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Bioball Biofilter and Phytoremediation Methods in Decreasing the Linear Alkylbenzene Sulfonate Content of Greywater

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Abstract. Bioball biofilter and phytoremediation are some of the types of domestic sewage treatment to minimize environmental pollution. The use of *Avicenia marinaa* as a phytoremediation media plant has been studied previously and has been shown to affect the quality of waste so as to meet environmental quality standards set by the government. The purpose of this study was to analyze the effectiveness of the use of aerobic bioball biofilter and phytoremediation using *Avicennia marinaa* on the content of Linear Alkylbenzene Sulfonate (detergent) and liquid waste fatty oils.

The design of this study was a pretest and posttest control group with a treatment time of 14 days to measure the decrease in the content of detergent and fatty oil in the liquid waste from the kitchen and dormitory laundry. The data that has been obtained were analyzed by one way ANOVA test and compared against environmental quality standards.

The results showed that the Avicennia marina plant was effective in reducing the content of fatty oils and detergents (Linear Alkylbenzene Sulfonate). Within 14 days of treatment, the average fatty oil and detergent were 5.8 ppm and 3 ppm, respectively. The effectiveness of aerobic biofilters and phytoremediation in reducing the content of fatty oils and detergents is about 48.5%. When compared with the domestic waste quality standard received by class II water bodies (PermenLH 5 of 2014), this is in accordance with applicable requirements.

For boarding house managers, it is suggested that before greywater is disposed of to a body of water, it can be processed beforehand so that the pollutant load received by the river is not overly high exceeding the quality standard.

Keywords: phytoremediation, bioball biofilter, greywater, fatty oil, linear alkylbenzene sulfonate

Introduction

WALHI's 2018 data showed that water quality in East Java continues to decline if there is no immediate environmental recovery effort and will be one of the causes of the water crisis in the long term. Metropolitan cities including Surabaya produce household liquid waste which is generally discharged directly into rivers without going through any kind of processing. Domestic waste contributes to water quality pollution by 60%, while industrial waste by 40%.

Greywater waste or waste from laundry generally does not have a treatment system and is channeled directly into a drainage channel which will eventually empties into the Kali Mas River, Surabaya City. This will result in an increased water pollution in Kali Mas, Surabaya. Thus, it can be stated that the main pollution load that cannot be reduced comes from domestic wastewater pollution from bathing and washing activities (greywater). Greywater is wastewater resulting from bathing and washing activities (DLH, 2017).

Soil pollution management efforts can be realized by remediation methods which are divided into two, namely phytoremediation and bioremediation. Phytoremediation is the restoration of polluted land by using plants to absorb, degrade and transform pollutants, both heavy metals and organic compounds (Hamzah, 2013). According to the study of Rokhmalia and Hermiyanti (2018), *Avicennia marinaa* mangrove plants can reduce lead levels in soil flooded with lead solution. Also, according to the study, phytoremediation treatment to

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improve the quality of greywater effluent is expected to be achieved. The use of biofilters and phytoremediation techniques in the processing of household greywater has not been widely used by the community at the same time, so that mangroves have been chosen as a phytoremediation media plant.

Linear Alkylbenzene Sulfonate (LAS) in detergents has a significant effect on decomposition in water bodies. LAS also affects human health if exposed to the skin directly or through digestion. In the long term, drinking water contaminated with detergent waste has the potential to cause cancer. The decomposition process in water will produce residual benzene which when reacted with chlorine will be very dangerous, which has the potential at the stage of chlorination/disinfection of water (Jati, 2017). Therefore, detergent content analysis is required in processed liquid waste before being discharged into water bodies to comply with the required quality standards.

Student dormitories generally do not have greywater treatment facilities, thus, the waste generated from the bathroom and laundry is directly channeled into the city's drain. The treatment of dormitory wastewater at universities is generally mixed with domestic waste from offices (Budiatma, Sholichin, & Pranoko, 2019). The aim of this study was to analyze the effectiveness of the use of aerobic bioball biofilter and phytoremediation using *Avicennia marinaa* on the detergent and fatty oil content in liquid waste.

Research Methods

The design of this research was experimental with one group pre and posttest design which aimed to compare the content of greywater after treatment with phytoremediation and biofilter. The changes observed in this study were the content of detergent (LAS) and fatty oil in liquid waste. The sample size in this study was 24 samples (6 samples each on the 1st, 7th and 14th days). The data collected were then analyzed using the one-way ANOVA test.

Results

As shown in Table 1, the average content of oil and fat in greywater on day 1 was 11.2 ppm and decreased on day 14 to 5.8 ppm. The effectiveness of reducing oil and fat through biofilter and phytoremediation treatment was 48.2%.

Table 1. Measurement Results of Oil and Fat in Greywater

Replication	Day 1 (ppm)	Day 7 (ppm)	Day 14 (ppm)
1	11.2	9.62	6.28
2	10.26	10.11	5.1
3	12.03	9.84	6.05
Average	11.2	9.9	5.8
Decrease Percentage		11.6%	48.2%

Table 2. Measurement Results of Detergent (LAS) in Greywater

Replication	Day 1 (ppm)	Day 7 (ppm)	Day 14 (ppm)
1	6.11	5.88	3.1
2	5.69	6.02	2.85
3	6.02	5.16	2.9
Average	5.9	5.7	3
Decrease Percentage		3%	49.1%

As shown in Table 2, the average greywater detergent (LAS) on day 1 was 5.9 ppm and decreased on day 14 to 3 ppm. The effectiveness of reducing oil and fat through biofilter and phytoremediation treatment was 49.1%.

Table 3. Comparison of Household Greywater Quality with Domestic Waste Standards

Parameter	Measurement Result	Regulation of the Minister of Environment No. 68 of 2016	Regulation of the Minister of Environment No. 5 of 2014
Fatty oil	5.8 ppm	5 ppm	5 ppm
Detergent (LAS)	3 ppm	-	-

Discussion

The biofilter bioball and phytoremediation methods according to Table 3 have been effective in reducing the oil and fat content in wastewater up to 48.2%. This is in accordance with the research of Fikri and Barus (2020) that through the biofilter and filtration method, the oil and fat content in domestic waste can effectively decrease to 97.57% after going through processing for 24 hours. Oils and fats in wastewater can be separated by gravity or can also be degraded through the oxidation of microorganisms and oxidation in the presence of sunlight. Processing of oil and fat in liquid waste was carried out by gravity and oxidation with a biofilter, which were shown to be effective.

Biofilter and phytoremediation processing were able to effectively reduce the detergent content by 49.1%. The use of biofilters and artificial swamps (phytoremediation) was also carried out by Violenta, Sutanto, and Prihatmo (2022), showing that microorganisms in biofilters and artificial swamp media can reduce the detergent content up to 93.1%. Degradation occurs to break down organic matter with the enzyme beta oxidase followed by the reaction of tricarboxylic acid.

The content of fatty oil in greywater processed using bioball biofilter and phytoremediation was still short of Regulation of the Minister of Environment No. 68 of 2016 concerning Domestic Waste Quality Standards, but has met with the requirements in Regulation of the Minister of Environment No. 5 of 2014 concerning Wastewater Quality Standards with a pollution load in class II water bodies. For the detergent parameter (LAS), it has not been regulated in Regulation of the Minister of Environment regarding the quality standard of domestic waste, but based on the measurement results, it has decreased on the 14th day. LAS is part of the surfactant that can be degraded by microorganisms into CO_2 and H_2O (Paulo et al., 2017).

Conclusions

Processing domestic waste using bioball biofilter and phytoremediation is effective in reducing the content of oil and fat as well as detergent in greywater. The reduction effectiveness of the fatty oil and detergent content is 48.2% and 49.1%, respectively. The fatty oil and detergent content of the greywater has met the requirements in Regulation of the Minister of Environment of 2014 on Wastewater Quality Standards with a pollution load in class II water bodies.

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