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SCOURING-RUSH HORSETAIL'S (*Equisetum hyemale*) CAPABILITY TO REDUCE DETERGENT, COD AND PHOSPHAT (PO₄) LEVELS OF LAUNDRY WASTEWATER IN PURWOKERTO IN 2016

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ABSTRACT

Background: There will be an increasing demand for goods and services as a result of rapid economic growth and development, increasing activities in the society, and also with the establishment of universities. This has caused the emergence of some laundry business that aims to alleviate the burden on society. The emergence of the laundry business may cause environmental pollution, especially in the levels of detergent, if the waste generated is not treated before it is discharged. Therefore, it is necessary to find a method to treat waste efficiently. One of the ways is to employ phytoremediation using scouring-rush horsetail (*Equisetum hyemale*).

Aims: The purpose of this study is to analyze the scouring-rush horsetail media's ability in decreasing the levels of detergent, Phosphate (PO₄), and COD of laundry waste.

Methods: This type of research is called true experiment with design randomized control group pretest-posttest. The data is analyzed using Analysis of Covariance (ANCOVA) statistical test.

Results: The results of the analysis showed that there are influences from the residence time, the scouring-rush horsetail's (*Equisetum hyemale*) ability and the continuous process by reducing the levels of detergent (88.9%), COD (99.5%), and PO₄ (63.4%). Scouring-rush horsetail media has an average efficiency of COD reduction (90%), PO₄ (51%), and Detergents (86%). The value of Detergents, COD, and PO₄ level in laundry wastewater after treatment by using scouring-rush horsetail (*Equisetum hyemale*) with a residence time (0 day, 1 day, 3 days and 7 days) based on Government Regulation No. 82 of 2001 on the Management of Water Quality and Water Pollution Control has been under NAB.

Conclusion: It is necessary to make additional acclimatization time in the study using a scouring-rush horsetail to reduce the levels of COD, phosphate and detergent. It is advisable to plant the scouring-rush horsetail in the tub as high as 30 cm, thus the water can be pooled.

Keywords: scouring-rush horsetail (*Equisetum hyemale*), laundry wastewater, detergents, Phosphate (PO₄), and COD.

INTRODUCTION

There will be an increasing demand for goods and services as a result of rapid economic growth and development, increasing activities in the society, and also with the establishment of universities. For instance, in Purwokerto and in other cities, this has caused the emergence of some laundry business that aims to alleviate society's burden in terms of housekeeping, such as laundry business (washing clothes).

These large numbers of laundry services will worsen the quality of the surrounding water because this business is not equipped with waste treatment; instead they discharged it directly into

sewers or nearby water bodies. The result of this continuous discharged of laundry wastewater into water bodies without being processed may cause water pollution problems (water bodies).

Laundry wastewater contains chemicals with high concentration; it includes phosphates, surfactants, ammonia and nitrogen as well as levels of dissolved solids, turbidity, BOD and high COD [1]. These chemicals become a problem of pollution in the water bodies caused by the use of detergents as washing materials. Detergents is used because it has good washing power and is unaffected by water hardness, but it also has a phosphate content that is quite high because phosphate is the main precursor in detergent [2].

The emergence of these laundry business in addition to providing benefits and a solution in terms of housekeeping, also provide new jobs for the people of the surrounding area. However, the advantage gained is inversely proportional to the quality of the resulting environment. These large number of laundry services will worsen the quality of the surrounding water because this business is not equipped with waste treatment processes; instead it is discharged directly into sewers or water bodies nearby. The result of this continuous discharged of laundry wastewater into water bodies without being processed may cause water and soil pollution problems. One of laundry wastewater treatment is using decorative plants media, specifically scouring-rush horsetail (*Equisetum hyemale*) which has a fairly good performance in wastewater treatment with artificial wetlands subsurface flow (SSF-Wetlands) processing system. According to the measurement results of one domestic waste parameter, scouring-rush horsetail have an efficiency of average BOD levels reduction on 86% and 84% COD. The advantage of using this method is due to a narrow field requirement, efficient in reducing heavy metal compounds, cheap and easily available scouring-rush horsetail.

Laundry services in Purwokerto mostly do not treat its wastewater, instead they discharged it directly into sewers and ended in the water body and have not been monitored and examined the pollutant parameters by the relevant authorities and the existence of Laundry services in Purwokerto has never been monitored and the pollutant parameter has never been examined by relevant authorities. In connection with this, to prevent water body in Purwokerto polluted like in big cities a method is required; that is with efficient waste treatment called phytoremediation. This method uses scouring-rush horsetail (*Equisetum hyemale*) by examining the ability of the plant (*Equisetum hyemale*) in reducing the detergent, COD, and PO₄ levels of laundry wastewater in Purwokerto.

METHODS

This research is true experiment with randomized control group pretest-posttest design. Laundry wastewater samples were taken from 5 location points that are close to a college in Purwokerto, which is then chosen one by random sampling. Laundry wastewater was taken with jerry cans. It was filled to the brim from washing machine's exhaust outlet as much as 200 liters; both for the intervention and control group, inserted into the container vessel. Each laundry service industry have their own detergent dose according to the weight of the laundry and how much clean water is used, so it is possible that the levels of detergent, COD, and phosphate are different. This design consists of interventions in the treatment and control unit. The treatment group with residence time 0, 1, 3, and 7 days have an average reason to wash laundry services 1-3 days and 7 days a week. The amounts of scouring-rush horsetail needed are 12 packs; with one pack consists of 10 plants. The scouring-rush horsetail's acclimation process is carried out in advance in research media for 10 days with flowing water. Then for the next 7 days, it is gradually replaced by laundry wastewater until the sampling is implemented. The intake of effluent samples on the SSF-Wetlands vessel outlet at 0 days is the first time water flowed on the Subsurface Flow Wetlands (SSF-Wetlands) vessel, followed by taking sample on the residence time of 1, 3 and 7 days (the flow is continuous) and to control without

a scouring-rush horsetail. Calculate the mean for each group. The variables studied were dependent variable (levels of detergent, COD and PO₄), the independent variable (biomass type of scouring-rush horsetail) and covariate variable (residence time, 0 day, 1 day, 3 days, and 7 days), replication as much as 5 repetitions. The data were analyzed using Analysis of Covariate (ANCOVA) with SPSS software series 20 [12].

RESULTS

The decrease in detergents, PO₄, and COD Level

Table 1 Measurement Result of Detergents, PO₄, and COD Levels

Residence time (hari)	COD (mg/l)					PO ₄ (mg/l)					Detergents Levels (mg/l)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
0	56	85	77	96	52	0,15	0,54	0,84	0,13	0,64	0,11	0,45	0,10	0,09	0,07
1	17	50	40	42	49	0,45	0,64	0,68	0,8	0,89	0,00	0,00	0,01	0,01	0,03
3	40	33	74	36	46	0,27	0,44	0,34	0,39	0,3	0,00	0,00	0,01	0,01	0,01
7	4	5	5	8	2	0,29	0,43	0,7	0,4	0,49	0,00	0,00	0,00	0,00	0,00

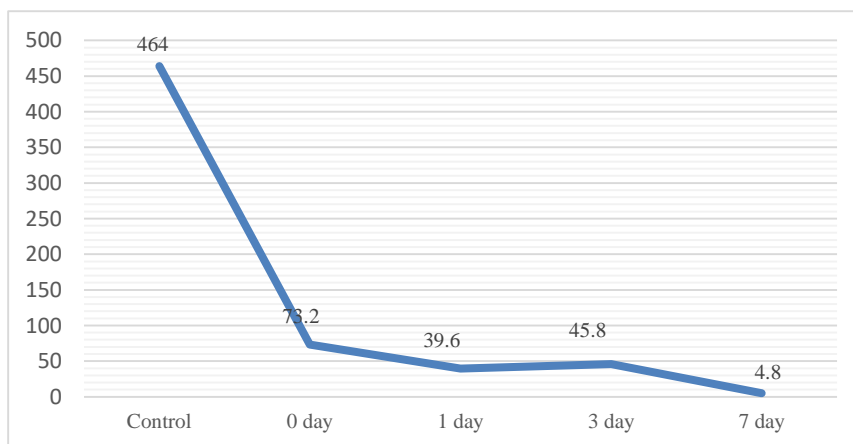


Figure 1. COD level in different residence time

Table 1 and Figure 1 show a decrease in COD. The COD before it goes through the medium of a scouring-rush horsetail (*Equisetum hyemale*) or as control shows the number of 464 mg/ lt, which means that the results of these controls exceeds the quality standards established at 25 mg/ lt [3]. The result of the decline in COD at residence time of 7 days is the average of the highest decrease in the amount of 4.8 mg/ lt.

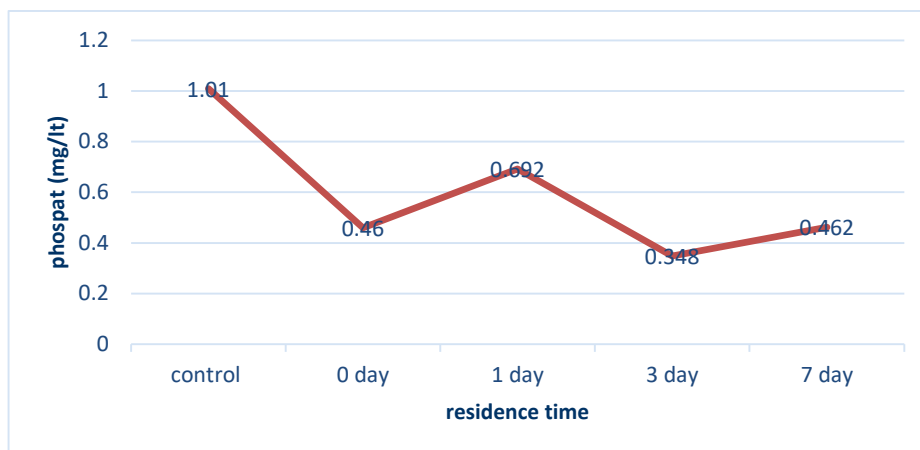


Figure 2. Phosphate level in different residence time

Based on Table 1 and Figure 2, the decrease in Phosphate (PO₄) levels has fluctuated. It is shown in the contact time 1 day 0,692 mg/ Lt then it decreases and the figure climbed back to 0,462 mg/ Lt in the contact time of 7 days.

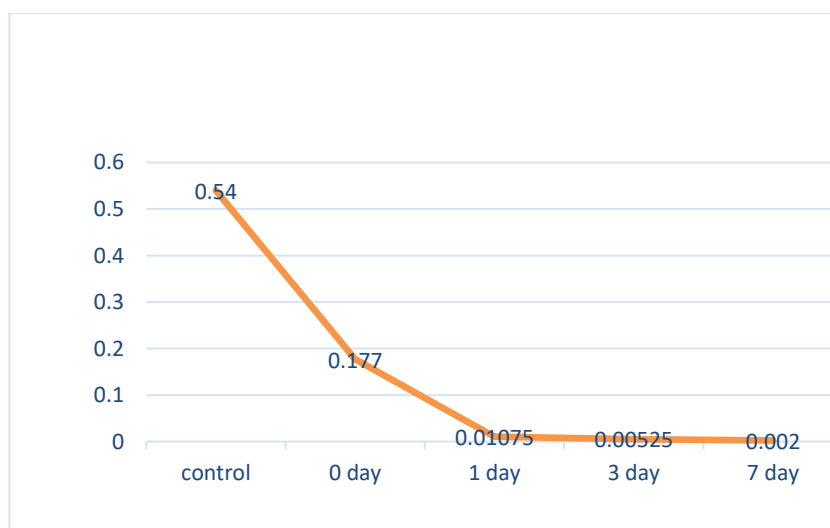


Figure 3 Detergents levels in different residence time

According to Table 1 and Figure 3, detergents levels as the control shows the results of 0.54 mg/ Lt, which means the detergent concentration exceeds the quality standards established i.e. 0.2 mg/ Lt, average decrease in detergent levels at the residence time of 7 days is the highest decrease in detergent levels of 0.002 mg/ Lt. The lowest decline occurred in the residence time of 0 day, which is 0.177 mg/ Lt.

Efficiency of the decrease in COD, phosphate, and detergents levels

Figure 4 summarizes the decrease's efficiency based on the average decline of the three parameters for a residence time of 7 days, for COD, phosphate, and Detergents levels showed that the scouring-rush horsetail plant is most optimal in the process of COD at about 90%, followed by the decrease in detergent levels that is equal to 86% and the lowest average efficiency is a decrease in phosphate levels that is equal to 51%.

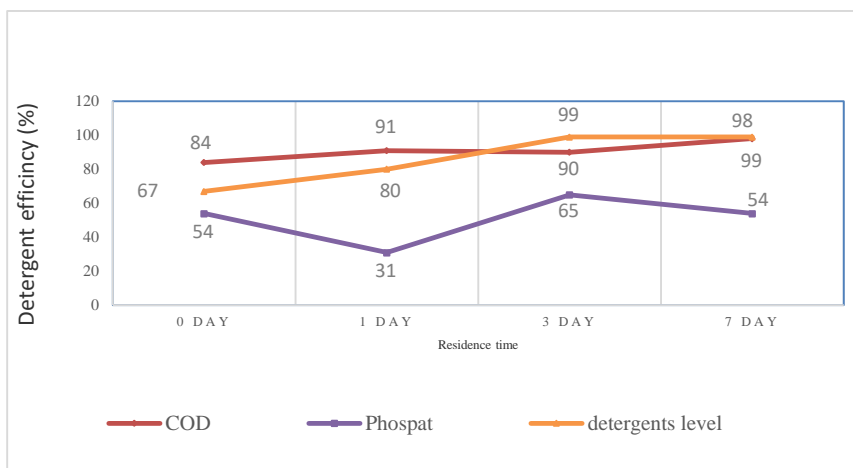


Figure 4. COD, phosphate, and detergent efficiency in different residence time

(i) Detergent

The result of processing shows that the number of significance for scouring-rush horsetail variable is 0,000. Because the value is far below 0.05, then H_0 is rejected. Thus, it can be concluded that at a rate of 95% confidence level, there is an influence of residence time differences toward the decrease in Detergent levels. To determine the effect of residence time and the presence of scouring-rush horsetail on phosphate levels can be seen simultaneously from the figures of significance in the Corrected Model. It is shown that the significance figure is 0,000. Because the significant value is far below 0.05, then H_0 is rejected. Thus, at the 95% confidence level, it can be concluded that simultaneously, residence time and scouring-rush horsetail affect the decreased in detergent levels.

R square figure or coefficient of determination is 0.679; meaning 67.9% reduction in detergent is caused scouring-rush horsetail (independent variable), while 32.1% is caused by other factors. Based on the F test value, it is obtained that F count is 20.384 with a significance level of 0.000. The probability (0.000) is much greater than 0.05, thus the regression model can be used to predict a decrease in the detergent levels, or it can be said that the scouring-rush horsetail does affect the decrease in detergent levels.

(ii) Phosphate

The result of processing shows that the number of significance for scouring-rush horsetail variable is 0.065. Because the value is far above 0.05, then H_0 is accepted. Thus, it can be concluded that the influence of the residence time, at a rate of 95% confidence level, the influence of residence time differences toward the decrease in Phosphate levels is nonexistent. To determine the effect of residence time and the presence of scouring-rush horsetail on phosphate levels can be seen simultaneously from the figures of significance in the Corrected Model.

It can be seen that the figure of significance is 0.083. Because the significant value is far above 0.05, then H_0 is accepted. Thus, at the 95% confidence level it can be concluded that simultaneously, residence time and scouring-rush horsetail does not affect the reduction in phosphate levels. R square figure or coefficient of determination is 0.242; meaning 24.2% reduction in phosphate is caused by scouring-rush horsetail (independent variable), while 75.8% is caused by other factors. Based on the F test value, it is obtained that F count is 3.874 with a significance level of 0.065. The probability (0.065) is much greater than 0.05, causing the regression model cannot be used to predict a

decrease in the phosphate levels, or it can be said that the scouring-rush horsetail does not affect the decrease in phosphate levels.

(iii) COD

The result of processing shows that the number of significance for scouring-rush horsetail variable is 0,000. Because the value is far below 0.05, then H_0 is rejected. Thus, it can be concluded that at a rate of 95% confidence level, there is an influence of residence time differences toward the decrease in COD levels. To determine the effect of residence time and the presence of scouring-rush horsetail on phosphate levels can be seen simultaneously from the figures of significance in the Corrected Model.

R square figure or coefficient of determination is 0,972, meaning 97,2% reduction in detergent is caused scouring-rush horsetail (independent variable), while 0,28% is caused by other factors. Based on the F test value, it is obtained that F count is 470,235 with a significance level of 0.000. The probability (0.000) is less greater than 0.05, thus the regression model can be used to predict a decrease in the COD levels, or it can be said that the scouring-rush horsetail does affect the decrease in COD levels.

DISCUSSION

The efficiency value of the decrease in phosphate levels is the lowest value compared to the efficiency of the decrease in other parameters. However, the results of the analysis showed the presence of a process that reduces the phosphate level in the effluent after it is passed to the processing system. Orthophosphate is a form of phosphate that can be used directly by aquatic plants for photosynthesis, respiration, transfer and energy storage, thus enabling the absorption of phosphate [4].

The decrease in levels of COD is not influenced by environmental factors such as temperature, pH, toxic substances and microorganism's activity. The decrease in COD concentration showed that was decreasing of organic load in the effluent so that the amount of oxygen was used for oxidation also decreased [3].

The decrease in detergent levels occurs because of the surfactant compound is reformed. The surfactant reforming process by microbes occur in three stages: the oxidation process of alkyl cluster that is located at the end of the alkyl chain forms intermediate in the form of alcohol, and this oxidation process occurs until the alkyl chain only has 4-5 carbon atoms [5].

Organic substances contained in waste water will be overhauled by microorganisms into simpler compounds and will be used by plants as a nutrient, while the root system of water plants will produce oxygen that can be used as a source of energy/ catalyst to a series of metabolic processes for the life of microorganisms [6].

Scouring-rush horsetail medium capability in lowering the levels of detergents and COD has already met the threshold value. The decrease in COD and detergent levels is stable, while the scouring-rush horsetail's ability to decrease PO_4 experienced fluctuating and the results have not met the quality standards that have been set. Ion PO_4 is a source of Phosphorous (P) for plants which is taken by plants' roots as nutrients for the plants, so the longer the plant life in the waste medium, the smaller the concentration of PO_4 in the waste [7]. A number of plants from many families are proven to be hypertolerance that are able to accumulate metals with high concentrations in root and stem, thus it is hyperaccumulator in nature. Hyperaccumulator means it can accumulate a certain metallic element with a high concentration in the stem and can be used for phytoextraction [8]. It can be said that every part of the scouring-rush horsetail plants such as roots, stems and leaves play a role in the

process of absorption and adsorption of the heavy metals in the laundry wastewater. The advantage of scouring-rush horsetail is that the bamboo plant has a strong and hard stem structure so that it has resilience in absorbing, and it is also a type of plant which roots are suspended in the soil. The process of wastewater treatment in the wetland system with the physics, chemistry and biology are caused by the interaction of microorganisms, plants and substrate [9].

The processes in wetland system are consists of the physics, physics-chemistry and biochemistry. Physical process consists of sedimentation and filtration processes. Physical-chemical process consists of process adsorbs pollutants by aquatic plants, sediments and organic substrate. While the biochemical processes consists of the decomposition of contaminants by bacteria that attached to surfaces substrate or media, plant roots, as well as the absorption of nutrients and the other contaminants by plants [10]. Roots has an important part in supporting the growth of the plant because the roots absorb water and nutrients. To get the nutrients in the growth environment, the growth of plant roots has a great influence. Good roots (roots like yarn, a lot of hair roots) will be able to absorb nutrients. While Rooting is not good, will obstruct the absorption of nutrients [13].

The cost required to construct a wetland system may be cheaper 50-90% of the cost required to build a conventional waste water treatment systems. Likewise, the cost of the necessary investment is much cheaper because the system bogs artificial does not require high-tech equipment, does not require the input electrical energy, and chemicals (coagulants, flocculants, fertilizers), and does not require personnel trained operator [11].

CONCLUSION

There is a decrease in the levels of COD, Phosphate and detergent after the treatment using scouring-rush horsetail (*Equisetum hyemale*). There is a decrease in the COD, phosphate, and Detergent levels after the treatment using scouring-rush horsetail (*Equisetum hyemale*) toward the residence time of 0, 1, 3, and 7 days. Scouring-rush horsetail plants' efficiency in reducing the levels of COD 90%, levels of detergent 86% and phosphate (PO₄) 51%. There is a significant difference between the residence time and COD levels ($p < 0.05$). There is a significant difference between the residence time and detergent levels ($p < 0.05$). There are significant differences between the residence time and the decreased levels of PO₄ ($p < 0.05$), but the decreased levels of PO₄ appears to fluctuate. There is a decrease in detergents, PO₄ and COD levels after it is treated by scouring-rush horsetail medium. This occurs because the selection of a good stem will be able to remediate pollutants if the plant had reached adulthood. Treatment using scouring-rush horsetail with residence time influences the decrease in COD and detergents levels, but it has less effect on PO₄ decline. The addition of acclimation time in the study using a scouring-rush horsetail to reduce the levels of COD, phosphate and detergent. Planting of scouring-rush horsetail into a tub of water preferably with space for stagnant water can be as high as 30 cm.

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