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LAUNDRY WASTEWATER TREATMENT USING ACTIVE CARBON MEDIA FROM COCONUT SHELL, MATOA SHAWS POWDER, IRON AND LINGUA WOOD

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Abstract

Limbah laundry banyak mengandung sejumlah surfaktan, Carboxyl Methyl Cellulose (CMC),kalsium (Ca), phosfat (P), dan pemutih pakaian. Limbah tersebut menimbulkan dampakyang berbahaya bagi lingkungan. Tujuan penelitian ini untuk manganalisis penurunan kadar COD, TSS dan phospat air limbah laundry menggunakan karbon aktif dibandingkan dengan kontrol positif karbon aktif terstandar SNI. Rancangan penelitian adalah pertest posttest control group design. Air limbah dilakukan pengolahan pendahuluan melalui penyaringan terbuat dari susunan ijuk, koral, kerikil dan pasir. Selanjutnya dialirkan ke dalam karbon aktif untuk proses adsorpsi. Hasil penelitian menunjukkan karbon aktif mampu menurunkan parameter COD, TSS dan Phosfat. Ke-empat karbon aktif mampu menurunkan kadar COD, TSS dan Phosfat secara bermakna (p< 0,05). Penurunan terbaik adalah karbon aktif terstandar SNI dan bahan kayu besi, keduanya mempunyai kesamaan dalam menurunkan kadar COD, TSS dan Phosfat dibandingkan dengan karbon aktif dari bahan serpihan/serbuk kayu matoa, lingua dan tempurung kelapa. Kesimpulan dalam penelitian ini adalah ke-empat karbon aktif yang diujicobakan dalam mengolah air limbah laundry mampu menurunkan kadar COD, TSS dan phosfat secara bermakna. Karbon aktif yang terbuat dari kayu besi mampu menurunkan kadar COD, TSS dan phosfat paling tinggi, atau secara bermakna menyamai karbon aktif yang dijual dipasaran dengan standar SNI dalam menurunkan kadar COD, TSS dan phosfat.

Keywords*: Activated Carbon; Laundry Waste; Iron Wood Powder; Linggua; Matoa*

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INTRODUCTION

The changes in the lifestyle and busy life of Jayapura residents especially employees and students have made the free time for washing clothes, drying, and ironing increasingly narrow. As an alternative to this phenomenon, most people use laundry services.

The practicality of the community towards laundry services is not followed by friendliness to the environment. Waste generated from the laundry business can have a negative impact on the environment. Laundry waste contains a lot of surfactants, Carboxyl methyl Cellulose, calcium, phosphate, clothes bleach (Yuliana *et al.*, 2020; Nugrahalia & Karim, 2021). These compounds include compounds that are not environmentally friendly (non-biodegradable) (Astuti & Sinaga, 2015; Chairunnisa *et al.,* 2019). Each laundry industry can produce liquid waste with COD concentrations between 488-2847 mg/l and TSS between 38-857 mg/l. Likewise, the laundry industry in Jayapura City produces liquid waste which can directly or indirectly damage the environment. The negative impact of using detergent on the environment, if it is directly discharged into water bodies without any treatment, is that it can stimulate excessive growth of algae or aquatic plants or eutrophication (Mu'in *et al.,* 2017; Raissa & Tangahu, 2017; Afrianti & Irni, 2020).

According to the Regulation of the Minister of Environment of the Republic of Indonesia Year 2014 concerning the quality standards of wastewater, it has been regulated that every large and small industry or household is required to manage their waste before being discharged into water bodies (Permen, 2014). The laundry service industry is also required to treat its waste before being discharged into water bodies.

Based on this background, an effective method is needed in the treatment of laundry liquid waste, so as not to pollute the environment. The method that can be used is the adsorption method of activated carbon. Research on laundry waste treatment using the adsorption method of activated carbon with widely available raw materials in Jayapura, namely hacksaw wood chips or powder, matoa and linggua. This study is necessary be done to reduce wood waste to be used optimally as activated carbon and reduce environmental pollution of water bodies in Jayapura City and its surroundings.

This study aims to compare the percentage rate of decline in laundry wastewater parameters Chemical Oxygen Demand (COD), Total Suspended Solid (TSS) and Phosphate using activated carbon made from wood chips or powder, matoa and linggua and coconut shell with activated carbon standardized by SNI. 1995 (LIPI SNI-06-3730-1995, 1995).

MATERIALS AND METHODS

The type of research was experiment with a pretest-posttest control group design. This study is to compare the quality of the liquid waste before it is processed (pretest) and then compared with the quality of the liquid waste after it is processed (posttest) with a laundry service liquid waste treatment tool with activated carbon media from coconut shell, ironwood sawdust, matoa and linggua wood. Control was carried out using activated carbon media sold in the market in accordance with the Indonesian national standard SNI 1995.

The research was conducted for 2 months, located in the household-scale laundry service industry, having its address at Jalan Baru, Abepura District, Jayapura City. Parameter examination of COD, TSS and Phosphate of laundry wastewater before and after processing was carried out at the Papua Blood Health Laboratory.

The research started with the manufacture of activated carbon from flakes or sawdust from ironwood, matoa and linggua and coconut shells. The process began with the carbonization of the material. The basic material after carbonization was then chemically activated by soaking the activated carbon material with 20% NaOH for 24 hours.

The research then continued with the manufacture of prototypes or waste treatment equipment with the sequence of preliminary processing and main processing. Pretreatment through a screening process with the sequence of coral, palm fiber, gravel and quartz sand. Furthermore, the main processing was carried out with activated carbon made from ironwood, matoa, linggua, coconut shell and positive control using activated carbon standardized by SNI 1995.

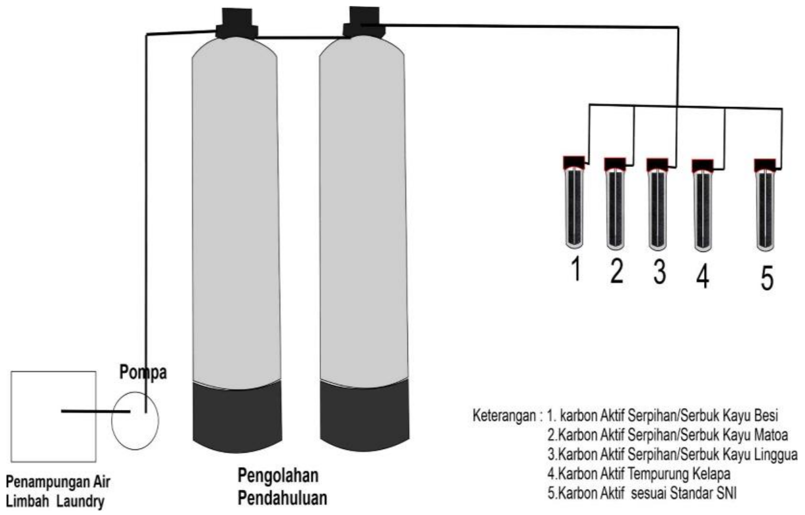

Figure 1: Schematic of Laundry Wastewater Treatment with Adsorption Using Activated Carbon

Data collection for sample analysis of the COD, TSS and Phosphate parameters was carried out on the waste before processing and after the waste was processed. Samples before being processed were taken from the laundry waste water reservoir. Samples of treated wastewater were taken from wastewater that came out of activated carbon, which included activated carbon: iron wood, matoa, linggua wood, coconut shell and positive control of activated carbon standardized by SNI 1995.

Data analysis was carried out to find out the difference in the level of decrease in COD, TSS and Phosphate parameters before and after being treated with activated carbon using the paired test. This test was conducted to compare the quality of wastewater before (pretest) and after treatment of wastewater (posttest) using activated carbon media from ironwood, matoa wood, linggua wood, coconut shell and positive control of activated carbon standardized by SNI 1995.

Further analysis was carried out using the ANOVA test to find out the differences or similarities of Activated Carbon from ironwood, matoa, linggua and coconut shells with positive control of activated carbon standardized by SNI 1995.

RESULTS AND DISCUSSION

This study used the adsorption method in reducing the laundry waste pollutant parameters tested. The adsorption process aims to remove organic substances such as COD. Observation of the quality of laundry liquid waste from wastewater treatment with activated carbon made from wood chips or ironwood sawdust, matoa, linggua and coconut shells as well as activated carbon that has been standardized by SNI was observed for 21 days. Wastewater sampling was carried out on the first, 3rd, 5th, 7th, 9th, 11th, 14th, 17th and 21st days. Sampling of laundry wastewater was carried out on untreated wastewater and after the laundry wastewater was treated with activated carbon. The results of the analysis of the content of COD, TSS and phosphate before and after waste treatment through activated carbon media are explained as follows.

Table 1. Decreasing COD Parameters Before and After the Wastewater is Treated Using Activated Carbon

Activated Carbon Material	Average COD Parameters (Mg/l)		
	Before	**After**	**Decrease**
Ironwood	746.3	210.9	71.74%
Matoa Wood	746.3	241.1	67.69%
Linggua Wood	746.3	236.6	68.30 %
Coconut shell	746.3	225.9	69.73%
SNI standard	746.3	210.2	71.83%

The table above indicates that on average there was a decrease in COD parameters before and after passing the waste treatment prototype using activated carbon. The highest percentage decrease was activated carbon standardized by SNI 1995, then activated carbon from sawdust or iron wood chips, while the lowest was from activated carbon from linggua wood.

Statistical analysis shows that all activated carbons were able to significantly reduce COD parameters ($p<0.05$). Anova analysis results obtained a significant difference in the percentage level of COD parameter reduction before and after processing laundry waste using activated carbon from flakes or sawdust of ironwood, matoa wood, linggua wood and coconut shell as well as activated carbon standardized by SNI 1995 ($F=2,789$; $p<0, 05$).

The significant differences in the decrease in COD levels were found in activated carbon from control with activated carbon from flakes/sawdust from matoa wood, linggua and coconut shells ($p<0.05$), whereas activated carbon from ironwood material had similarities in lowering COD parameters ($p>0.05$).

The decrease in COD parameters was not in accordance with the quality standard effluent (Permen, 2014). It was since the contact time between wastewater and activated carbon as the adsorbent medium was not too long, so it was necessary to adjust the discharge from small to larger to regulate the contact time between activated carbon and wastewater.

The longer the wastewater in contact with the activated carbon used, the greater the decrease in the COD value of laundry waste. It was since the more activated carbon, the more surface area available to absorb substances that were in contact with activated carbon, so that the absorbed substance will be more extensive (Badmus *et al.*, 2007). The more pores that can be passed, the greater the contact of the liquid waste with activated carbon, so that the parameters in the liquid waste were absorbed by the activated carbon more and more. Setting the discharge that came out of the wastewater treatment plant through activated carbon resulted in better wastewater quality. The small discharge allowed the activated carbon to be in contact with the wastewater for longer, so that the adsorption process that occurs also takes longer. Therefore further research is required to regulate wastewater discharge through activated carbon from small to larger ones.

The lifespan of activated carbon also has a limit in absorbing pollutants in wastewater. The longer activated carbon is used for the pollutant adsorption process, the more saturated the pore structure will be to absorb pollutants in the waste (Kusuma *et al.*, 2019).

Based on (Manocha, 2003) activated carbon made from wood with a hardness level between 800-1100 Kgm/m3 has a long life to be used as an activated carbon material. With long life, it will allow the rate of replacement of activated carbon media and the backwash process (cleaning) is not done often, it will take time.

Table 2. Decrease in TSS Parameters before and after the Wastewater is Treated Using Activated Carbon

Activated Carbon Material	**TSS Parameter Mean (Mg/l)**		
	Before	**After**	**Drop Rate**
Ironwood	383.78	125.44	67.35%
Matoa Wood	383.78	159.56	58.59%
Linggua Wood	383.78	162.11	56.43%
Coconut shell	383.78	150.44	61.14%
SNI standard	383.78	119.78	68.63%

Table 2 shows that on average there was a decrease in the TSS parameter before and after wastewater was treated using activated carbon. The highest percentage of decrease was in SNI-3730-1995 standardized activated carbon then activated carbon from ironwood chips/sawdust, while the lowest was from activated carbon from lingua wood.

The results of the paired-test statistical analysis showed that all activated carbons were able to significantly reduce TSS parameters ($p<0.05$). Whereas Anova statistical analysis obtained there was a significant difference in the percentage level of TSS parameter reduction before and after processing laundry waste using activated carbon from ironwood chips/sawdust, matoa wood, linggua wood and coconut shell with activated carbon standardized by SNI 1995 ($F=5,990$; $p<0.05$).

A significant difference in the decrease in TSS levels was found in activated carbon from Control with activated carbon from flakes/sawdust from matoa wood, linggua and coconut shells ($p<0.05$), whereas activated carbon from ironwood and coconut shells had similarities in decrease the TSS parameter ($p>0.05$).

Total Suspended Solids (TSS) is still high in the effluent due to the preliminary process in the treatment of laundry wastewater has not run optimally. This preliminary process serves to reduce the content of TDS, TSS and solid elements dissolved in wastewater. Thus, it is necessary to process the laundry wastewater optimally before flowing it into activated carbon.

Based on the results of laboratory analysis, it is known that the value of TSS effluent from laundry wastewater treatment which was originally 383.78 mg/l to 143.78 mg/l, or decreased by 62.7%. Based on these results, in general, the laundry waste experimental effluent does not meet the wastewater quality standards according to (Permen, 2014) regarding wastewater quality standards. Parameter Threshold Value TSS is 100 mg/liter.

TSS is a major pollutant affecting waterways worldwide. Predicting TSS value is important for quality control of wastewater treatment (Verma *et al.*, 2013). Laundry wastewater has waste that is rich in synthetic organic substances including Methylene Blue Active Surfactant (MBAS) ranging from 25.0-33.9 mg/L (Ardiyanto & Yuantari, 2016).

Suspended solids can be classified into floating solids which are always organic and suspended solids which can be organic and inorganic. Suspended material has an unfavorable effect on the quality of water bodies because it causes a decrease in water clarity so that it can block sunlight from entering the water and ultimately affect the photosynthesis process in water.

Pre-treatment is needed before the adsorption process with activated carbon is carried out to streamline the laundry liquid waste treatment process. The preliminary process can be with the phytoremediation process (Ruhmawati *et al.*, 2017). Pretreatment can also use the addition of coagulant followed by precipitation.

Table 3. Decreasing Phosphate Parameters before and after the Wastewater is Treated using carbonActive

Activated Carbon Material	**Average Phosphate Parameters (Mg/l)**		
	Before	**After**	**Drop Rate**
Ironwood	5.06	2.84	46.6%
Matoa Wood	5.06	3.35	35.1%
Linggua Wood	5.06	3.24	36.5%
Coconut shell	5.06	3.37	31.6%
SNI standard	5.06	2.87	45.3%

Table 3 indicates that on average there was a decrease in the level of Phosphate parameters before and after wastewater was treated using activated carbon. The highest percentage decrease was in activated carbon media from iron wood chips/sawdust then activated carbon standardized by SNI 1995 while the lowest was from activated carbon from coconut shell material.

The results of the paired-test analysis showed that all activated carbons were able to significantly reduce the phosphate parameter ($p<0.05$). Whereas Anova statistical analysis obtained there was a significant difference in the percentage level of Phosphate parameter reduction before and after processing laundry waste using activated carbon from ironwood chips/sawdust, matoa wood, linggua wood and coconut shell with activated carbon standardized by SNI 1995 (F=4,450; $p<0.05$).

Significant differences in the decrease in phosphate levels were found in activated carbon from Control (activated carbon certified SNI-3730-1995) with activated carbon from flakes/sawdust from matoa wood, linggua and coconut shell ($p<0.05$), while with activated carbon made of iron wood have similarities in lowering the TSS parameter ($p> 0.05$).

*Prototype reactor l*aundry wastewater treatment using activated carbon was also able to reduce phosphate parameters up to 38.6%. The decrease in phosphate was due to the filtration process in the coral and sand zones, while the adsorption process occurred due to the laundry wastewater was in contact with activated carbon.

However, this decrease was not in accordance with the Laundry Wastewater Quality Standard. In order to be able to reduce phosphate to the desired level, it is necessary to have a preliminary treatment before the wastewater is in contact with activated carbon or the adsorption process. either physical by filtration or the addition of coagulant substances.

The decrease in the value of COD, TSS and Phosphate Parameters was due to the waste material in the wastewater being attracted and bound by activated carbon in the adsorption process. If the waste material bound by activated carbon is greater, the value of the COD, TSS and Phosphate content of the wastewater after contact with activated carbon will be smaller.

Based on Ramadhani *et al.,* (2020), activated carbon can be used in wastewater treatment processes that have a high organic content, because activated carbon is able to remove or filter dyes, odors and synthetic organic pollutants.

CONCLUSION

There was a significant decrease in COD, TSS and Phosphate parameters after wastewater treatment with activated carbon media. COD content of activated carbon made from iron wood 210.90 mg/l, jayu matoa 241.11 mg/l, Linggua wood 236.56 mg/l, Coconut Shell 225.89 mg/l and SNI standardized Activated carbon 210.22 mg /l. TSS content of activated carbon made from iron wood 125.44 mg/l, Matoa wood 159.56 mg/l, Linggua wood 162.11 mg/l, Coconut Shell 150.44 mg/l and SNI standardized Activated carbon 119.78 mg /l. Phosphate content of activated carbon made from iron wood 2.48 mg/l, Matoa wood 3.35 mg/l, Linggua wood 3.24 mg/l, Coconut Shell 3.37 mg/l and SNI standardized Activated carbon 2.87 mg /l.

There was a difference in the decrease in COD and phosphate parameters between the rector which used activated carbon standardized by SNI and activated carbon made from matoa wood and linggua wood. In the phosphate parameter, there was a significant difference in phosphate reduction between the rector which used SNI standard activated carbon and activated carbon made from matoa wood and linggua wood and coconut shell.

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