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Bioball Biofiltration and Avicennia Marina Phytoremediation as Greywater Treatment

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Abstract: ***Efforts to treat domestic waste can be done by using the phytoremediation method. The use of Avicennia marina as a phytoremediation media plant has been studied previously and proven to maintain the quality of waste according to environmental quality standards. The combination of bioball biofiltration and phytoremediation methods is expected to reduce the pollution of water bodies from greywater. This study aimed to determine the effectiveness of the Avicennia marina phytoremediation and the bioball aerobic biofiltration methods in treating household greywater waste. This study is experimental research with a pre-test and post-test control group design. The data that has been obtained were analyzed with one-way ANOVA with the aim of using one-way ANOVA to compare physical (turbidity) and chemical parameters (BOD, COD, TSS, nitrate, and phosphate). The turbidity of greywater after going through the treatment with bioball biofiltration and phytoremediation was reduced by 88%. The chemical parameters in BOD, COD, Nitrate, Phosphate, and TSS were also reduced by 83.73%, 84.10%, 89.28%, 92.68%, and 86.06% respectively – after going through the treatment with bioball biofiltration and Avicennia marina phytoremediation for 14 days. BOD, COD, Nitrate, and TSS have not met the quality standards required by Minister of Environment Regulation No. 68 of 2016 concerning Domestic Waste Quality Standards. Bioball biofiltration and Avicennia marina phytoremediation reactors are effective in reducing turbidity, BOD, COD, Nitrate, Phosphate, and TSS. The existence of Avicennia marina plants on the coast can be useful as an absorbent of pollutants of water bodies***

Keywords: Phytoremediation, aerobic biofiltration, greywater

1. Introduction

Currently, blackwater waste has already had a treatment system, while greywater waste hasn't had a treatment system yet—and is channeled directly into a drainage channel which eventually empties into Kali Mas river, Surabaya. This will have an impact on increasing water quality pollution in Kali Mas river, Surabaya. Thus it can be said that the main water pollution load that cannot be reduced comes from domestic wastewater pollution originating from bathing and washing activities (greywater). Greywater is wastewater that comes from bathing and washing activities [1].

Efforts to manage soil pollution can be done 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 [2]. Avicennia marina mangrove plants can reduce lead levels in soil flooded with lead solution [3]. The use of mangrove wetlands can reduce the turbidity of waste originating from the liquid waste in Kepetingan Sidoarjo Village. The nitrate level of the effluent was reduced to 0.13 mg/l at the outlet from the original 0.63 mg/l at the inlet and the phosphate level of the effluent was reduced to 0.05 mg/l at the outlet from the original 0.35 mg/l at the inlet. The maximum BOD level in the wetlands is 76 mg/l. Based on this study, phytoremediation treatment to improve the quality of greywater waste was expected to be achieved [4].

Biofiltration is commonly used to filter particles contained in liquid waste and reduce turbidity. According to Filliazati's study, biofiltration processing with bioball and kiambang plants is able to reduce parameters, especially BOD in household wastewater with 2 weeks of acclimatization and 3 days of treatment [5]. The use of biofiltration and phytoremediation methods at the same time—in the treatment of greywater household waste has not been widely used by the community, so mangroves have been chosen as a plant used as a phytoremediation medium.

The use of the Avicennia marina as a phytoremediation medium for greywater waste treatment can reduce turbidity in the physical parameters of water quality. Mangrove plants on the coast of Sidoarjo can increase the brightness of physical parameters in reducing pollution of the aquatic environment. Mangrove plants have the ability to trap sediment particles to reduce the turbidity content in the waters [4].

In a similar study, BOD content could be reduced through aerobic and anaerobic biofiltration at the Permata Bunda Bontang INBIS WWTP. The study states that the use of WWTP is effective in reducing the BOD content of greywater by 83.86%. The presence of microorganisms in the biofiltration helps the degradation of organic compounds in the liquid waste so that the BOD content after processing can decrease [6]. This study aimed to determine the effectiveness of the utilization of bioball biofiltration aerobically and Avicennia marina phytoremediation on the quality of household greywater.

2. Research Methods

This study is experimental research with a pre-test and post-test control group design with the aim to compare the physical and chemical qualities of greywater after going through treatment with phytoremediation and biofiltration. The changes observed in this study were the physical

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(turbidity) and chemical (BOD, COD, TSS, Nitrate, and Phosphate) qualities in household wastewater (greywater). The statistical test used was one-way ANOVA to compare physical (turbidity) and chemical parameters (BOD, COD, TSS, Nitrate, and Phosphate) with a monitoring time of 2 days (7th and 14th day).

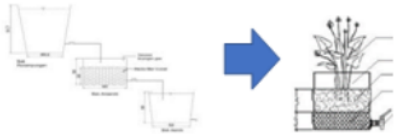

Figure 1 Design of Biofilter and Phytoremediation

3. Result and Discussion

This study compared the physical and chemical qualities of greywater (BOD, COD, TSS, Nitrate, and Phosphate) through bioball biofiltration processing and phytoremediation with a monitoring time of 14 days. The processing was studied aerobically using a bioball biofiltration, followed by phytoremediation for 14 days using Avicennia marina plants. Sampling was carried out twice, namely on the 7th and 14th days to measure the physical and chemical qualities.

Table 1: Greywater Turbidity Measurement

Replication	0 Day (NTU)	7th Day (NTU)	14th Day (NTU)
1	31.5	11.25	3.9
2	33.6	10.5	4.05
3	30.9	12.6	3.57
Average	32.00	11.45	3.84
Reduction percentage		64.22%	88.00%

Table 1 explains that the average household greywater turbidity reduced significantly on 14th day. The percentage of turbidity reduction reached 88% on the 14th day after going through bioball biofiltration and phytoremediation processing. Turbidity reduces with residence time in the reactor; there is a significant effect of increasing residence time in the filter to reduce the level of turbidity of the waste. In that study, it is also explained that the thickness of the sand used for filtration media affects the level of turbidity resulting from processing. Likewise, what happened in this study was that the phytoremediation media was also the planting media for Avicennia marina; sand reduced the turbidity content of household greywater waste [7].

The use of Avicennia marina as a phytoremediation medium for greywater waste treatment can reduce turbidity in the physical parameters of water quality. Mangrove plants on the coast of Sidoarjo can increase the brightness of physical parameters in reducing pollution of the aquatic environment. Mangrove plants have the ability to trap sediment particles to reduce the turbidity content in the waters [4].

Table 2: Greywater BOD Measurement

Replication	Day 0 (ppm)	7th day (ppm)	14th day (ppm)
1	308.4	162.3	49.9
2	310.9	160.9	50.03
3	295.85	161.55	48.95
Average	305.05	161.58	49.63
Reduction percentage		47.03%	83.73%

The average household greywater BOD according to table 2 has reduced significantly on the 14th day by 49.63 ppm. The percentage of turbidity reduction reached 83.73% on the 14th day after going through bioball biofiltration and phytoremediation. BOD content could be reduced through aerobic and anaerobic biofiltration at the Permata Bunda Bontang INBIS WWTP. The study states that the use of WWTP is effective in reducing the BOD content of greywater by 83.86%. The presence of microorganisms in the biofiltration helps the degradation of organic compounds in the liquid waste so that the BOD content after processing can decrease [6].

Table 3: Greywater COD Measurement

Replication	Day 0 (ppm)	7th day (ppm)	14th day (ppm)
1	616.24	316.8	95.9
2	622.8	320.9	98.92
3	615.9	310.85	100.05
Average	618.31	316.18	98.29
Reduction percentage		48.86%	84.10%

Table 3 explains that the reduction percentage in household greywater COD reached 84.10% on the 14th day. The average reduction in COD on the 14th day was 98.29 ppm after processing using a bioball biofiltration and phytoremediation. The COD content can be reduced through waste treatment using biofiltration; organic compounds contained in the liquid waste are broken down by the activity of microorganisms. Microorganisms need oxygen to degrade organic content in greywater waste [6].

Table 4: Greywater Nitrate Measurement

Replication	Day 0 (ppm)	7th day (ppm)	14th day (ppm)
1	33.1	17.8	4.02
2	32.95	15.85	3.21
3	31.07	16.9	3.18
Average	32.37	16.85	3.47
Reduction percentage		47.95%	89.28%

Table 4 explains that the average household greywater nitrate on the 14th day was 89.28%. The average reduction in nitrate on the 14th day was 3.47 ppm after going through processing using a bioball biofiltration and phytoremediation. The use of mangrove plants can reduce the nitrate content in the water that pollutes the coastal waters environment. Nitrate is an essential element for plants in forming tissues. Mangrove roots are strong and dense—capable of absorbing water and minerals, including nitrates. The reduction in nitrate content in greywater indicated that the nitrate in the effluent was absorbed by Avicennia marina plants [4].

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Table 5: Greywater Phosphate Measurement

Replication	Day 0 (ppm)	7th day (ppm)	14th day (ppm)
1	61.9	21.5	5.56
2	60.84	20.15	3.9
3	62.56	19.88	4.1
Average	61.77	20.51	4.52
Reduction percentage		66.79%	92.68%

Table 5 explains that the reduction percentage in household greywater phosphate on the 14th day reached 92.68%. The average reduction in phosphate on the 14th day was 4.52 ppm after going through processing using a bioball biofiltration and phytoremediation. Phosphate is a sign of detergent content in the effluent, but it is also an important nutrient used for plant growth. The presence of effective phosphate content reduction in this study indicates that phosphate is absorbed by mangrove plants for growth. Nitrate and phosphate are important nutrients for plant growth – especially for the growth of leaves and plant stems [8] [9].

The presence of detergent content in household waste including phosphate compounds can cause aquatic plants in receiving water bodies to become fertile to the point where they can exceed normal limits resulting in eutrophication if not treated first. Phytoremediation with aquatic plants has been widely carried out; the use of mangrove species of Avicennia marina is an alternative for coastal areas to be used as phytoremediation media. According to the reduction in phosphate levels in this study, microbial activity in plant roots remodels orthophosphate compounds which are builders in detergents into simple phosphate compounds that are more easily absorbed by plants [10]. Phosphate compounds that are absorbed by Avicennia marina plants are used for photosynthesis like other plants.

Table 6: Greywater TSS Measurement

Replication	Day 0 (ppm)	7th day (ppm)	14th day (ppm)
1	642.6	235.9	90.56
2	645.1	235.66	88.7
3	640.9	240.02	89.55
Average	642.87	237.19	89.60
Reduction percentage		63.10%	86.06%

The reduction percentage in household greywater TSS on the 14th day according to table 6 reached 86.06%. The average reduction in TSS on the 14th day was 89.6 ppm after going through processing using a bioball biofiltration and phytoremediation. The use of biofiltration and phytoremediation correlates to TSS with a significance value of 1% and an R-value of 0.735. Time has no significant effect for even though it had been through biofiltration and phytoremediation processing for 10 days because the bacteria in the processing were still in the lag phase where the bacteria were still making adjustments to the environment. Likewise in this study, although it has reduced to 86.06% on the 14th day, it is still not following the required quality standards [11].

The results of statistical analysis showed that the data of all parameters of the greywater content studied were normally distributed and homogeneous ($p>0.05$). There is a difference in the decrease in parameters from the beginning to the 14th day with a significance value of 0.001 for the turbidity and BOD parameters and 0.000 for the COD, Nitrate, Phosphate, and TSS parameters, respectively.

Based on the table above, it can be explained that the BOD and TSS content of household greywater still does not meet the requirements for the quality standards of domestic waste regulated in the Minister of Environment Regulation No. 68 of 2016. The quality of turbidity and phosphate is not regulated in the Minister of Environment Regulation No. 68 of 2016 because its quality standards have not been regulated yet. The content of phosphate and nitrate is a nutrient for plant growth, in which this study used mangrove plants. Nitrates and phosphates are nutrients as nutrients for plant growth [8]. Plants need nitrate and phosphate nutrients to stimulate the growth of leaves and stems [9]. It can be seen that the content of greywater waste reduced for the nitrate and phosphate content was used by mangrove plants for their growth.

4. Conclusion

The physical parameter, namely household greywater turbidity, after going through the treatment with bioball biofiltration and phytoremediation was reduced by 88%. The chemical parameters in BOD, COD, Nitrate, Phosphate, and TSS were also reduced by 83.73%, 84.10%, 89.28%, 92.68%, and 86.06% respectively – after going through the treatment with bioball biofiltration and Avicennia marina phytoremediation for 14 days. The results of statistical analysis show that there are differences in the reduction in the content of the parameters studied from the beginning to the 14th day ($p<0.05$). The COD and household greywater nitrate parameters that have been studied are in accordance with the quality standards required by the Minister of Environment Regulation No. 68 of 2016 concerning the quality standards of domestic waste. Meanwhile, turbidity and phosphate parameters are not regulated in the Minister of Environment Regulation. Although from the results of the study there are some parameters that do not meet the quality standards, the reduction percentage in physical and chemical parameters is significant.

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References

[1] Dinas Lingkungan Hidup (2017) *Dokumen Informasi Kinerja Pengelolaan Lingkungan Hidup Daerah Provinsi Jawa Timur Tahun 2017*.Dinas Lingkungan Hidup Provinsi Jawa Timur
[2] Hamzah (2013) Fitoremediasi Logam berat dengan Menggunakan Mangrove. Ilmu Kelautan: Indonesian

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Journal of Marine Sciences , *18 (4)*pp:203-212 doi:10.14710/ik.ijms.18.4.203-212

[3] Rokhmalia,Fitri dan Pratiwi Hermiyanti (2018) Fitoremediasi Tumbuhan Avicennia Marinaa Terhadap Half Time Pb.*Suara Forikes 9(3)*pp:166-169 http://dx.doi.org/10.33846/9301

[4] Kusumastuti, Widayati.2009.*Evaluasi Lahan Basah Bervegetasi Mangrove Dalam Mengurangi Pencemaran Lingkungan (Studi Kasus Di Desa Kepetingan Kabupaten Sidoarjo)*. Thesis. Semarang: Universitas Diponegoro

[5] Filliazati, Mega (2013) Pengolahan Limbah Cair Domestik Dengan Biofilter Aerob Menggunakan Media Bioball Dan Tanaman Kiambang.*Jurnal Teknologi Lingkungan Lahan Basah* 1-10 http://dx.doi.org/10.26418/jtllb.v1i1.4028

[6] Busyairi, Muhammad, Nikita Adriyanti, Abdul Kahar, Dian Nurcahya, Sariyadi, Tathok D. Hudayana (2020) Efektivitas Pengolahan Air Limbah Domestik *Greywater* dengan Proses Biofilter Anaerob dan Biofilter Aerob (Studi Kasus: IPAL INBIS Permata Bunda, Bontang). *Serambi Engineering V(4)pp:1306-1312* https://doi.org/10.32672/jse.v5i4.2316

[7] Wulandari, Lies Kurniawati, Munasih, Ester Priskasari (2019) Pembuatan Alat Pengolahan Limbah Domestik dengan Menggunakan Pasir Sebagai Filter di IPAL Tlogomas. http://eprints.itn.ac.id/5365/1/5.%20Abdimas%20Final%20%2B%20Summary%20%28Juli%202019%29.pdf

[8] Gultom, Tumpal., Sutanto, Haryati Bawole (2019) Penerapan Hibrid Sistem Biofilter dan Hidroponik Sebagai Alternatif Pengolahan Limbah Pemukiman Low Income People. *Saintek* : Jurnal Ilmiah Sains dan Teknologi Industri 3(2). Pp.70-79 https://doi.org/10.32524/saintek.v3i2.117

[9] Siregar, J., Triyono, S., Suhandy, D (2015) Pengujian Beberapa Nutrisi Hidroponik pada Selada dengan Teknologi Hidroponik Sistem Terapung (THST) Termodifikasi. *Jurnal Teknik Pertanian Lampung V*,4(1), pp.65-72

[10] Suastuti, Ni G.A. M Dwi Adhi, I Wayan Suarsa, Dwi Kurnia Putra R (2015) Pengolahan Larutan Deterjen dengan Biofilter Tanaman Kangkungan (*Ipomea crassicaulis*) dalam Sistem Batch (curah) Teraerasi. *Jurnal Kimia 9(1)* Januari 2015 pp:98-104 https://doi.org/10.24843/JCHEM.2015.v09.i01.p16

[11] Alfonso, M. Arief (2021) Kombinasi Biofilter Anaerob dan Fitoremediasi Tumbuha Kayu Apu (Pistia stratiotes) dalam Pengolahan Air Limbah Rumah Makan. Tugas Akhir. Universitas Islam Negeri Ar-Raniry Banda Aceh

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