quality for 60 days of maintenance. The optimum water quality for the growth of fish and rice was in treatment P3 (4.5 cm thickness of activated carbon) and P4 (6 cm thickness of activated carbon).

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