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Efficiency of Reducing Pollutant Levels and pH of Citarum River Water Using the Phytoremediation Method

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Abstract. The Citarum river is one of the largest rivers in West Java and has benefits for the environment, not just the industrial sector but also the needs of the surrounding community. The increase in population and lack of awareness of keeping the river environment clean makes the river become polluted. The Citarum river is currently in a moderately polluted to heavily polluted condition. This research aims to analyze the effect of residence time and the effectiveness of reducing pollutant levels and neutralizing pH in Citarum river water using the phytoremediation method. The plant used in this research is water jasmine (*Echinodorus paleofolius*) variable residence time for Citarum river water in the reactor is 3, 5, and 7 days.The results of the research showed quite good results where there was an increase in the pH value towards neutral where the Citarum river water before treatment was at 5.6 to 6.5. The efficiency of reducing COD levels reached 40% during a residence time of 7 days with a concentration reaching 25,085, close to the established quality standard. The efficiency of reducing BOD levels reached 68.15% during the residence time7 days with a concentration reaching 3,895, close to the established quality standards. The efficiency of reducing TSS levels reached 29.33% during a residence time of 7 days.
Keywords: *Citarum River, phytoremediation, Echinodorus palaefolius*

Introduction

Water is a natural resource that is needed for living things. Water is divided into two categories of sea water and also fresh water, fresh water can be obtained from land and surface, namely river and lake water, this type of water is more often used by humans for various needs, such as household purposes, agriculture, industry and others [1]. The quality of the Citarum river water is currently still in class III and IV, not in the condition of class II quality standards according to PP No.22 of 2021. The pollution of the Citarum river due to the disposal of factory waste, as well as domestic waste of residents around the Citarum river, this raises concerns for the government and the community. There have been many programs made to clean the Citarum river such as those carried out by the Citarum Love Society (MCC) and the clean times program (Prokasih) but the results have not been satisfactory [2]. One effort to reduce pollution levels from water is using phytoremediation methods.

Phytoremediation is the use of plants to minimize pollutants, because plants have a high ability to absorb metals and minerals. This method is the concept of utilizing plants and microorganisms for water treatment, one of the methods is an artificial wetland system constructed wetland [3]. Phytoremediation is defined as the use of plants with microbes to remove, move, stabilize, or destroy pollutants both organic and inorganic compounds [4]. The advantage of the phytoremediation method is low operational costs and easy application. The use of this method depends on the plant used, because not all plants can metabolize, votalize and accumulate all pollutants by the same mechanism

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[5]. The properties that must be possessed from plants that can be used in this study are fast growing, able to consume large amounts of water in a short time, able to remediate more than one pollutant [6].

Constructed Wetland is a planned or controlled treatment system designed and built using natural processes involving vegetation, media, and microorganisms to treat wastewater [7]. The goal is to improve water quality and reduce pollutants in water, as well as contribute to water conservation efforts. Constructed wetlands is one of the cheap, easy and effective water treatment technologies to improve river water quality, where the working principle of the waste treatment system is by utilizing symbiosis between aquatic plants and microorganisms in the media around the root system (Rhizosphere) of the plant [8]. The aquatic plant to be used is *Echinodorus palaefolius*, because this plant is easy to grow and also has a hollow root structure of fibers and stems, so it is able to supply oxygen to the roots in large quantities. Main functions of Constructed Wetlands is to improve wastewater quality by degradation or absorption, control flooding by creating storage for rain and surface runoff, and recycle nutrients [9]. This is the background of choosing a phytoremediation system using *Echinodorus palaefolius* plants in an effort to reduce pollution levels in the Citarum river.

Method

The tools used in this study are reservoir, gauze, Beaker 1000 mL, pH meter, thermometer and the materials used in this study are as follows; Citarum River water, *Echinodorus palaefolius, s*oil, water gravel. The research variables were divided into two, namely free vriabel and bound varabel.

- The independent variable in this study was detention time for phytoremediation. Detention time includes 3 days, 5 days, and 7 days.
- The variables tied to this study are that acclimatization time is 7 days, the liquid waste used is 8 liters and the *Echinodorus palaefolius* plants used 4 pieces.

In this research process, there are several processes including the preparation of tools and raw materials, making reactors, acclimatization processes, planting *Echinodorus palaefolius* with soil and gravel media, adding river water, phytoremediation processes, taking and testing samples, and continued with the analysis of research samples.

Preparation

1. Making rectangular plastic container bodies with size
2. Acclimatization of aquatic plants is the process of adapting plants to their new environment. This acclimatization process lasts for 7 days, this process is carried out before the start of research to ensure the plants do not die or wither. This process is carried out by mixing plants with water and clay. After that it is left for 7 days and placed in a cool place but can still be exposed to sunlight.

Experiment

1. Planting *Echinodorus palaefolius* with soil planting medium with gravel
2. Citarum River Water Addition
3. The phytoremediation process is carried out by observing variations in the length of retention time. This process lasts for 7 days, water is taken on days 3, 5, and 7 for testing. However, pH checking is done every day at 4 pm.
4. Sample taking & testing
5. Data Analysis

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The stages of this research are shown in Figure 1 below

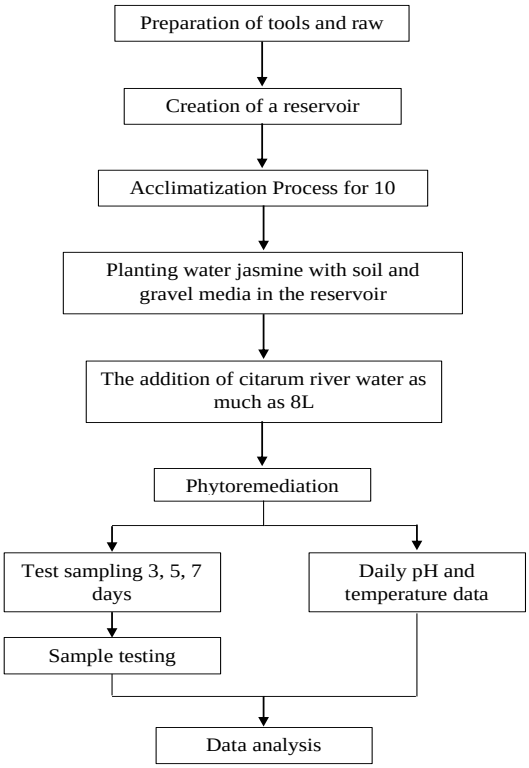

Figure 1 Research Stages Flow Chart.

Result and Discussion

Sample testing was carried out at the Karawang Environmental Service Lab with parameters pH, BOD, COD and TSS before treatment is shown in table 1.

Table 1. Method and results of testing Citarum River water parameters before treatment

No	Parameters	Test Results	Class 2 Quality Standards	SNI
1	Ph	5,60	6-9	pH meter
2	BOD (mg/L)	12,23	3	SNI 6989.72:2009
3	COD (mg/L)	41,81	25	SNI 6989.73:2019
4	TSS (mg/L)	75	50	SNI 6989.3:2019

(Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management)

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After phytoremediation with detention of 3, 5, and 7 days with 2 trials, the results of pH, BOD, COD, and TSS tests were obtained as follows in table 2.

Table 2 Parameter Test Results

Time of detention (days)	trial to	BOD (mg/L)	COD (mg/L)	TSS (mg/L)
3	1	9.12	33,32	73
3	2	8.62	32.07	69
Average		8.87	32.695	68.5
5	1	7.29	30,56	62
5	2	5,72	29.72	60
Average		6.505	30.14	61
7	1	4.56	25.27	56
7	2	3.23	24.9	50
Average		3.895	25.085	53

From table 1, it shows that each parameter tested on the Citarum river water taken on the boat crossing bridge has not met the class II threshold limit set by government regulation number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The test results show that the citarum river water used has a pH value of 5.60 where the citarum river water has a pH value threshold of 6-9. The BOD content of 12.23 mg / L is in class IV, where the content at the threshold of class II is at 3 mg / L. COD content of 41.81 is in class III and TSS content of 75 mg / L is in class III. The results obtained after phytoremediation are shown in table 2 where each parameter tested decreases.

Discussion

pH parameters

pH testing or acidity aims to determine the balance between acid-base in Citarum river water. Based on the results of the test before phytoremediation was carried out, a pH value of 5.60 was obtained, indicating that the Citarum river water contains a considerable concentration of organic acids. Based on government regulation No.22 of 2021 concerning the Implementation of Environmental Protection and Management. The pH value for river water in each class is at 6-9, the pH value obtained before treatment has not met the predetermined threshold. An increase in the pH value towards neutral is obtained after treatment along with the length of detention time as shown in figure 2. The increase

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in pH value is due to photosynthetic activities, denitrification, nitrogen breakdown and sulfate reduction during the day which can shift the pH value towards neutral[10].

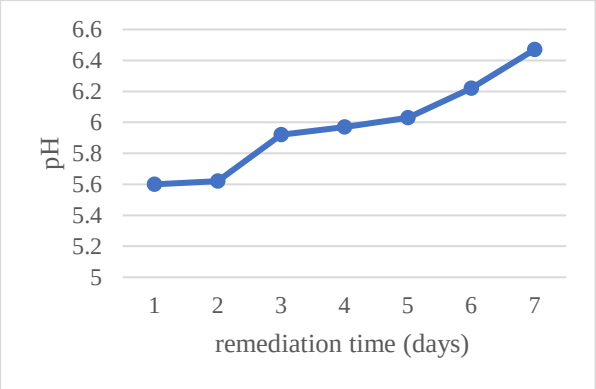

Figure 2 Effect of pH value on day

BOD parameters

According to Government Regulation No.22 of 2021 on maintenance of environmental protection and management, the BOD content obtained from the river water of the citarum still does not meet the threshold. The results of the trial after the phytoremediation process using Echinodorus palaefolius against river water showed a decrease in BOD levels, which indicates that the organic material contained in riverwater is mostly biogdegradable[11]. Figure 3 shows the correlation of the day with the BOD parameter, where in trials 1 and 2 each day the levels of BOD in river water decreased. The average decrease in BOD levels over detention time can be seen in figure 4. The reduction in the level of pollutants in the river water is not exempt from the influence of the absorption of the roots of aquatic plants that are the elements of harvest. The lowering of the BOD levels that occurred in the river citarum due to the influence of Echinodorus palaefolius which has a strong, long and long burning system that functions to absorb and remove pollutants[12].

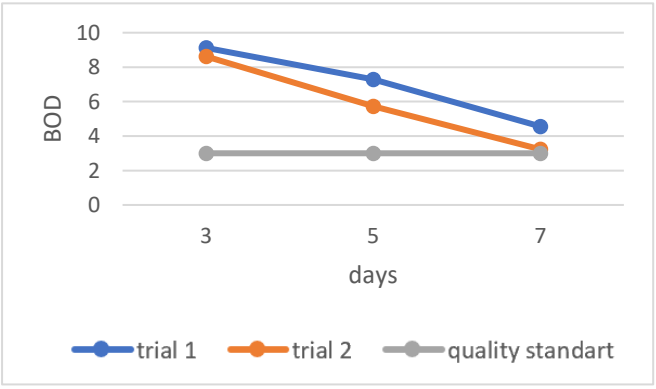

Figure 3 average decrease in BOD levels over days

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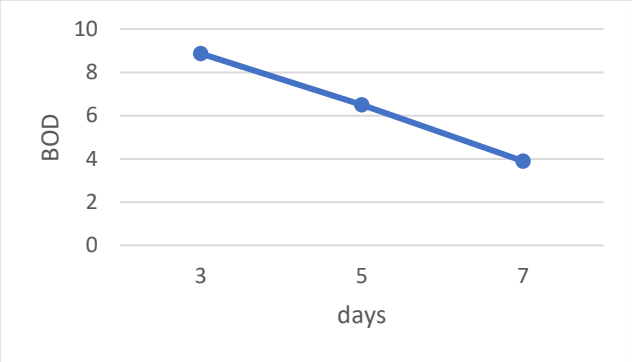

Figure 4 average decrease in BOD levels over days

COD Parameters

Based on government regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, the class II threshold value for COD content is at 40 mg / L. The use of phytoremediation methods on river water is quite effective which can be seen in figure 5 to reduce COD levels every day. One of the decreases in COD content in plants is influenced by the function of roots in absorbing and decomposing pollutants and decreasing COD content. The root system in water jasmine is very strong, long and creeping so it is very effective in expanding the area where microorganisms are attached[13]. The decrease in COD on the day can be seen in Figure 5 where every day COD levels in the Citarum River decrease. The average decrease in COD over days can be seen in figure 6.

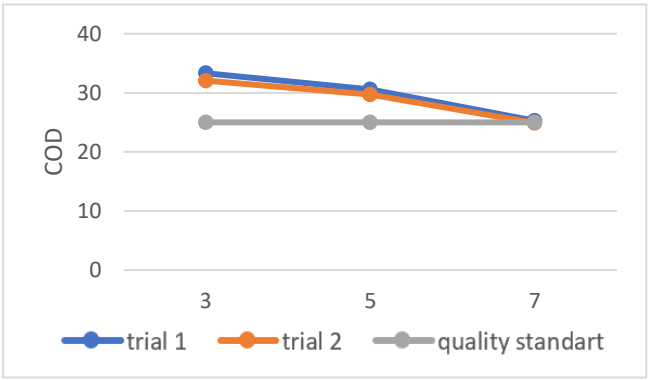

Figure 5 COD decrease over day

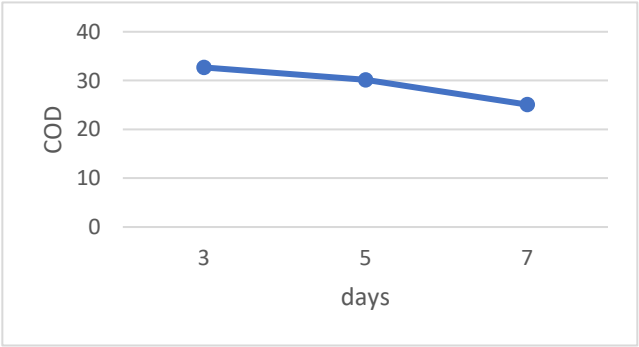

Figure 6 Average decrease in COD

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TSS Parameters

Based on the test results before phytoremediation of TSS content in citarum river water of 75 mg / L, this condition indicates that the TSS content of the citarum river does not meet the class II threshold limit. The decrease in TSS levels in Citarum river, water occurs every day as shown in figure 7 where in experiments 1 and 2 decreased close to the quality standard. The average decrease in TSS levels in Citarum River water can be seen in figure 8. The loss of TSS in river water is caused by physical processes in the form of deposition and retention of solid particles in plant roots[14] .

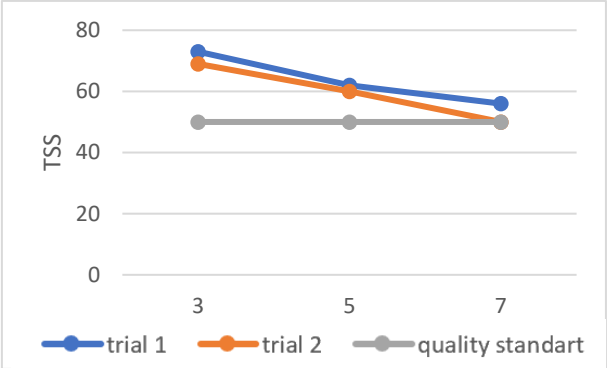

Figure 7 effect of TSS on day

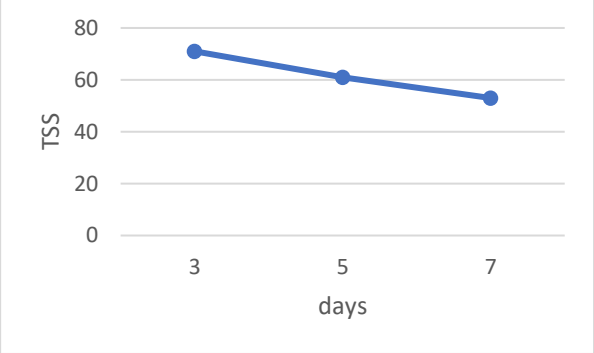

Figure 8 Average TSS decrease

Based on the picture described above, this indicates that the phytoremediation method using water jasmine plants is able to reduce physiochemical levels effectively. Each parameter used as a test is close to class II quality standards in accordance with the Government Regulation on the Implementation of Environmental Protection and Management. Phytoremediation is proven to be able to reduce pollutant levels in Citarum River water, maybe it cannot approach the class I quality standards that can be used as drinking water, but with the levels of pollutants in river water have decreased closer to class II so that the use of citarum water can be more efficient which can be used for water recreation, agricultural livestock and also in accordance with class II quality standards

Conclusion

Based on the formulation of the problem and the discussion above, several conclusions can be drawn as follows water jasmine plants are able to increase pH towards neutral and successfully reduce COD, BOD and TSS levels close to river water quality standards. The treatment of long stay time in reducing COD, BOD and TSS levels is most effective at 7 days, this means that the longer the stay time, the better the decrease in pollutant levels. The input suggestions in this study are as follows. There needs

to be further research on the use of water jasmine. Further research is needed to increase the effectiveness of jasmine plants

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