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Research Article

Treatment of Domestic Wastewater with Combination of Phytoremediation and Filtration Using Activated Carbon of Tea Dregs

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Abstract
One source of water pollution comes from domestic wastewater as a result of daily human activities. As one of the work units in the field of education, the university also produces domestic liquid waste that needs to be processed so as not to pollute the environment. The use of the phytoremediation method with water jasmine and water hyacinth combined with the use of tea dregs as an activated carbon filter is one method that can be used to treat domestic greywater wastewater. The purpose of this study was to determine the efficiency of reducing levels of COD, BOD, TSS, NH_3, and turbidity in domestic greywater waste at Pelita Bangsa University by phytoremediation methods using water jasmine plants and water hyacinth plants with a combination of filters from tea dregs. The research procedure starts by making activated carbon from tea dregs, characterizing activated carbon with SEM, sampling greywater wastewater, characterizing wastewater test, plant acclimatization, range-finding test, phytoreactor test with activated carbon filter, and data analysis. The phytoremediation method with a combination of filtration using tea dregs activated carbon produces an efficiency of 99.61% COD reduction, 100% BOD, 98.68% TSS, 100% ammonia, and 97.50% turbidity.

Keywords: tea dregs; phytoremediation; activated carbon; greywater

1. Introduction

Domestic wastewater is one of the sources of pollution in water bodies. Prevention of ecosystem pollution by domestic wastewater is essential to ensure continuity for future generations (Murugunandam et al., 2017). One of the business sectors that produce domestic wastewater is Educational Institutions. Higher education is an educational institution with the duty and responsibility to educate the nation's children through implementing the tri dharma of higher education, namely education, and teaching, research, and community service. In carrying out the tri dharma, all activities carried out by the academic community every day can generate domestic waste. Domestic waste generated comes from soapy water, wastewater, and fecal water. One of the private universities proliferating in Bekasi Regency, West Java, is Pelita Bangsa University (UPB) (Nurhidayanti et al., 2021b).

Pelita Bangsa University has a land area of 21,103 m^2 which consists of 4 (four) Faculties. Pelita Bangsa University currently has 256 lecturers and 12,924 students. Due to its location, which is surrounded by the most significant industrial area in Southeast Asia, the number of students continues to increase every year. The increase in the number of students can increase the amount of domestic waste produced. Domestic waste treatment at Pelita Bangsa University currently uses a Wastewater Treatment Plant (WWTP) provided by the Pelita Bangsa Foundation. Broadly speaking, the WWTP building, owned by Pelita Bangsa University, uses a submerged biofilter technology process. The principle of this submerged biofilter technology process is to drain domestic wastewater into a biological reactor equipped with a buffered media as a place for the attachment of microorganisms to decompose wastewater pollutants. Aerobic or anaerobic processes can carry out this process. In the aerobic process, oxygen is needed utilizing aeration, which is used to decompose organic substances. In contrast, the anaerobic process does not require oxygen (aeration) to decompose organic substances (Siregar, 2008).

The adsorption method, anaerobic process, stabilization pond, artificial swamp, and aquatic plant pond can treat domestic wastewater treatment. One method of controlling water pollution using plants is phytoremediation. Phytoremediation is a method to reduce, degrade, or isolate pollutants in the environment using the application of plants and microorganisms. The use of plants makes phytoremediation techniques more environmentally friendly, add aesthetics, and be cheap and easy to apply (Moosavi & Mohamd, 2013). Research on domestic waste treatment at Pelita Bangsa University has previously been carried out using the phytoremediation method using apu wood and kana flowers with activated charcoal filters from coffee grounds in domestic wastewater samples able to reduce Total Dissolved Solid (TDS) by 29.03%, Total Suspended Solid (TSS) by 98.20%, and Biological Oxygen Demand (BOD) of 76.04% (Nurhidayanti & Ardiatma, 2020). The phytoremediation method using apu wood and kana flowers requires affordable costs and can beautify the area near the WWTP (Nurhidayanti et al., 2021b).

Phytoremediation using water hyacinth plants can reduce BOD, TDS, Chemical Oxygen Demand (COD), TSS, Pb content in wastewater and can adjust the pH either increase or decrease the pH of the water to around 6-9 (Zahro et al., 2020). Phytoremediation using water jasmine plants can reduce iron levels as much as 99.40% on the ninth day (Rachmawati, 2020), phosphate levels in laundry wastewater as much as 98.90% on the fourteenth day (Sari et al., 2021), BOD levels by 96.82%, COD by 87.40%, and TSS of 93.17% in domestic liquid waste on the ninth day (Adinata, 2020). The utilization of tea dregs waste can also be used as a bioadsorbent which can reduce lead levels with an efficiency of 93.75%-94.25% (Azzahra, 2020), copper by 72.13%, and berries by 80.78% (Pratama et al., 2017). Using a combination of phytoremediation using apu wood and kana flowers with activated charcoal filters from coffee grounds in domestic wastewater samples at rented X was able to reduce BOD by 80.65%, COD by 70.59%, and TSS by 79.17% (Nurhidayanti et al., 2021a). It is also very effective in reducing the ammonia content in domestic wastewater, with effectiveness of 97.10% (Nurhidayanti et al., 2021b).

Indonesia can produce as much as 150 thousand tons of tea per year, of which 50% of the tea made is exported abroad. The remaining 50% is sold domestically and consumed by the public (Pratama, 2017). Of the tea consumption, 30% will produce dregs that are not utilized. Tea dregs in large quantities that are directly stored without being used first are domestic wastewater is one of the sources of pollution in water bodies. Prevention of ecosystem pollution by domestic wastewater is essential to ensure continuity for future generations (Murugunandam et al., 2017). One of the business sectors that produce domestic wastewater is Educational Institutions. Higher education is an educational institution with the duty and responsibility to educate the nation's children through implementing the tri dharma of higher education, namely education, and teaching, research, and community service. In carrying out the tri dharma, all activities carried out by the academic community every day can generate domestic waste. Domestic waste generated comes from soapy water, wastewater, and fecal water. One of the private universities overgrowing in Bekasi Regency, West Java, is Pelita Bangsa University (UPB) (Nurhidayanti et al., 2021b).

Based on some of the research results above, the researchers tried to combine the phytoremediation method of water jasmine and water hyacinth plants with activated carbon filters from tea dregs to treat Pelita Bangsa University domestic wastewater. The results of the preliminary analysis of UPB domestic greywater wastewater obtained pH values of 7.36, TSS of 40.14 mg/L, NH_3 of 19.93 mg/L, BOD of 75.02 mg/L, COD of 140.07 mg/L, turbidity 53.90 NTU and Oils and Fats 0.0083 mg/L. The COD, BOD, TSS and NH_3 values still exceed the domestic wastewater quality standards according to the Minister of Environment and Forestry Regulation No. 68 of 2016 concerning Domestic Wastewater Quality Standards, while the pH values and oils and fats still meet the quality standards.

This study aims to determine the optimum concentration of domestic wastewater for the growth of water jasmine and water hyacinth plants and to determine the efficiency of reducing COD, BOD, TSS and NH_3 levels in domestic greywater waste at Pelita Bangsa University by using phytoremediation methods using water jasmine plants and water hyacinth plants in combination. Filter from tea dregs. The novelty of this research is the use of tea dregs as an additional adsorbent combined with the phytoremediation method using water jasmine and water hyacinth plants.

2. Methodology

2.1. Research Materials and Tools

The materials used in this study consisted of domestic waste originating from WWTP Pelita Bangsa University, filtration materials (tea dregs, silica sand and gravel), water hyacinth plants, water jasmine plants, 85% H_3PO_4 solution, materials for BOD analysis using the method Winkler titration (aquadest, 1.5 N phosphate buffer solution, 0.71 N ammonium chloride solution, 0.25 M calcium chloride solution, 0.41 M magnesium sulfate ($MgSO_4$) solution, 0.018 M ferric chloride, 6 N calcium hydroxide solution, 1 N H_2SO_4 solution and NaOH solution 1 N), material for COD analysis by closed reflux method (H_2SO_4 solution, ferrous ammonium sulfate solution, sulfamic acid and potassium hydrogen phthalate standard solution), NH_3 analysis by phenate method (phenol solution, 0.5% sodium nitroprusside, alkaline citrate, sodium hypochlorite), materials for TSS analysis using the gravimetric method (microglass-fiber filter media with porosity sizes of 0.7 m to 1.5 m; mineral-free water), materials for general research Monia using a phenate spectrophotometer method (ammonia chloride, phenol solution, 0.5% sodium nitropusside, alkaline citrate solution, 5% sodium hypochlorite solution) and materials for turbidity analysis using a nephelometer (hydrazine sulfate solution, hexa methylene tetramine solution, turbidity parent suspension 4000 NTU , standard suspension turbidity 40 NTU).

The tools needed in this research consist of 4 main parts. In the first part, a tub measuring 550 mm x 360 mm x 300 mm with a volume of 50 liters is used as a container for domestic liquid waste, which is connected to a PVC pipe with a diameter of 2/3 inch and is equipped with 2 pumps with a speed of 500 liters/hour. The second part is a filter tube made of cans measuring 173 mm x 142 mm x 240 mm with a volume of 6 liters which contains 3 layers, namely; on the top layer, there is activated carbon of tea pulp, in the middle layer of silica sand and on the bottom layer of gravel. In the third part, there are 3 reactor tanks made of plastic measuring 550 mm x 360 mm x 300 mm with a volume of 50 liters as a container for the growth of water hyacinth plants. The three containers are connected by a PVC pipe measuring 2/3 inches. In the fourth part, there are 10 reactor tanks made of plastic measuring 100 mm x 80 mm x 80 mm with a volume of 8 liters which are used for water jasmine plants which are equipped with an 11 mm hose to connect the water jasmine plant to the water hyacinth plant—and fitted with a faucet so that it can regulate the discharge to be issued.

After passing through the four sections, the domestic waste treated is returned to the first section of the tub using a 2/3 inch PVC pipe. In the middle of the pipe, a faucet lever is given as the output of sampling the results of domestic waste treatment. In addition to this equipment, the analytical equipment used in this study is test equipment following APHA 5210D 2017 for BOD parameters, APHA 5220D 2017 for COD parameters, and APHA 4500-NH3 F 2005 for ammonia parameters, and SNI 06-6989.25-2005 for turbidity parameters. Researchers make tool designs as an illustration of the shape of the phytoreactor that will be used. The series of phytoreactor equipment is presented in Figure 1.

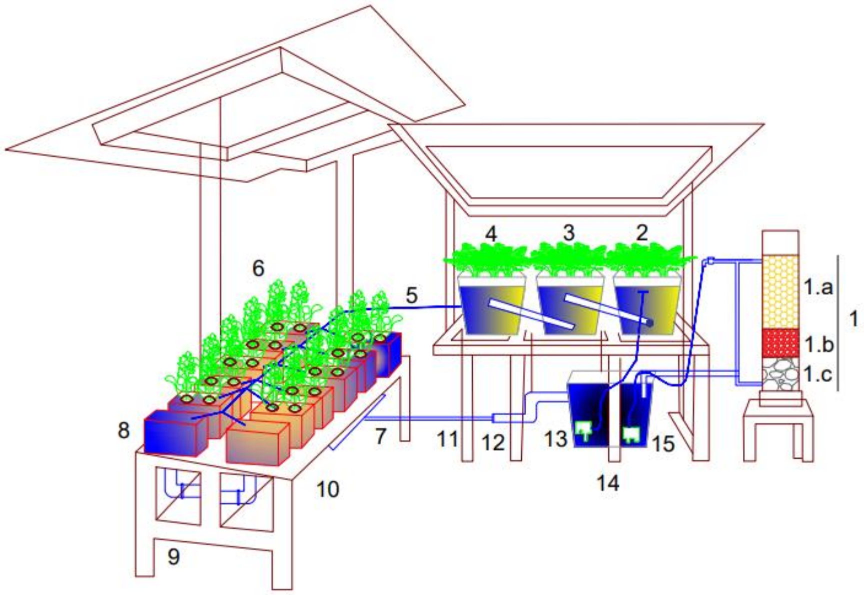


Figure 1. Phytoreactor equipment circuit with filter combination (Modified from Nurhidayanti, 2020)

Image caption 2: 1). Filter (1.a. Tea dregs activated carbon; 1.b. Silica; 1.c. Pebbles); 2). Water hyacinth I phytoreactor tank I; 3). Water hyacinth II phytoreactor tub; 4). Water tub hyacinth phytoreactor III; 5).Hose connector; 6). Water tub Phytoreactor Jasmine Water I; 7). Phytoreactor tub water Jasmine II; 8). Control Body I; 9). Connecting pipe for Water Jasmine Phytoreactor; 10).Control tub II; 11). Pipe connecting the phytoreactor tank to the wastewater reservoir; 12). Outlet Sampling; 13). Wastewater reservoir; 14). Pump into the water hyacinth phytoreactor and 15). Pump connecting to the filter.

2.2. Testing Method

The testing method for each pollutant parameter of domestic greywater wastewater follows table 1 as follows:

Table 1. Domestic wastewater pollutant parameters and analytical methods used

No.	Parameters	Unit	Reference	Analysis Method
1.	pH	-	-	Potentiometry
2.	TSS	mg/L	APHA 2540 D 2017	Gravimetry
3.	BOD	mg/L	APHA 5210 B 2017	Winkler titration
4.	COD	mg/L	APHA 5220 D 2017	Closed reflux
5.	NH_3	mg/L	APHA 4500 F 2017	Spectrophotometry
6.	Oil and fat	mg/L	APHA 5520 B 2017	Gravimetry
7.	Turbidity	NTU	SNI 06-6989.25-2005	Nephelometer

2.3. Research Stages

2.3.1. Wastewater Sampling

The sampling method used in this study is to use an exact sampling method, namely samples taken from the same domestic wastewater collection point on the 0, 1st, 3rd, 5th and 7th day at 16:00 pm until 16:15 pm, with duplicate samples used to test the accuracy of the sampling procedure.

2.3.2. Wastewater Quality Analysis

Analysis of domestic greywater wastewater quality was carried out in the laboratory of PT Tuv Nord Indonesia, Cikarang, Bekasi Regency.

2.3.3. Making Activated Charcoal from Tea Dregs

The tea dregs were dried using a tray dryer at a temperature of 40°C to dry. Then the tea dregs were mashed using a ball mill and sieved using a 50 mesh sieve. Then the tea dregs were activated by dissolving in 85% phosphoric acid solution for 24 hours with a weight ratio of 1:2 for tea dregs with phosphoric acid. Furthermore, the dried tea dregs were put into a vacuum furnace operated at a temperature of 500°C for 15 minutes. Likewise, the activated carbon of the tea dregs from the furnace was washed with hot water at 85°C and dried in the oven at 110°C. The resulting activated carbon is then pulverized using a mortar and ready to use (Pratama, 2017)

2.3.4. Acclimatization

The acclimatization stage was carried out on water jasmine plants aged 2 months and over as many as 20 plants grown in the drift hydroponic system and 282 water hyacinth plants planted in phytoreactors for 7 days. The selection of ages 2 months and over was based on the results of previous studies, which stated that at that age, water jasmine plants could reduce phosphate levels by 98.90% (Sari, 2021). Determination of the number of water hyacinth plants based on the equation (1).

Water Hyacinth Mass = Water Hyacinth Density x Volume (1)
= $1.88\ gr/cm^3$ x 150 L
= $1.88\ gr/cm^3$ x 150,000 cm^3
= 282,000 gr

Number of plants = (Water Hyacinth Mass)/(Wet Weight) (2)
= (282,000gr)/(1,000 gr)= 282 plants

The purpose of acclimatization is to obtain water jasmine and water hyacinth plants adapted to the media in the Range Finding Test (RFT)/phytoreactor test. Water hyacinth and water hyacinth plants that are still alive and green will be taken for research. The total volume of domestic liquid waste used is 150 liters.

2.3.5. Range Finding Test (RFT)/Phytoreactor Test

At this stage, preparing greywater wastewater with 5 variations in concentration must be done, namely 20%, 40%, 60%, 80%, and 100%. Tests were carried out using the same phytoreactors and plants with the acclimatization process. Furthermore, wastewater is added and circulated into the phytoreactor for 7 days. The concentration of wastewater that does not cause death in water hyacinth and water jasmine plants will be observed for parameters BOD, COD, TSS, NH_3, and turbidity every day for 7 days with sampling carried out in the afternoon with 2 liters of test samples taken in the afternoon (hours 16:00) on the 0^{th} day, 1^{st} day, 3^{rd} day, 5^{th} day and 7^{th} day.

2.3.6. Phytoreactor Test with Activated Carbon Filter

At this stage, the same steps as the phytoreactor test stage must be carried out. The difference is by combining water hyacinth and water jasmine plant phytoreactors with a filter consisting of tea dregs activated carbon, silica sand, and gravel.

2.3.7. Data Analysis

Quantitative data processing using Microsoft excel software is then displayed in the form of graphs and bar charts. Determination of the efficiency of reducing the concentration of pollutants in domestic greywater wastewater using equation (3) as follows (Maryana, 2020):

$$E = \frac{S0-S1}{S0} x100\% \quad (3)$$

Description: E = Efficiency (%) ; So = Concentration of waste pollutants on day 0 (mg/L); S1 = Concentration of waste pollutants on day 7 (mg/L).

3. Result and Discussion

Based on the results of laboratory tests in Table 2 shows that the treatment of domestic greywater waste using the phytoremediation method using water jasmine and water hyacinth plants can reduce wastewater pollutants COD, BOD, TSS, and ammonia which previously did not meet the quality standards to meet the quality standards according to the Regulation of the Minister of the Environment Number 68 of 2016. The addition of an additional turbidity parameter is done because the wastewater looks cloudy, so it is necessary to observe the efficiency of using the tea dregs filter used.

Table 2. Domestic greywater waste quality test results before and after phytoremediation

No	Parameters	Unit	Previous Test Results	Quality standards	Test Results
1	pH	-	7.36	6 – 9	7.92
2	COD*)	mg/L	140.07	100	0.55
3	BOD*)	mg/L	75.02	30	0
4	TSS*)	mg/L	40.14	30	0.53
5	NH_3*)	mg/L	19.93	10	0
6	Oil and Fat	mg/L	0.0083	5	0
7	Turbidity	NTU	53.90	-	1.35

*) does not meet the quality standards before processing with phytoreactors

The results of the observation of the RFT process for seven days showed that water jasmine and water hyacinth plants could survive well at all concentrations of waste. This is indicated by plant growth that continues without problems, and plants look fresh from the first day until the seventh day. The concentration of waste used in the study was the highest concentration obtained from the RFT results of the two types of plants, namely the concentration of 100%. This is done so that the absorption of plant nutrients from wastewater is more optimal, and there is no need to dilute it first. The results of the RFT can be seen in Table 3.

Table 3. Results of the range-finding test (rft) for water jasmine and water hyacinth

Waste Concentration % (v/v)	Number of Water Jasmine Plants (x)	Amount of dead Water Jasmine	Number of Water Hyacinth Plants (y)	Amount of dead Water Jasmine	Plant Death Effect (%)
0	20	0	282	0	0
20	20	0	282	0	0
40	20	0	282	0	0
60	20	0	282	0	0
80	20	0	282	0	0
100	20	0	282	0	0

3.1 Research Results

3.1.1 COD Parameters

The results of testing the COD concentration during the phytoremediation process with a modification of the tea dregs activated carbon filter is presented in Figure 2 as follows:

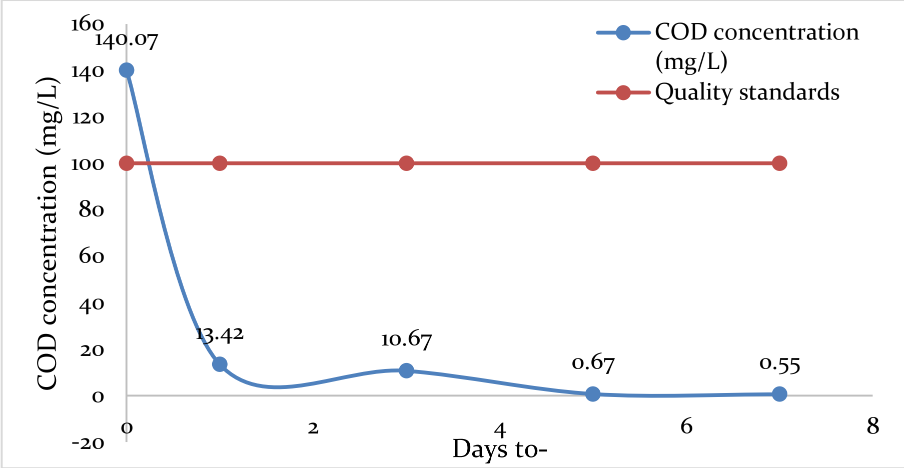


Figure 2. COD concentration test results during the phytoremediation process with modified tea dregs activated carbon

The Figure 2 shows that the longer the domestic waste solution in the phytoreactor bath, the lower the COD value. This is because the residence time during the phytoremediation and filtration process will allow microorganisms in plant roots to decompose organic compounds in domestic greywater wastewater. The decrease in COD value is also influenced by the availability of oxygen gas and sunlight in photosynthetic reactions that support the growth of microorganisms on the roots of water jasmine and water hyacinth plants more and more (Raissa, 2017; Nurhidayanti et al., 2021). The presence of an activated carbon filter from tea dregs also plays a role in the COD adsorption process contained in greywater wastewater. The pores of activated carbon from tea dregs will absorb COD so that the concentration of COD during phytoremediation and filtration will decrease.

The COD results on day 0 were obtained at 140.07 mg/L, so the COD results did not meet the quality standards set, but after the phytoremediation process was carried out using water jasmine and water, hyacinth plants and tea dregs from COD from day 1 to day 2. -7 has met the quality standard according to the Minister of Environment and Forestry Regulation No. 68 of 2016, which is the 1st day of 13.42 mg/L; day 3 of 10.67 mg/L; day 5 of 0.67 mg/L; and day 7 of 0.55 mg/L. After comparing the previous phytoremediation research conducted by Kurniawati et al. (2018), using jasmine water resulted in a % COD removal of 89.31% on the 7th day. This study resulted in a more effective % COD removal within 7 days of 99.61% compared to previous studies due to the combination of the use of coffee grounds activated carbon filter with water jasmine and water hyacinth plant phytoreactors. So that it can increase the ability of COD absorption carried out by the ability of water jasmine and water hyacinth plants followed by the presence of activated carbon pores from tea dregs which can further reduce COD concentrations. Based on the data of this study, the COD concentration after going through the phytoremediation process for 7 days has met the quality standard according to the Minister of Environment and Forestry Regulation No. 68 of 2016. The results of previous studies showed that the efficiency of water hyacinth in reducing COD levels in laboratory wastewater has an increasing pattern that tends to be linear. The reaction that occurs during the phytoremediation process so that it can reduce COD follows equation (4) as follows (Sawyer et al., 2003):

$$C_nH_aO_bN_c + dCr_2O_7^{2-} + (8d + c)H^+ \xrightarrow{\Delta} nCO_2 + \frac{a + 8d - 3c}{2} H_2O + cNH_4^+ + 2dCr^{3+} \quad (4)$$

The effectiveness of reducing COD concentration during the phytoremediation process in this study reached 99.61%. So it can be concluded that microorganisms in this phytoremediation process can optimally decompose organic matter in domestic greywater wastewater.

3.1.2 BOD Parameters

The results of testing the BOD concentration during the phytoremediation process with a modification of the tea dregs carbon active filter are presented in Figure 3 as follows:

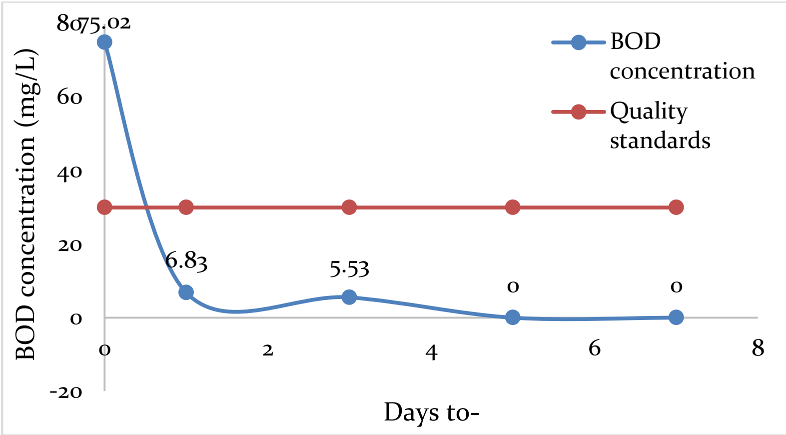


Figure 3. BOD concentration test results during the phytoremediation process with modified tea dregs activated carbon

The results of BOD on day 0 were obtained at 75 mg/L, so the results of BOD did not meet the quality standards that had been set, but after the phytoremediation process was carried out using water jasmine and water hyacinth plants and tea dregs from the BOD result from day 1 to day 2. -7 has met the quality standard according to the Minister of Environment and Forestry Regulation No. 68 of 2016, which is the 1^{st} day of 6.8 mg/L; day 3 of 5.5 mg/L; day 5 of 0 mg/L; and the 7^{th} day of 0 mg/L. After comparing the previous phytoremediation research conducted by Kurniawati (2018) using water jasmine, the % BOD removal was 88.50% on the 7^{th} day. This study resulted in 100% more effective BOD removal within 7 days of 100% compared to previous studies because the use of a combination of filtration in the phytoremediation method using water jasmine and water hyacinth plants can absorb more BOD as plant nutrients and also absorption by the pores of the activated carbon residue.

The longer the phytoremediation time, the more organic compounds will be absorbed by plants and undergo phytodegradation by wastewater microorganisms into water and carbon dioxide (Nurhidayanti et al., 2021). The reaction for reducing BOD during the phytoremediation process that occurs follows equation (5) as follows (Sawyer et al., 2003):

$$C_nH_aO_bN_c + \left(n + \frac{a}{4} - \frac{b}{2} - \frac{3}{4}c\right)O_2 \rightarrow nCO_2 + \left(\frac{a}{2} - \frac{3}{2}c\right)H_2O + cNH_3 \qquad (5)$$

The effectiveness of reducing the concentration of BOD during the phytoremediation process in this study reached 100%. So it can be concluded that microorganisms in this phytoremediation process can decompose organic matter in domestic greywater wastewater into water and carbon dioxide optimally. Plants will use the carbon dioxide that is formed to carry out the process of photosynthesis. Then, dissolved oxygen in greywater wastewater will increase due to the reaction of photosynthesis from water jasmine and water hyacinth plants (Sari & Hermiyanti, 2020).

3.1.3 TSS Parameters

The results of testing the concentration of TSS during the phytoremediation process with modified tea dregs activated carbon filter are presented in Figure 4 as follows:

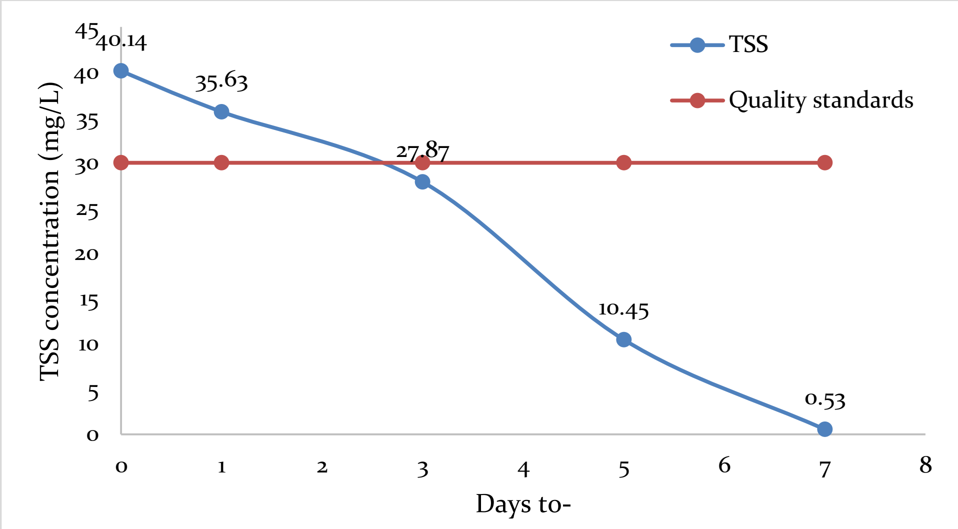


Figure 4. Test results TSS concentration during the phytoremediation process with modified tea dregs activated carbonate

The Figure 4 shows that the concentration of total suspended solids in wastewater decreased from day 0 to day 7. The TSS concentration on day 0 was 40.14 mg/L. In this case, the TSS concentration had exceeded the TSS quality standard set at 30 mg/L. During the phytoremediation and filtration processes, there was a significant decrease in TSS concentration. The TSS concentration on day 1 was 35.63 mg/L, on day 3, it was 27.87 mg/L, on day 3, it was 10.45 mg/L, and on day 3, it was 10.45 mg/L. 7th is 0.53 mg/L. The use of phytoremediation and filtration methods until the 7th day of TSS concentration has met the quality standard according to PermenLHKi No. 68 of 2016. The decrease in TSS concentration during the phytoremediation process is due to the solid particles in domestic greywater wastewater forming floc solids, causing the density to be greater than that of the density of wastewater which results in the deposition of solid particles at the bottom of the phytoreactor, while for solid particles that have a density that is smaller than the density of water will float and stick to the plant roots (Fachrurozi et al., 2010) while in the filtration process will cause solid particles filtered on the tea dregs activated carbon filter. The phytoremediation and filtration processes also cause domestic greywater wastewater to be more evident than on day 0. This is due to the operation of particle deposition and suspended solids particles that are absorbed by plant roots (Dewi & Akbari, 2020; Nurhidayanti, 2020).

3.1.4 Ammonia Parameters

The results of testing the ammonia concentration during the phytoremediation process with modified tea dregs activated carbon filter are presented in Figure 5 as follows:

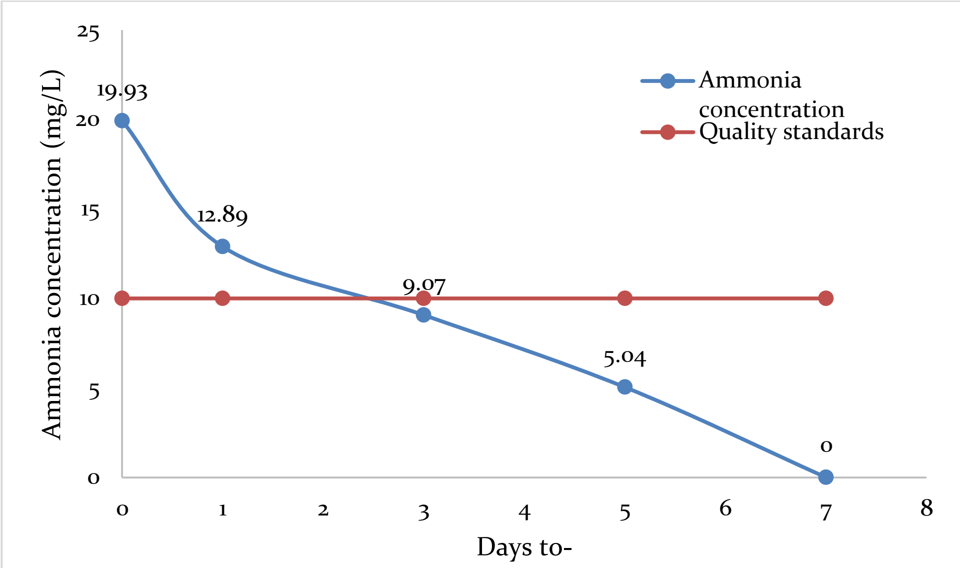


Figure 5. Test results in ammonia concentration during the phytoremediation process with modified tea dregs activated carbon

Ammonia concentration on day 0 was still relatively high at 20.00 mg/L because the primary source of ammonia came from domestic activities such as feces and laundry water. During phytoremediation and filtration using water jasmine and water hyacinth, the ammonia concentration gradually decreased from day 1 to day 7. Ammonia decreased on day 1 to 8.06 mg/L; on day 3 of 0 mg/L; day 5 of 0 mg/L; and the 7th day of 0 mg/L. This shows that the ammonia concentration on the second day has met the quality standard according to the Minister of Environment and Forestry Regulation No. 68 of 2016. According to Hendriarianti and Ratna (2018), the longer the plant contact time with wastewater during the phytoremediation process, the lower the ammonia concentration value due to nutrient absorption. Plant. Phytoremediation of water hyacinth (*Eichornia crassipes*) through a 25% dilution process can improve ammonia pollutant levels. It is safer to be discharged into the environment because it meets tofu wastewater quality standards. The morphology of water hyacinth and water jasmine plants during the phytoremediation process at a concentration of 100% v/v domestic wastewater can also beautify the environment. It is indicated by the color of the leaves of water hyacinth and water hyacinth, which remain green until the end of the treatment, and the biomass of water hyacinth and water jasmine increases in size. (Yuni et al., 2014). The effectiveness of reducing ammonia concentration during the phytoremediation process in this study reached 100%. So it can be concluded that the absorption of ammonia nutrients by water jasmine and water hyacinth plants during the phytoremediation process has been running optimally.

3.1.5 Turbidity Parameters

The results of testing the turbidity concentration during the phytoremediation process with modified tea dregs activated carbon filter are presented in Figure 6 as follows:

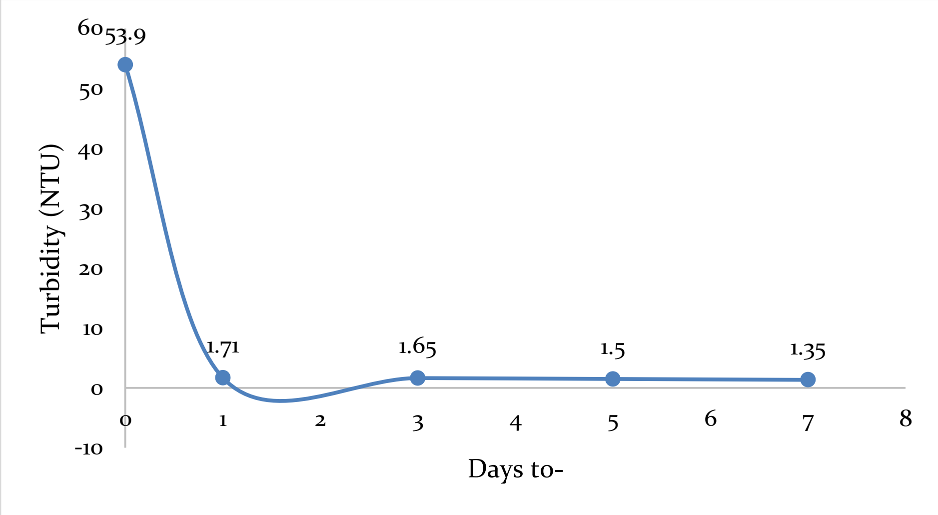


Figure 6. Turbidity test results during the phytoremediation process with modified tea dregs activated carbon

The figure 6 shows that during the phytoremediation process using water jasmine and water hyacinth plants and filtration using tea dregs activated carbon, the turbidity of domestic greywater wastewater decreased from day 0 to day 7. On day 0, turbidity was 53.90 NTU, then decreased on day 1 to 1.71 NTU; on the 3rd day of 1.66 NTU; day 5 of 1.50 NTU; and the 7th day of 1.35 NTU. The highest decrease in turbidity on day 1 was 52.19 NTU, and this was due to the process of particle deposition/colloidal sedimentation in wastewater (Nurhidayanti, 2020) and the process of particle adsorption by rhizosphere microbes on the roots of water jasmine and water hyacinth plants (Novita, 2019). Organic and inorganic compounds in domestic greywater wastewater can be reduced by rhizosphere microbes present in the roots of water hyacinth and water jasmine. Rhizosphere microbes absorb organic and inorganic compounds from wastewater and sediment on plant roots, which accumulate to other plant parts such as stems and leaves (Rukmi, 2013).

3.1.6 Efficiency of Reducing Domestic Wastewater Pollutants

The results of the calculation of the efficiency of reducing domestic wastewater pollutants during the phytoremediation process with a modification of the tea pulp activated carbon filter are presented in Figure 7 as follows:

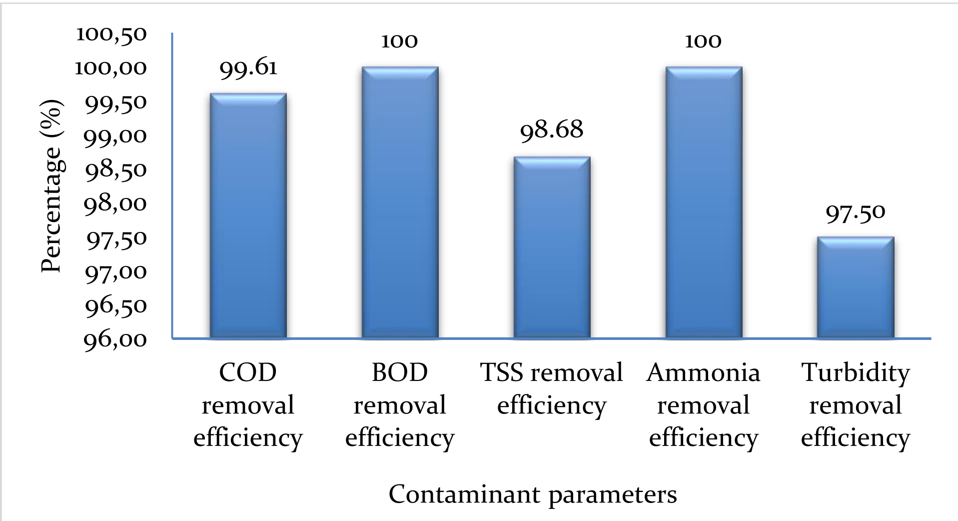
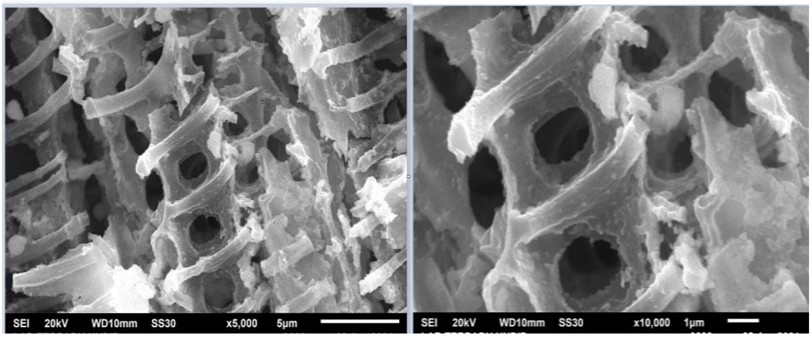


Figure 7. Contaminant reduction efficiency graph after phytoremediation process with filtration

Figure 7 shows that the results of the calculation of the efficiency of reducing domestic wastewater pollutants during the phytoremediation process by modifying the tea dregs activated carbon filter, namely the efficiency of reducing COD by 99.61%, the efficiency of reducing BOD by 100%, the efficiency of reducing TSS by 98.68%, the efficiency of reducing ammonia by 100% and the efficiency of reducing turbidity by 97.50%. This shows that the use of phytoremediation methods using jasmine water and water hyacinth plants with modified tea dregs activated carbon filter has high efficiency in reducing the concentration of wastewater pollutants to meet the quality standards that have been set. This is because the addition of an activated carbon filter from the tea dregs used has activated carbon pores that can absorb pollutants from domestic greywater wastewater. The characteristics based on the results of Scanning Electron Microscopy (SEM) with a magnification of 5000 times and 10000 times of activated carbon of tea dregs are presented in Figure 8 as follows:



a) b)

Figure 8. SEM analysis results activated carbon from tea dregs with magnification a) 5000 times and b) 10000 times

Figure 8 shows that the activated carbon from tea dregs has a reasonably large adsorption ability, as indicated by the number of pores scattered on the surface of the activated carbon so that it can absorb TSS, BOD, COD, ammonia, and turbidity of domestic greywater wastewater. The highly carbonated and aromatic structure of tea pulp-activated carbon with enlarged internal pores and many cavities can be beneficial in the absorption of wastewater contaminants (Rajaphaksa, 2014). In another study also showed the adsorption ability of activated carbon from tea dregs, which can reduce the levels of heavy metals lead (Pb^{2+}) by 125 mg/g and cadmium (Cd^{2+}) by 142.90 mg/g (Joshi et al., 2020), and chromium (Cr^{6+}). 197.50 mg/g (Khalil et al., 2020).

4. Conclusion

Based on the research that has been done, it can be concluded that the optimum concentration of domestic wastewater for the growth of water jasmine and water hyacinth plants is 100%. Using the phytoremediation method with a combination of filtration using tea dregs activated carbon can produce efficiency of 99.61% COD reduction, 100% BOD, 98.68% TSS, 100% ammonia, and 97.50% turbidity. So that the phytoremediation method with water jasmine and water hyacinth plants with a combination of filtration using tea dregs activated carbon is very effective in treating domestic graywater wastewater.

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