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IMPACT OF ALBIZIA WOOD (*Albizia Chinensis*) ADSORBENT ON THE REDUCTION OF POLLUTANTS AND COPPER IN INDUSTRIAL WASTEWATER

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ABSTRACT

This paper investigated the possibility of using mothball tree wood to absorb copper from industrial wastewater. The adsorbent is made from sawdust, activated with 3N H_3PO_4 for 24 hours to increase its porosity and surface area, and examined its morphology and microstructure by Scanning Electron Microscope (JEOL-6510A). Pollution abatement experiments were carried out with uncontrollable samples from these three original rivers contaminated by textile, laundry, and industrial revenues. Copper content was determined by Atomic Absorption Spectroscopy (AAS), and various parameters such as the dissolved oxygen (DO), BOD5, cod consumed nitrates nitrogen, TDS, and TSS were measured. As a result of the adsorption process, a significant reduction of pollutants was achieved. The concentrations of copper in samples reduced to lower than measurable levels or became "trash elements," while initial Cu content turned to 0.017ppm, 0.006ppm, and 0.026ppm. Gains included incorruptible DO rates (54.17% textile)d5 BOD falls by 50.05%, 58.56%, and 68.94%, respectively. COD decreased by 33.33%, 50.00%, and 25.00%. Lower TDS enrolled 3.9%, 12.9%, 57.4% TSS went down to 96.38%, 79.17%, 39.76%. These results illuminate the potential of using Albizia wood as an adsorption medium in wastewater treatment, with pollution reductions evident. Future research can further this by using more advanced analysis methods such as XRD, FTIR, and turbidity tests and looking at other natural adsorbent materials for improving water treatment.

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INTRODUCTION

These days, people are frequently preoccupied with water pollution challenges, and industrial sewage expenses alone often outstrip the combined cost of treatment and recycling energy. Water pollution is dreadful, messing up the environment and making people sick. According to the Ministry of Environment and Forestry, some 70% of Indonesia's rivers are polluted by industrial waste. Data from the Central Statistic Agency shows that water pollution levels have increased by 15% over the past five years [1].

Various chemicals from different waste sources contribute to pollution production, including industrial, household, agricultural, and mining waste. Industrial waste, for example, from the textile and chemical industries, may often be filled with such hazardous pollutants as heavy metals (i.e., copper, lead, mercury) and organic chemicals (i.e., phenols, pesticides). Household waste generally adds detergents, oil, and microplastics; agricultural waste frequently contains nitrogen and phosphorus-rich pesticides and fertilizers, encouraging eutrophication [2].

Heavy metals with high toxicity found in wastewater compose mercury (Hg), cadmium (Cd), copper (Cu), nickel (Ni), arsenic (As), lead (Pb), silver (Ag), chromium (Cr), tin (Sn), manganese (Mn) and zinc (Zn) [3]. Mercury is highly toxic and can cause nerve damage and central damage to nerves (and even the liver) in man. In the environment, mercury bioaccumulates up the food chain, especially in fish that men eat. The Minamata incident in Japan, ca. 1950s, is a well-known example of mercury pollution that caused widespread poisoning by consuming contaminated fish [4]. Cadmium is also highly toxic, causing kidney, bone, and respiratory system damage. It is often found in soil and water as a pollutant due to industrial waste disposal or pesticide use. A study of industrial areas in China revealed how cropland was being polluted with high levels of cadmium from industry, thus affecting the environment and people's health [5]. Copper, while necessary at low levels, can become poisonous if its concentration rises too high, resulting in gastrointestinal system disorders and liver and kidney damage. In the environment, copper is often present in agricultural and industrial waste. One Indian experiment found that copper pollution from metal processing plants polluted the groundwater quality they used to irrigate and drink from [6].

When they enter the bowl, heavy metals are extremely toxic and can produce poisoning. Inhalation of polluted air, contaminated food and water consumption, and direct skin contact. This information plaque shows that natural organisms cannot break down heavy metals [3], so small amounts can significantly affect living creatures. Every heavy metal has a threshold of absorption by living organisms [7]. The heavy metals in wastewater may pollute the water around industrial areas and poison aquatic life [8]. The Ministry of Environment and Forestry in Indonesia reports that rivers near industrial areas in West Java are heavily polluted. Mercury, cadmium, and copper levels exceed WHO safety standards [1].

Bioaccumulation occurs when metal accumulates in the cells of aquatic organisms such as fish and invertebrates over long periods. These organisms then become food sources for higher predators in a food chain, increasing heavy metal concentration at each trophic level of bamboo. [4] As this imbalance in fluidity spreads through the many forms of contamination [9], The Citarum River is located in West Java. It is often mentioned as one of the world's most polluted rivers. Wastes discharged by industry into this river contain various heavy metals, including copper, cadmium, and mercury [1].

Water takes the lead in irrigation and meeting the people's daily needs; water around industrial areas such as the Citarum River is important to local communities.

Several years ago, a study by Padjadjaran University found that Some parts of the Citarum River had 0.005 milligrams per liter of mercury, twice the WHO limit. In the case of heavy metal levels in river water, adsorption is The most economical and efficient treatment [8]. Organic and inorganic substances unite through a simple atomic interaction to form larger particles, colloidal and solid, a process called adsorption [10].

A study has demonstrated the feasibility of reducing Cr(VI) and As(V) concentrations in wastewater using modified sawdust, showcasing a highly practical and eco-friendly water treatment method due to its ability to rapidly and effectively bind heavy metals [11]. Another investigation revealed that lead adsorption by sawdust biomass was most effective at a neutral pH of 7, with 0.15 mg of lead adsorbed using 400 mg of the adsorbent material [12]. Research on tamarind seed as a coagulant found that, at an optimal dosage of 4 grams, BOD in restaurant wastewater was reduced by 90.97% and TSS by 95.18% [13]. Unlike previous studies that focused on industrial waste from pharmaceutical companies, restaurant wastewater, and river effluent, this research employed domestic waste. This approach aims to mitigate pollution, particularly in water bodies.

The results demonstrate the effectiveness of tamarind seeds in significantly reducing dissolved organic matter and suspended solids from wastewater.

Nworu et al. (2019) studied the use of mixed animal bone adsorbents (cow, donkey, chicken, and horse) for Cr(VI) adsorption at 53 mm adsorbent size 35 minutes' results were obtained with pH 6. 70 mg/L chromium ion concentration, 3 g adsorbent dose and 303K respectively. The results had a higher R2 value of 0.9938 for the Freundlich isotherm than Langmuir's 0.99, indicating mixed animal bones as an effective Cr(VI) adsorbent [14]. This study demonstrated that adsorbents from mixed animal bones effectively removed Cr(VI) from wastewater, reducing heavy metal pollution.

The significance of these projects to the present research lies in using different adsorbent materials to study money application cases. This is such as Albizia wood sawdust activated with 3N H_3PO_4. While using different materials, these studies aim to transform the efficiency of heavy metal removal from wastewater (distinguishing aspects of both human health and environmental research).

Against the background of current environmental problems, it is clear that making adsorbents to adsorb heavy metal pollutants from various industrial wastewaters through Albizia wood sawdust--a type of solid waste. Just using Albizia wood sawdust brings us a solution to solid waste problems and permits us to solve the problem of water pollution. Using Albizia wood sawdust, this approach must become effective whenever you want to manage waste sustainably. With the volume of industrial waste continuously rising and the looming threats from serious water pollution, Albizia wood sawdust offers a new approach to controlling and reducing waste. In addition to environmental benefits, using Albizia wood sawdust to produce adsorbents has significant economic potential. Sawdust waste is usually readily available in significant amounts at a low price, so using it as a raw material for producing adsorbents is affordable. This can reduce wastewater treatment costs and add value to previously considered waste.

The study aims to develop an adsorbent from Albizia wood sawdust that can capture copper and other water pollutants discovered in river water tainted by industrial sludge. This examination centers around building practical and capable waste administration arrangements. What makes this investigation novel is its utilization of animated Albizia wood sawdust as an adsorbent, which has rarely been concentrated until now. The objective is to determine the effect of animated Albizia wood sawdust on retaining copper and different pollutants from contaminated waterways. Also, it looks at the adsorption proficiency of Albizia wood sawdust contrasted with different regular adsorbents, for example, tamarind seeds or creature bone blends. Furthermore, the investigation will recognize interaction parameters that can be adjusted to improve the adsorption limit of Albizia wood sawdust. This examination relies upon the fact that Albizia wood sawdust is a viable adsorbent for expelling copper and other pollutants from modern wastewater. It is additionally trusted that the examination will recognize ideal conditions for the adsorption procedure, permitting it to be connected on a more extensive scale for mechanical wastewater administration and fundamentally adding to natural administration by giving naturally agreeable and supportable wastewater treatment strategies.

METHODS

The study aimed to gauge the viability of synthesizing adsorbents from Albizia chinensis wood for heavy metal purification from industrial wastewater contaminants using an experimental method elucidating relationships between causes and effects. This experiment would predict the outcome of activating Albizia wood sawdust with 3N H_3PO_4 to adsorb heavy metals from river water tainted by chemicals, laundry, and textiles discharged from factories.

Six samples spanning three varieties of industrial waste served as controls before treatment; another six represented those processed with activated Albizia. Water quality would be probed by quantifying dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total dissolved solids, and total suspended solids, then calculating percentage increases or decreases across parameters. Preliminary testing sought to pinpoint the ideal activation conditions, including phosphoric acid concentration exposure length and pH level. Such trials aimed to ensure the activation protocol facilitated the most effective adsorption, which the core experiment would assess.

1. Materials

The materials used include sawdust as a natural adsorbent due to its easy availability and good adsorption capacity. $KMnO_4$(aq) (98% purity) is used for the oxidation process, and high purity is necessary to ensure efficient and consistent reactions. H_2SO_4(aq)

(98% purity), a strong acid, is used in various chemical reactions, with high purity required to ensure accurate reactions and prevent contamination. $H_2C_2O_4$(s) is used as a reducing agent or to clean metal surfaces. NaN_3(s) is used as a source of azide ions for specific chemical reactions. KI(s) is used in titration reactions as an indicator or precipitating agent. $MnSO_4$(s) is a source of manganese ions in chemical reactions to produce Mn(II). HNO_3(aq), a strong acid, is used for oxidation processes and preparation of metal solutions. H_3PO_4 3N (aq) is used for acidification and as a precipitating agent. $Na_2S_2O_3$ 0.025 N is used in redox titrations as a reducing agent. The standard copper metal solution is used to calibrate analytical instruments. Acetylene gas (C_2H_2) is used as a fuel in atomic absorption spectroscopy analysis. Distilled water is used as a general solvent and for rinsing.

Contaminated river water specimens were gathered from three industrial locales that discharge chemical, laundering, and textile effluents. Sterile containers and identifiers accompanied samples transported for on-site and off-site analysis. Tests included dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total dissolved solids, and total suspended solids as delineated by standard methods and titration techniques. Atomic Absorption Spectroscopy determined heavy metal levels, notably copper, before and after adsorption treatment.

Labels distinguished waste sources and subsequent treatment outcomes as chemical, laundering, and textile waste on specific collection dates. Tags also accompanied post-treatment samples to track pollution reductions facilitated by sawdust adsorption. This structured process demonstrated sawdust's effectiveness in mitigating heavy metal contamination in industrial wastewater discharged into surrounding rivers and streams.

2. Instrumentation

Some of the tools used are Scanning Electron Microscope (SEM)-EDS (Energy Dispersive X-Ray Spectroscopy) Jeol type 6510A, Cu cathode hollow lamp, 5 mL measuring pipette; 10 mL; 20 mL; 30 mL; and 40 mL, 100 mL volumetric flask, glass funnel, electric heater, Whatman 40 filter paper, with a pore size of 0.42 m, Atomic Absorption Spectrophotometry (AAS), analytical balance, thermometer, mesh 80, pH meter, Dissolved Oxygen meter or DO meter, Total Dissolved Solid meter or TDS meter, magnetic stirrer, 250 mL Winkler, 100 mL Erlenmeyer flask, 250 mL Erlenmeyer flask, 100 mL beaker, 250 mL beaker, 500 mL beaker, 50 mL burette, blender, oven, and desiccator.

3. Sample preparation of the adsorbents

Sawdust samples from Albizzia wood were dried for 24 hours in an oven at 105^{o}C, a temperature chosen to remove moisture but not so high that it causes partial decay [17]. The exaggerated moisture level can cause agglomeration and hinder activation operations. This drying ensures that the sawdust is free from water, which might interfere with activation and adsorption processes. It helps maintain the pore structure and surface area, which are crucial for adsorption capacity. Overmuch moisture could cause particle clumping and make an otherwise efficient adsorbent less effective. The dried sawdust was ground and sieved through an 80 mesh screen for uniform particle size. The dry sawdust was stored in a tightly sealed container to keep it moisture-free until ready for activation.

4. Activation of the adsorbent

Twenty grams of sawdust, passing through an 80 mesh, was added to 350 mL of 3N H_3PO_4 solution in a covered glass container and set to stand overnight (24 hr). The 3N H_3PO_4 solution, with such high acidity levels, was selected to open up the pores in the sawdust and increase its surface area without damaging the wood structure too much [18]. It has been previously demonstrated in other studies that this amount effectively improves the adsorption ability of lignocellulose materials. After 24 hours, the mixture was filtered using Whatman No. 1 filter paper. The filtered sawdust was then washed with distilled water until the wash liquid reached pH 7.0 (neutral). The washing step removes all remaining phosphoric acid. The residue was dried in an oven at 110ºC for 3 hours, cooled in a desiccator, and weighed. The activated sawdust was stored in a tightly closed container for further use in adsorption experiments.

5. Pore Characteristics of Wood Sawdust

Images of the sawdust were recorded on a scanning electron microscope (SEM) at a beam voltage (ACC V) of 15 kV. How else could it be done? This voltage allowed the penetration of electrons into Albizia wood sawdust, much like that practical for real surface morphology and internal structure information [19]. The process of conducting SEM consisted, in turn, of (1) exposing the activated sawdust sample to an aluminum stub using a coat of conductive paste. To ensure that it was not completely covered in ionic vapor and therefore able to carry electrons better, the sample was coated with a thin layer of gold (Au) using a sputter coater, (2) Capturing images at beam voltage (ACC V) of 15 kV, Working Distance (WD) 14 mm and magnifications starting at 3.000x to cover detailed pore structure information and morphology, (3) Turning on the Power Amplifier EDS, increasing Z by two units each step until the bias indicator has lighted up and then opening Analyzer Manager application SSM Ratemeter and analysis station, adjust the SS (Spot Size) with SSM ratemeter to 5.000cps for mapping, (4) Determining and capturing SEM images at magnifications as high as 5.000x and 10.000x from various points on the sample surface to give a full picture of the adsorbent's morphology and pore structure.

6. Adsorption Process

Nine grams of sawdust adsorbent - a quantity agreed upon by preliminary tests to achieve adsorption equilibrium when the pollution level was in balance- was placed in an Erlenmeyer flask, each of which held differing types of contaminated river water, 150 mL from industries ranging from light textile to washing, chemical and otherwise. Erlenmeyer flasks give good stirring from their shape, even mixing of the solution and adsorbent, and they can be sealed up tight to avoid contamination and evaporation. This was set upon a magnetic stirrer for 40 minutes at 750 rpm to ensure that the adsorbents had even contact with all corners of the solution. The mix was then filtered through Whatman filter paper (using No. 1) to separate the sawdust from the solution; so, outlets = contaminated river water samples. As with this type of sample, the adsorption process was done three times to check that each had yielded consistent and valid results, and should disparities be causing them to declare themselves, all data was taken over again.

7. Analysis of Water Quality: DO, TDS, and TSS

For inlet and outlet water samples from polluted river water through industries such as textiles, laundries, and chemicals measured dissolved oxygen (DO), total dissolved solids (TDS), and total suspended solids (TSS). This was used to judge whether using Albizia wood sawdust for adsorption effectively removed pollutants.

The level of DO was measured using a DO meter, which signifies how well-stocked a body of water can be with life-sustaining oxygen. Textile wastewater is characterized by dyes, solvents, surfactants, and heavy metals such as copper (Cu). This leads to a high DO by adding pollutants that feed on organic matter. Without decent DO, it cannot respire from anaerobic respiration. Laundry wastewater brings extra amphiphilic compounds and all the problems described above. If it continued as no better than one could hope, then indeed, some kind people there are in this world. Another point about doing so is that I may eat "ordinary or common" bamboo. Wastewater from chemical equipment interpolates toxic heavy metals like copper (Cu), mercury (Hg), and cadmium (Cd), which can kill aquatic life, circulate through the food chain, and make humanity sick. When sewage from these sources heads into the water, reduced levels of DO brought on by contaminants lead to algae blooms. These harm the biota in a water body and reduce its quality.

Total dissolved solids were measured using a TDS meter to check the concentration of dissolved ions and organic substances. The average level of TDS is high in water pollution from textiles and the chemical industry. This endangers life in water bodies and makes what they have for human use fairly barren.

The content of total suspended solids was quantified by the SMEWW 2540-D method. High TSS concentrations show that the water has many suspended substances, which can shade out light and deprive aquatic plants of sunshine in photosynthesis. This isn't good for overall water quality. The particulates, mostly from textile dyes and amphiphilic organic materials, contribute to siltation and ecological disturbance.

The analysis of DO, TDS, and TSS presented here reflects industrial wastewater's critical environmental and health consequences and points out how important advanced treatment techniques are. For example, sawdust made from Albizea wood.

8. Atomic Absorption Spectrophotometry (AAS) Analysis

A series of standard copper solutions (0.0 mg/L, 0.2 mg/L, 0.5 mg/L, 1.0 mg/L, 2.0 mg/L, 3.0 mg/L, and 4.0 mg/L) were prepared by diluting 10 mg/L copper stock solution. Each standard solution was measured at a wavelength of 324.8 nm, and inlet and outlet wastewater samples (25 mL each) were prepared for sequential measurement using AAS.

9. COD and BOD Analysis

The COD analysis is performed by titration of samples. For both accurate results and to ensure sample and reagent stability during titration, it is important that tests are performed at room temperature (i.e., around 25°C) [22] 10 mL of wastewater sample was added to a 100 mL Erlenmeyer flask on a water bath set at a constant temperature to prevent fluctuations in flask temperature from affecting the titration results. Ten drops of 0.02 N H_2SO_4 were used, followed by 1 mL 0.1 N $KMnO_4$. To this was added 0.05 N $H_2C_2O_4$ in small amounts until purple disappeared. Then, the sample was titrated with 0.1 N $KMnO_4$ until a definite purple color appeared. The control sample for COD analysis by permanganometric titration was the inlet wastes of the studied samples.

BOD analysis is biological oxygen demand (measurement). The samples tested with a DO meter were diluted 25 times. It was found that this aeration factor can keep dissolved oxygen (DO) levels within the range of measurement if applied to all samples, provided that on no occasion are these raised above the upper limit set by Winkler-Ossian Method and differences due to dilution become non-detectable [23]. Aeration also meant that other interfering chemicals in the original samples were reduced. Original sewage samples were diluted with distilled water at a ratio of 1:25, adding 10 mL of sewage to 240 mL of distilled water in a clean container to make a total of 250 mL. Then, 250 mL was put in Winkler bottles where 1mL of $MnSO_4$(aq) and 1 mL of alkaline iodide azide (see photo) were added, and the tip of the pipette only just above the liquid surface was taken into bottle-top. After plugging, shaking to produce a precipitate and left to settle down for 10 minutes. 2N 98% H2SO4 was added after plugging and shaking until the precipitate was completely dissolved. 100 mL of the sample was pipetted into a 250 mL Erlenmeyer flask and titrated with 0.025 N $Na_2S_2O_3$ until a pale yellow appeared. Then, two drops of starch indicator were added until blue, followed by titration with 0.025 N $Na_2S_2O_3$ until the blue color disappeared. The Winkler method for BOD analysis has the following potential errors: (1) Inaccurate measurement of sample or distilled water volumes during dilution may result in BOD data errors. Uncontrolled dilutions result in variations. (2) Some substances in the original sample that react with Winkler reagents, other than dissolved oxygen, can lead to errors in measurement. (3) BOD data can be corrupted if equipment or the environment contaminates samples during collection and testing.

RESULTS AND DISCUSSION

After the samples were titrated, their COD was analyzed at room temperature.

Both samples and reagents must attain equilibrium during the titration to obtain accurate results. Using a constant-temperature water bath, at water baths which gave different The temperature of the Erlenmeyer flask was kept constant to prevent changes in flask temperature from influencing titration results with rim measurement and decal reading as to flask temperature. Ten drops of 0.02N H_2SO_4 were added, followed by 1 mL of 0.1N $KMnO_4$.Titration was then carried out with 0.05N $H_2C_2O_4$ drop by drop until the purple color disappeared. Then, it was titrated with 0.1N $KMnO_4$ until a definite purple color appeared (the control sample). The control sample of COD analysis was inlet waste from different samples studied by permanganometric titration. BOD analysis measures the biological oxygen demand. The results obtained from a DO meter on these samples were diluted 25 times. Keeping dissolved oxygen (DO) levels within range becomes possible using this factor. If applied to all samples, this can yield results, provided that these do not occasionally exceed the upper limit set by the Winkler-Ossian Method, and differences due to dilution again become non-detectable.

Aeration had another effect: the concentration of other interfering substances in the original sample also decreased. Original sewage samples were diluted 1:25 with distilled water. In a clean container, 10 mL of sewage was added to 240 mL of distilled water, making a total volume of 250 mL. First, 250 mL was placed in Winkler bottles, then 1 mL of $MnSO_4$(aq) and a photograph of alkaline iodide azide were placed in the bottles with the mouth just over the liquid. Mix and shake to precipitate, and then, after 10 minutes of settling down, add 2N H_2SO_4 until all the precipitate has disappeared on the solution surface, after which 250 mL was put in Winkler bottles. 100 mL of the sample was pipetted into a 250 mL Erlenmeyer flask and titrated with $Na_2S_2O_3$ 0.025N until a pale yellow appeared. Then, two drops of starch indicator were added until blue, followed by titration with $Na_2S_2O_3$ 0.025N until the blue color disappeared. There were some errors in the Winkler method for BOD analysis: (1) Uncontrolled dilutions bring variations. Inaccurate measurement of sample or distilled water volumes during dilution may result in errors in BOD data--such as without a temperature read off scale coupled with never ceasing to record new flask temperatures for both this and that different flask being pulled out of hot lab. (2) measurement errors may result if some substances in the original sample react with Winkler reagents other than dissolved oxygen. (3) BOD data may be corrupted by equipment or the environment during collection and testing, contaminating samples.

1. Absorbent sample preparation and activation

The impurities are removed with distilled water from the sawdust and then dried at 105^{o}C for 24 hours. The wooden material was ground using a blender and passed through an 80-mesh sieve. Then, it was activated with 3N H_3PO_4 for 24 hours to produce a high-quality adsorbent sample. Sieving was performed to get an adsorbent particle size, which passed through an 80 mesh sieve and would perform well in the waste samples. This aspect of the work affects the characteristics of the adsorbent: surface area, total pore volume, pore diameter, and micropore volume [26]. The choice of 3N H_3PO_4 solution is because it is strongly acidic. It is enough to open the pores of the sawdust and increase its surface area, yet it does not severely damage the cellulose structure within the wood [27]. Tests of different concentrations and activation times reveal that 3N H_3PO_4 for 24 hours is the optimum condition for making top-quality sawdust adsorbent. It is a highly effective adsorbent that standardizes the process. It enhances adsorptive capacity while maintaining the structure of the sawdust.

2. Characterization of Sawdust Pores

The purpose of using SEM Jeol type 6510 A is to examine the presence of large pores and surface characteristics of Albizia chinensis sawdust [28]. SEM provides a high-resolution imaging tool for pore characterization since it can display surface structure and material morphology in detail. The size and distribution of pores are crucial during adsorption as they affect the material's rate and absorption capacity. Large pores let contaminant molecules in more easily and take them up more effectively. Furthermore, pores evenly distributed at the surface of a given adsorbent can provide more active sites for interaction with contaminants. Therefore, SEM analysis is indispensable to gain basic data that helps assess the quality and efficiency of an activated sawdust adsorbent.

Figures 1a and 1b show the surface of Albizia wood sawdust before activation with H_3PO_4. It is plain to see that there are no pores in Albizia wood, seeming very much like solid wood. If the adsorption process were carried out directly, the adsorbent would not be used effectively. That is why activation using H_3PO_4 for 24 hours is necessary. You see in Figures 1c and 1d the results of the activation process.

Figures 1c and 1d show changes in the pores of Albizia wood, with large pores forming in varying sizes, supporting the increased adsorption capacity of the sawdust. The clean and tidy distribution of pores is also observable, which indicates that the activation process has worked to produce a suitable pore structure. SEM studies have shown that the activation process with H_3PO_4 has successfully opened large channels in the normally closed pores of this fine sawdust. Its presence is critical to enhancing subscribed capacity as it provides an easier path for the various contaminants from outside--molecules that would contaminate your sub-layer materials before you could form them solidly. These findings are consistent with previous literature showing that acid activation can increase adsorbent materials' surface area and pores. In addition, H_3PO_4 shows stronger efficacy in producing well-developed mesoporous and microporous structures with a greater surface area [29]. The different pore sizes at magnifications of 5,000x and 10,000x serve to illustrate the adsorbent's pore surface. During adsorption, atomic or molecular attraction occurs with the adsorbent's surface. Under this force, the adsorbent attracts other molecules that come into contact with its surface. With a greater surface area and smaller adsorbent pore size, more adsorbate particles will enter it [30].

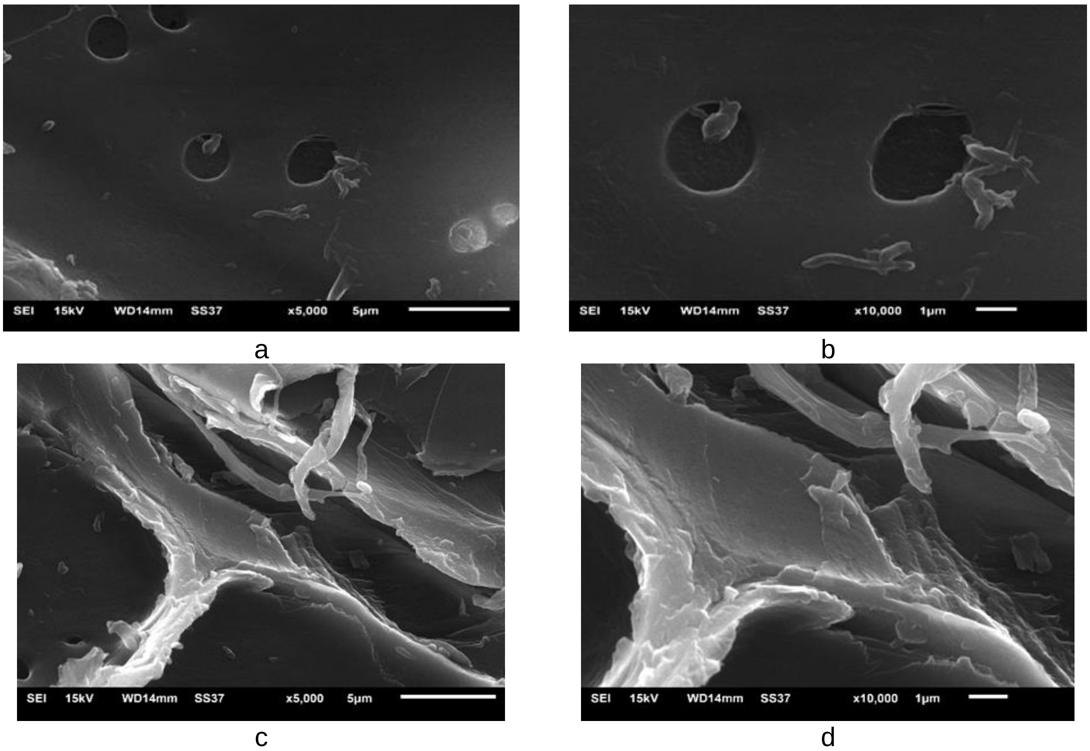

Figure 1 (a). SEM measurement results at 15kV with WD14mm at 5.000x magnification and a size of 5 µm before activation using H_3PO_4. (b). SEM measurement results at 15kV with WD14mm at 10.000x magnification and a size of 1 µm before activation using H_3PO_4. c. SEM measurement results at 15kV with WD14mm at 5.000x magnification and a size of 5 µm after activation using H_3PO_4. d. SEM measurement results at 15kV with WD14mm at 10.000x magnification and a size of 1 µm after activation using H_3PO_4.

3. Adsorption Process

Albizia chinensis sawdust was used to adsorb three different types of waste. The treated sawdust then underwent this adsorbing process. It is a mass transfer process around pores within an absorption material, and the particles will remain outside. This method can absorb harmful substances like heavy metals in liquid waste [31]. The three input liquid waste compositions were adsorbed in this stage using 9 grams of sawdust each. Adsorption was carried out at 25°C to simulate natural conditions. The pH before the adsorption process was 7.3 for the chemical waste, 7.5 for the laundry waste, and 6.7 for the textile waste. After absorption, the resulting effluent had pH values of 7.6, 7.7, and 7.6, respectively. These results demonstrate that Albizia chinensis sawdust can absorb well. After the pH was determined for each waste sample, further tests were conducted to determine the adsorption capacity of the biosorbent. These included DO, TDS, TSS, SS, COD, and biohazards tests.

4. DO Analysis

From six wastewater samples, each labeled 01/AK/IL/25/10/2021, 02/L/IL/25/10/2021, 03/T/IL/25/10/2021, 04/AK/OL/26/10/2021, 05/L/OL/26/10/2021, and 06/T/OL/26/10/2021, useful data were abstracted before and after the DO adsorption on Albizia sawdust. Through direct measurements with a DO meter, the authors found that after Albizia sawdust treatment of chemical equipment wastewater, there was a jump in DO from 2.4 mg/L to 3.2 mg/L. Laundry wastewater climbed from 3.2 mg/L to 3.7 mg/L; textile wastewater, for example, was far greater-from 2.4 mg/L up to 3.7 mg/L. Because of this, the effectiveness of Albizia sawdust in purifying pollutants from wastewater and thereby raising water quality is vividly portrayed (Figure 2).

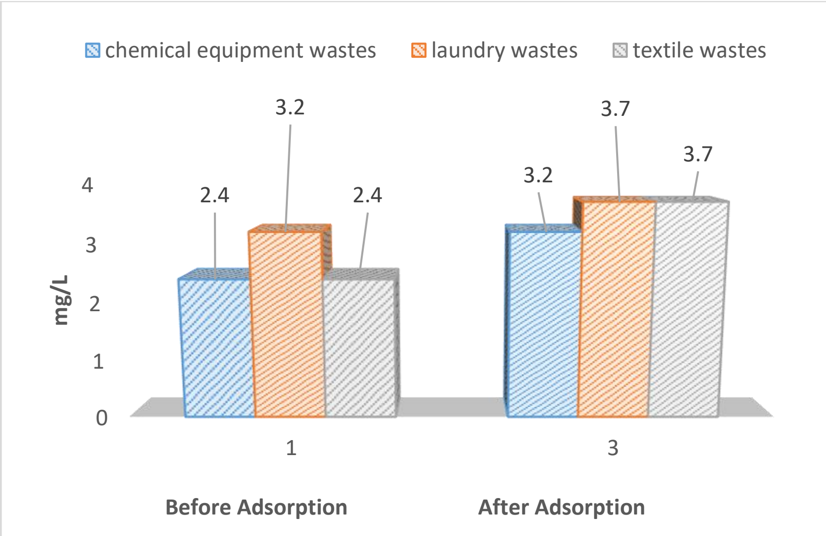

Figure 1. DO Measurement Results

The DO percentage increases were 54.17% for textile wastewater, 15.63% for laundry wastewater, and 33.33% for chemical equipment wastewater. The benefits to aquatic ecosystems of higher DO are extensive: oxygen is essential to fish and other organisms for survival, so adequate levels are crucial. Dissolved oxygen aids metabolic processes, lessens stress, and deters large-scale die-offs of aquatic life organisms. Also, high DO levels encourage the activities of aerobic microorganisms that consume organic pollutants, as well as • adding to the general productivity of water in such ways as promoting photosynthesis among aquatic plants and algae. This makes Albizia sawdust waste treatment technology very promising indeed.

5. TDS Analysis

the TDS meter test for the three inlet wastewater samples and three outlet wastewater samples data (Figure 3), The TDS test normally measures colloids and inorganic substances such as ions [33]; The chemical waste inlet sample was measured as 439 mg/L, laundry waste at 617 mg/L, and river water impacted with textile effluent reached 180 mg/L. TDS Values after treatment for the inlet samples were 187 mg/L, 537 mg/L, and 173 mg/L, respectively. The percentage reductions for each type of waste are 3.9%, 12.9%, and 57.4%—the variation in TDS measurements brought about by impurities and differences in wastewater sources. Several potential sources of error with qualitative TDS tests need to be considered. Sample contamination can affect the results obtained from TDS analysis. Inconsistent temperature and pH levels. Measurements should be taken at consistent temperatures and pH levels. Despite these potential sources of error, the researchers avoided sample contamination by maintaining sample cleanliness throughout the study [25] so that the data obtained demonstrate that the adsorption process using Albizia chinensis wood can reduce TDS levels in wastewater. This shows that Albizia chinensis wood can adsorb colloids and inorganic substances from liquid waste.

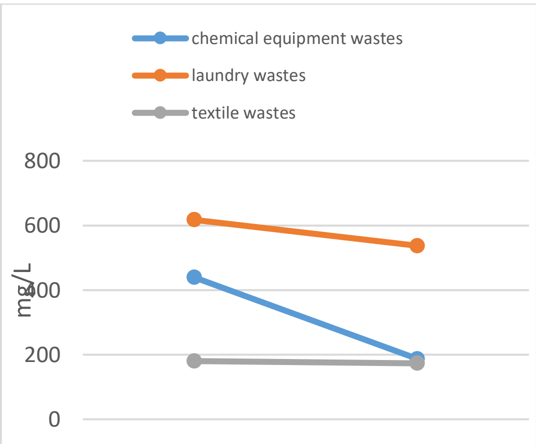

Figure 2. TDS Measurement Results

6. TSS Analysis

A test involving three inlet and three outlet wastewater samples treated with Albizia sawdust showed that the three inlet and the three outlet water effluents were tested according to the SMEWW 2540-D method for suspended solid analysis (Figure 4). Examples of suspended solids in sewage are silt, sand, and ReasonaTE 95 microorganisms. They can be screened out on a paper filter of 0.45 µm pore diameter. The suspended solids in the three sample inlets were 83 mg/L, 120 mg/L, and 690 mg/L. Then, the Osaka electroplating outlet data advertisement was made. The suspended solid became 50 mg/L for the outlet samples, 25 mg/L again, and 25 mg/L a third time. This means that the reductions in TSS are 96.38%, 79.17%, and 39.76%. After the reduction in TSS, there are many positive effects on the ecological environment: (1) Water turbidity declines while there is an increase in transparency. As shallow sunlight penetrates more deeply into the water, aquatic plants can photosynthesize throughout quite some depth, thus increasing ecosystem productivity (2) Weakens wastewater's capacity for sowing life, Thus protecting the biological chain and fish, which pollutants would threaten (3) The cost of water and sewage handling drops environmentally sustainable use can be made of those resources. [34] The results also demonstrate a considerable decline over time in TSS. The textile sewage water indicates that Albizia wood flour can remove suspended solids like ReasonaTE 97 silt, sand, and microorganisms.

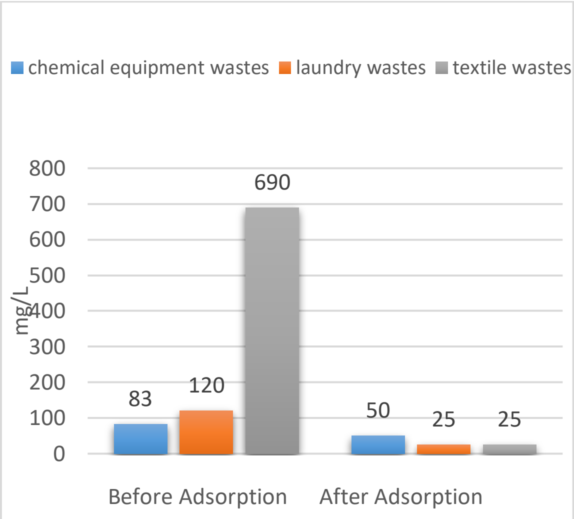

Figure 4. TSS Measurement Results

7. AAS Analysis

AAS analyzed the water in the three bypasses suggested methods for the Examination of Water and Wastewater, twenty-third Edition 2017 (below that is picture five). 5 Without the effect of adsorption, there will be a decrease in the Cu metal content of three wastewater samples. Before adsorption, their concentrations were 0.026 mg/L, 0.006 mg/L, and 0.017 mg/L, respectively. After adsorption, they are as follows: 0.008 mg/L, not measurable, and 0.010 mg/L. This occurs because using the adsorption process to purify Cu is one of the most promising methods for removing heavy metal ions from water [35]. In some cases, heavy metal ions are also good for the ecosystem of aquatic biota and plants, human beings, and animals. For example, if the latter two flee their native lands on account of an inability to find food or amphipods are unable to exist because accumulated amounts of arsenic will eventually kill them both off in toxic blooms (which is the case according to what we learned during our river research [33]). We can say that heavy metal ions are beneficial for ecosystems. Higher dispersion levels of particular chemical substances have begun to appear in soil and water. According to Permen LHK RI Number 6 of 2021, the maximum allowable level of copper is lower than any of the Permissible levels set in any other place or time, which makes it a very lax standard [34]. AAS confirms that the copper content of the wastewater before and after desorption is less than the permissible standard. But that is not the important point for those concerned with this field. What is significant to practical concerns is that adsorption drastically reduces the Cu content of wastes.

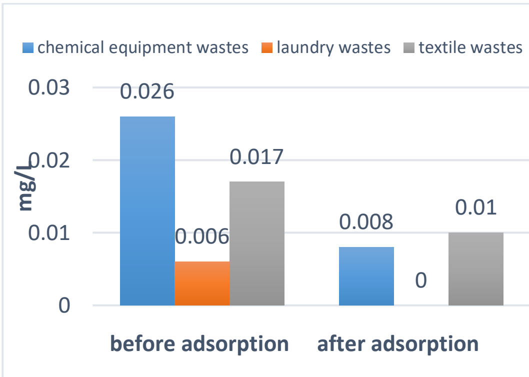

Figure 5. Cu Metal Measurement Results with AAS

8. COD (Chemical Oxygen Demand) Analysis

Based on the permanganometric titration method, three inlets and six-outlet wastewater samples are tested in Figure 6. Using the permanganometric titration method, levels of chemical substances that can be oxidized by oxygen in water, called COD, were measured in laboratory wastewater before and after adsorption (Figure 6). The adsorption process affected the COD parameter, with initial inlet sample levels of 32 ppm, 32 ppm, and 48 ppm. After adsorption, the COD levels for the chemical waste sample dropped back to 24 ppm, for the laundry waste sample to 16 ppm, and for the textile waste sample up to 32 ppm. The test results showed significant decreases in COD, with a percentage reduction of 33.33%, 50% in each case. The data indicated that chemical substances are adsorbed when water containing them is treated by sawdust from Elavaghalla albizzia trees. Despite careful COD examinations, several potential sources of error need to be borne in mind: (1) sampling methods and analysis procedures may vary and can affect test results, (2) the COD measuring instrument has to be calibrated with standard solutions of known concentration regularly to ensure it gives accurate readings, (3) alien substances or other chemicals might contaminate measurements taken, and (4) other substances present in the samples of wastewater such as detergents or other chemicals can potentially give misleading readings for COD measurements.

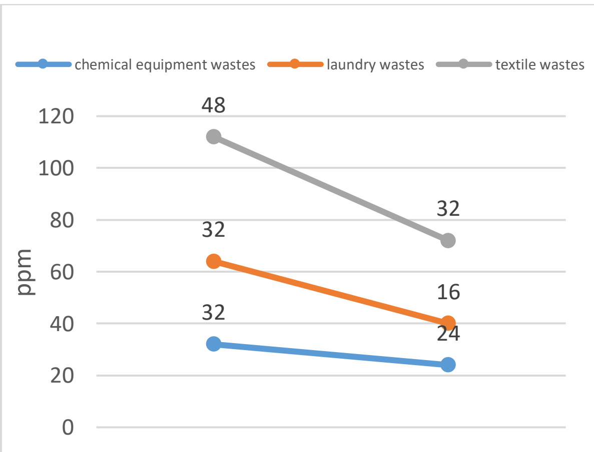

Figure 6. COD Measurement Results

9. BOD (Biological Oxygen Demand) Analysis

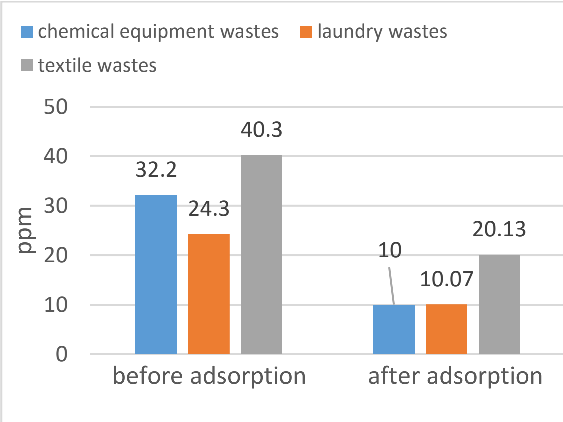

Figure 7. BOD Measurements Results

Based on Winkler (Iodometric) Law tests conducted to inlet and outlet samples of three Indian wastewater, it follows from Figure 7. BOD signifies how much oxygen microorganisms need to stabilize decomposing organic matter under aerobic conditions. Use albizia wood adsorbent to try and find a way to reduce BOD in various industrial effluents that pollute river water. The results showed that the average chemical, laundry, and textile waste load was reduced by 32.2, 24.3, and 40.3 ppm, respectively. After these reductions in load, the BOD levels for chemical, laundry, and textile wastes were 10.0, 10.07, and 20.13 ppm, respectively. The recorded reductions in BOD were 50.05%, 58.56%, and 68.94%, respectively. According to the prevailing legislation of LHK RI 68/2016, Permen, the maximal allowable BOD in wastewater is 30 ppm [36]. The BOD results show that the levels are within the permissible range after adsorption. A significant reduction in BOD is good for the environment; by reducing BOD, treating wastewater can raise the quality of water surrounding it, encourage aquatic life to grow back into it, and keep ecosystem equilibrium intact. Reducing BOD helps keep environmental standards set by regulations for protecting and preserving our natural resources.

CONCLUSION

However, brought about by various industries that often pollute the environment, especially waters such as rivers. The result was an adsorbent made from the albasia wood sawdust waste material, which could be a solution to remove many harmful substances from water. The prepared albasia wood adsorbent in adsorbing several kinds of impurity waste in River water is practical as it has passed many tests of stalked on various water parameters through the IBIS online analysis report system for TDS TSS COD BOD and AAS checking mercury with four sets, which gave results showing heavy metals decreased after adsorption process unequal albasia powder fed down an ITEC spout into Please air pump. Then again, dissolved oxygen shows a rather good increase after processing the waste by adsorption method using albasia wood. This study is interesting because it still posses the need for further study of SEM tests on albasia wood after the adsorption process and also to treat a variety of other wastes.

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