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Efficiency Analysis of COD and BOD decline of Coffee Wastewater in Phytoremediation Process using Water Hyacinth (Eichornia crassipes (Mart.) Solms)

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ABSTRACT

Coffee washing wastewater contains high organics. If the wastewater is directly discharged into the environment, it can pollute and harm the environment, therefore the wastewater should be treated before it is discharged into the environment. Phytoremediation is a kind of wastewater treatment using plants. This study used water hyacinth and four concentration treatments i.e. wastewater with concentration 880 mg/l (Aquarium A), concentration 1520 mg/l (Aquarium B), concentration 3680 mg/l (Aquarium C), and concentration 17760 mg/l (Aquarium D). Concentration of coffee wastewater dilution was 17 760 mg/l. This research was conducted by measuring the parameters of COD and BOD. Results this research was phytoremediation by using water hyacinth at different concentrations can reduce the content of COD and BOD. The most effective water hyacinth planted in coffee waste water with low concentration was 880 mg / l (Aquarium A) which decreases the efficiency of COD, BOD, are respectively 95.45%, 95.61%.

KEYWORDS

Coffee Wastewater, Phytoremediation, Water Hyachinth, COD, BOD

INTRODUCTION

In coffee processing there are two ways of processing coffee from fresh fruit until it is ready for consumption. It was wet process and dry process. The wet process uses a lot of water. The effluent results from the coffee processing are called coffee wastewater. Coffee wastewater, with no further handling, can cause environmental pollution. One effort to treat wastewater is by phytoremediation.

According Subroto (1996), phytoremediation is one way the media uses plants and their parts for the decontamination of waste and environmental pollution problems. According to Mangkoedihardjo (2005), several kinds of aquatic plants are able to work as an agent of phytoremediation such as zolla, water spinach, water hyacinth, and mangroves. This study will be conducted with the coffee wastewater treatment process with a method of phytoremediation and use of water hyacinth as phytoremediation agent. Hyacinth is easily available and has the ability to handle wastewater.

Based on research studies conducted by Mahmood et al. (2005) water hyacinth plants have several advantages, namely efficient in lowering levels of TSS, pH, BOD, COD, conductivity and heavy metals.

Aims this studi was 1) determine the characteristics of the coffee wastewater and water hyacinth plants as agents of phytoremediation at various concentrations waste, 2) determine the efficiency of COD and BOD on phytoremediation processes by water hyacinth with various concentrations of coffee wastewater.

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MATERIALS AND METHODS

Place and Time Research

This research was conducted at the Laboratory of Control Engineering and Environmental Conservation (TPKL) Department of Agricultural Engineering Faculty of Agriculture University of Jember and some of the parameters tested in the Environmental Quality Analysis Laboratory of Environmental Engineering Department of Institute of Sepuluh November Technology Surabaya in May 2014 until September 2014.

Materials and Devices Research

Materials used in this study are the coffee wastewater and water hyacinth. The tools used in this study are an aquarium, Ohaus analytical balance, measuring cup, filter paper, oven, erlenmeyer, desiccator, turbidimeter, flask and glass Bekker.

Procedure Research

Coffee waste water was taken from one of the coffee industry in Jember and water hyacinth was taken from a swamp in Gumuk Mas, Jember. Before the water hyacinth was used in the coffee wastewater it should be acclimatization. Acclimatization is the adjustment to different environmental conditions. After a process of acclimatization, water hyacinth drained and weighed as much as 300g. Having weighed hyacinth planted on four aquariums containing 10 liters of liquid waste coffee with different concentrations, which are:

1. Aquarium A : 880 mg/l
2. Aquarium B : 1520 mg/l
3. Aquarium C : 3680 mg/l
4. Aquarium D : 17760 mg/l
5. Aquarium E : Control (concentration of 17760 mg / l without water hyacinth)

Coffee wastewater characteristics measured before and after the phytoremediation process phytoremediation.

Data Analisys

Decrease efficiency value calculated using the formula:

$$\text{Eff}\ (\%) = \frac{\text{The initial value} - \text{The Ultimate value}}{\text{The initial value}}\ x100\%$$

Specification:

Eff (%) : Efficiency
The initial value : the value of the parameter before treatment
The ultimate value : the value of the parameter after treatment

RESULT AND DISCUSSION

Initial Characteristics Coffee Wastewater

The measurement parameters before the phytoremediation process obtained the following data:

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Table 1. Characteristics of coffee wastewater

Parameter Measurement	Result	Unit
1. pH	5,6	
2. COD	17760	Mg/L
3. BOD	11650	Mg/L
4. Turbidy	652	Ntu

(Source: Data processed, 2014)

Effluent standards for coffee by East Java Governor Regulation 72 Year 2013 are as shown in Table 2.

Table 2. Raw quality of coffee wastewater

Parameter	Maximum levels	Unit
1. pH	6 - 9	
2. COD	200	Mg/L
3. BOD	75	Mg/L

(Source: East Java Governor Regulation, 2013)

From the table it can be seen that the parameters of the coffee wastewater does not appropriate to the quality standards that have been defined. pH was 5,6, COD and BOD value exceeding the threshold of 17 760 mg / l and 11650 mg / l. Based on these parameters, the value of the coffee wastewater was not feasible for included to the environment because exceed predefined threshold.

Parameter Measurement

pH

From the results of the initial measurement of the coffee wastewater, the pH value was 5.6. This value indicates an acidic coffee wastewater. Results of pH measurements of coffee wastewater during processing using water hyacinth are presented in Fig.1

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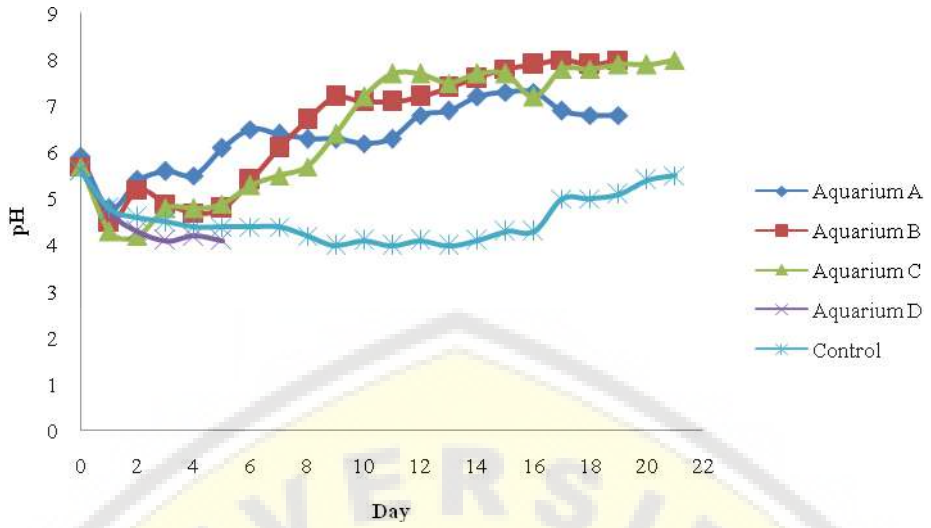

Figure 1. Graph changes in pH (Source: Data processed, 2014)

From Figure 1, it can be seen that the water hyacinth was able to fix the pH value. It can be proved that the coffee wastewater without planting water hyacinth, pH values did not change according to a predefined threshold. Aquarium A and B decreased in pH value on the first day, while in aquarium C pH did not decreased until the second day. Decrease in the aquarium was caused by the adaptation of water hyacinth plants, but on the third day of the aquarium experience increase until the last day. But in aquarium D, water hyacinth can not afford better of pH value, this was due to highly concentrated liquid waste that affects the ability of water hyacinth.

PH changes due to the process of photosynthesis and respiration in plants. pH change was closely related to the value of carbon dioxide. Photosynthesis requires a lot of CO_2, so it needs higher CO_2 in the waste and can lead to increased pH. While the process of respiration produces carbon dioxide to the ecosystem causing the pH to decrease (Effendi, 2000).

COD (*Chemical Oxygen Demand*) and BOD (*Biochemical Oxygen Demand*)

Chemical Oxygen Demand (COD) is one of the parameters that can indicate the level of water pollution by organic matter. Biochemical Oxygen Demand (BOD) is a biological oxygen demand required by living organisms that are used to describe or oxidize the waste material that is in the water. A water containing COD and BOD values that are high indicate that these waters are polluted by organic materials and shows low water quality. The value of COD and BOD removal efficiency were shown in Figure 4.

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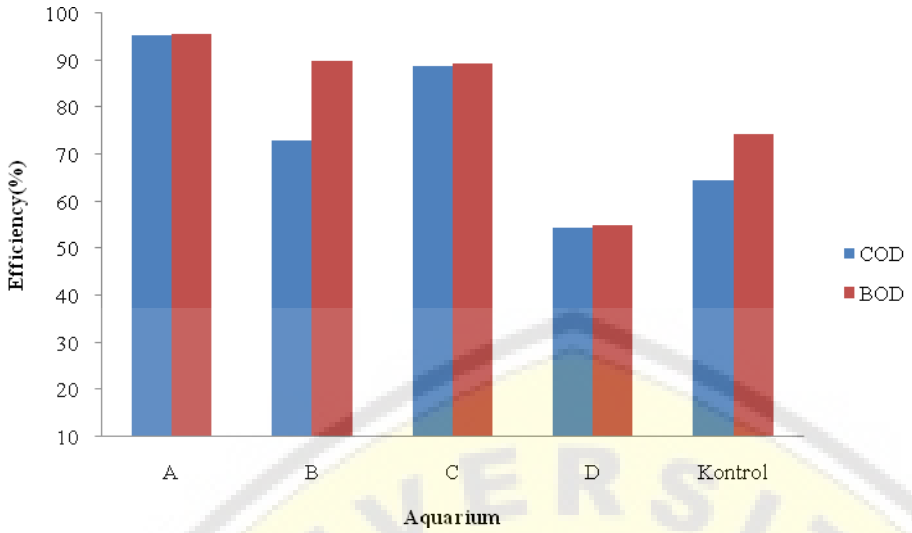

Figure 4. The removal efficiency of COD and BOD (Source: Data processed, 2014)

From Figure 4 it can be seen that the water hyacinth can reduce levels of COD and BOD in wastewater coffee with various concentrations. From the figure it can be seen that the removal efficiency of COD and BOD in the aquarium A was 95.45% and 95.61%. COD reduction was expected because the water hyacinth plant was plant that has the advantages of photosynthesis. This was confirmed by the statement by Mahmood et al. (2005) that aquatic plants can remove carbon dioxide content in the water during photosynthesis. By the time the water hyacinth plant photosynthesis requires lots of carbon dioxide. The process of photosynthesis can increase the dissolved oxygen in the water, thus creating aerobic conditions to support the activities of aerobic bacteria to reduce the content of COD in the effluent. There are several factors that can affect the value of BOD, Amount of organic compounds described, the availability of aerobic organisms are able to decipher the organic compound, and the availability of the required amount of oxygen in the decomposition process. The research of Rahmah (2013) proved that water hyacinth was able to reduce COD in the effluent mocaf by 69.17%. The initial value COD 2622 mg / l to 126.3 mg / l. This proves that the hyacinth plant is a plant that was useful to reduce waste.

The coffee wastewater with low concentrations of COD and BOD absorption by water hyacinth plants were growing fast. It can be concluded that the use of highly effective water hyacinth was on the coffee wastewater with a concentration of 880 mg / l.

Observations Crop Conditions

From the observations made during the study, the ability of water hyacinth to absorb wastewater is different. It can be seen from the relationship data volume from every aquarium that are presented in Figure 5.

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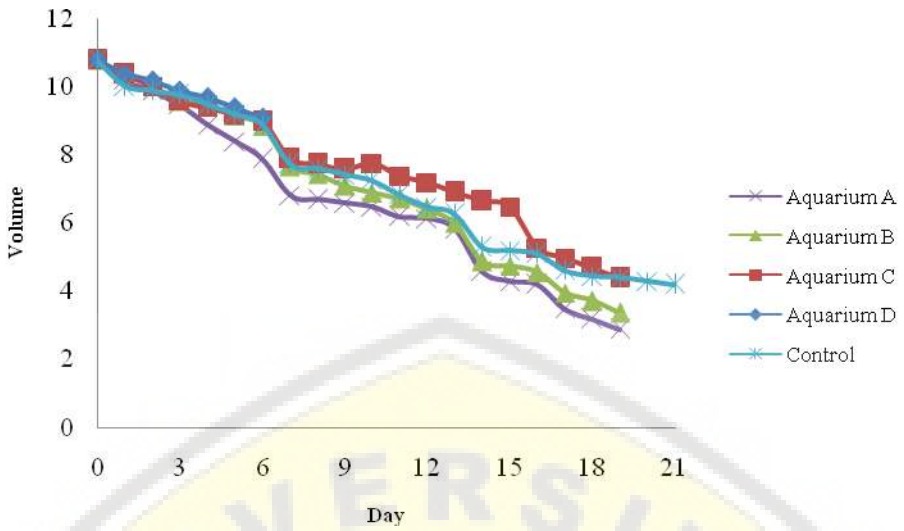

Figure 5. Data measurement volume (Source: Data processed, 2014)

From Figure 5 it can be seen that the water hyacinth in the aquarium D was able to survive until day 5. While in aquarium A, B and C it can last up to the volume depleted water which survive on day 21, A and B survive until day 19. However, in the aquarium three different absorption of water hyacinth. In aquarium A hyacinth absorbs water faster than the aquarium C and D. This was due to the higher level of pollutants and contaminants contained in the waste that hinder the growth process of the plant. While in aquarium E the reduced volume of the water was due to evaporation. Observation of the condition of the plants during the study shows that the roots of water hyacinth plants become slimy, this was due to the process of phytoremediation most instrumental in absorbing pollutants was the root. Aside from the change in the root there was also a color change in the water hyacinth plants that were initially a fresh green and then turn yellow and then brown.

According to Mangkoedihardjo (2005), the evaporation process is done by the water hyacinth plants with the phytoremediation process is fitovolatilisation . Fitovolatilisation stage is the stage where the water hyacinth plant will absorb water by the roots which will then be transported through the transport vessel and then evaporated into the atmosphere. Thus, from this study, it can be concluded that the coffee liquid waste with high concentrations, the water hyacinth plant is only able to survive to absorb toxins contained in wastewater coffee and died on the fifth day.

CONCLUSIONS

Based on the research that has been done, phytoremediation using water hyacinth on the coffee wastewater can reduce the content of COD, BOD, and turbidity levels as well as change the pH value of the acid to be normal. However hyacinth can not grow well in the coffee wastewater with high concentrations. Use of water hyacinth was most effective and efficient in the water hyacinth which was in aquarium A. The wastewater contained a low concentration was 880 mg / l. The value of COD removal efficiency of 95.45% and amounted to 95.61% BOD.

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