Adsorbing on Dissolved Copper Metal by Charcoal Rambutan Rods

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Abstract. Charcoal was produced from rambutan rods. The charcoal was then used as adsorbent to adsorb copper ion 70 ppm dissolved in solution. The charcoal rambutan has ability to adsorb the copper ion (%R) 62.068 or about 43,456 ppm. SEM EDX was used to confirm the ability of the charcoal to adsorb the metal ion. The ability to adsorb is 0.15 % of weight. The advantage the study is to give information that the rambutan rods charcoal has potential to use as adsorbent to clean of water contaminated by metal ions.

1. Introduction
Pollution caused by heavy metals is a big problem in developing countries. The high concentration of heavy metals in water can be toxic and not degraded [1]. The presence of heavy metal content in water makes the water quality decreases and damages the ecosystems.

Copper is one of the metals that was first extracted and utilized by humans and has contributed greatly to civilization. Despite the extensive benefits and applications of copper, it is inevitable that copper waste as one of the dominant heavy metals cannot be avoided. Concentration of copper waste in water must not exceed 1.0 mg / L and output of copper waste from the source must not exceed 0.1 mg / L, ecosystems in water bodies need copper concentrations of not more than 0.01 mg / L which in addition will cause fish death - fish in a body of water. As an essential element in the human body, copper is needed in the formation of red blood cells. Based on data obtained by World Health Organization, for human the recommended amount of copper should not be more than 1-3 mg/day [2]. However, excessive concentration can also damage the kidneys, liver, swelling of body tissues, depression, and necrosis [3]. The removal of heavy metals contained in water is very important to do to avoid the consequences that can be caused.

Adsorption is a popular method used in water treatment applications in the world. The liquid-solid adsorption system is based on the ability of certain solids to absorb certain substances from the solution to the surface of the solids. This principle can be used in cleaning pollutants in the form of metal ions and organic substances in wastewater [4]. Adsorption proved economical and efficient to remove heavy metals such as copper, cadmium, lead, chromium, nickel, and zinc from contaminated waters [5]. Using the adsorption method to remove metals from water is a good economical way to apply. The purpose of this study was to confirm adsorption ability of the charcoal rambutan rods using SEM-EDX analysis. This research is useful as information regarding the contamination of rambutan rods charcoal due to waste from metal ions.
2. Method
The research was conducted at the Chemical Engineering Unit Operations Laboratory and the Surfactant and Application Laboratory of the Chemical Engineering Department, the Faculty of Engineering, University of Sumatera Utara, Medan.

The materials used in this study are charcoal rambutan rods as an adsorbent from the Charcoal Factory Jl. Mulio Sejati, Tuntung Village, Deliserdang Regency. Copper (II) sulfate ($\text{CuSO}_4\cdot\text{H}_2\text{O}$) as a source of copper ($\text{Cu}^{2+}$), hydrochloric acid (HCl), sodium hydroxide (NaOH) as a regulator of pH, and water (H$_2$O) as a solvent bought from CV. Rudang Jaya. While the main analysis tools used in this study are Atomic Absorption Spectroscopy (AAS) (iCE 3300, Thermo Scientific, USA), SEM and EDX (Phenom ProX Dekstop SEM, Thermo Scientific, USA).

The rambutan rods were cleansed from dirt attached on the surface with aquadest. Perform the carbonation process by using furnace at Tuntungan Plant to obtain charcoal rambutan rods. After that the grinding process is carried out using a ballmill for 2 hours. To obtain particle size, charcoal rambutan rods sieving in 70/100 mesh size. Then was dried step for 2 hours at temperature 100$^\circ$C in oven to reduce water content [6]. A solution of 2,5 L $\text{Cu}^{2+}$ 70 ppm was made at pH 4,5 [7]. The chemicals for controlling pH are NaOH 0,1 M and HCL 0,1 M. For adsorption operation, the experiments were using 100 mL $\text{Cu}^{2+}$ 70 ppm solution, added by 1 gram of charcoal rambutan rods 70/100 mesh and stirring at 150 rpm at 27$^\circ$C [9]. Take the sample at 120 minutes for analyses with AAS. The samples were clarified after 3 hours operation time to reach the equilibrium stage of adsorption. The copper ion left in solution was measured by AAS. The adsorption percentage of copper ions can be calculated by the equation [5]:

$$R\% = \frac{(C_0-C_e)}{C_0} \times 100\%$$  \hspace{1cm} (1)

Which $R\%$ = percentage removal of adsorbed metal ion, $C_0$= initial metal ion concentration (mg/L), $C_e$= the equilibrium concentrations (mg/L). The SEM and EDX was applied to analyze the original charcoal and after used as adsorbent.

3. Result
The physical form of charcoal rod rambutan can be seen in figure 2. In figure 2A is the physical form of charcoal rod rambutan before absorption as a natural charcoal. The physical form of charcoal is dark black with homogeneity particle size. After using as absorbent charcoal rambutan is roughly in surface, it
may impact on the presence the copper ions on surface (Figure 2B). The physical images on particles of charcoal were relatively changed in comparing to the natural form of charcoal rod rambutan after adsorption operation. Charcoal that has been contaminated with metals experiences color changes, although not significantly.

A

B

Figure 2. Charcoal (A) natural and (B) after used as adsorbent (B)

In figure 3 the physical form of charcoal rod rambutan is taken with SEM EDX. Figure 3A shows the surface characteristic of the rambutan shaft at a 5000x magnification SEM. It can be seen that the rambutan shaft has pore slits. According to Tuas, Et al., 2019 [10], the formed pore will be the part that absorbs the metal element. Figure 3B shows the EDX results in which rambutan rods charcoal contains carbon and oxygen.

(A) SEM

(B) EDX

Figure 3. (A) SEM and (B) EDX of natural charcoal

The AAS analysis result is 70 ppm for Copper initial concentration (Co). Batch adsorption operation with speed 150 rpm after contact time 120 minutes was found about %R 62,068 or about 43,456 ppm was adsorbed by the carbon. The SEM and EDX analysis have been done to confirm the presence the copper ion on charcoal carbon surface.
4. Conclusion
Charcoal produced from rambutan rods has ability to interact and adsorb the metal ions. The charcoal as adsorbent has adsorbed (%R) 62,068 or about 43,456 ppm the copper ion dissolve in solution. The presence of copper ion on charcoal surface was confirmed by SEM EDX analysis. The result was is 0.15 % of weight of copper ions indentified on charcoal surface. This study is to give advantage information relate to ability of charcoal from rambutan rods charcoal that has potential to use as adsorbent to clean of water contaminated by metal ions.

5. References
[1] Teker M, Mustafa İ and Ömer S 1999 Adsorption of Copper and Cadmium Ions by Activated Carbon from Rice Hulls TÜBİTAK Turk J Chem vol 23 pp 185-191
[2] World Health Organization 2004 Copper in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality WHO/SDE/WSH/03.04.88. pp11-18.
[3] Duowen Q, Xu L and Cui C 2018 Research on disposal of copper (II)-containing wastewater by secondary strontium residue IOP Conference Series: Earth and Environmental Science vol 108
[4] Moreno J C, Rigoberto G and Liliana G 2010 Removal of Mn, Fe, Ni and Cu Ions from Wastewater Using Cow Bone Charcoal Materials vol 3 pp 452-466.
[5] Karniba M, Kabbaneb A, Holaila H and Olamaa Z 2014 Heavy Metals Removal using Activated Carbon, Silica and Silica Activated Carbon Composite Energy Procedia 50 pp113–120

[6] Hsu S T, Chen L C, Lee C C, Pan T C, You B X and Yan Q F 2009 Preparation of Methacrylic Acidmodified Rice Husk Improved by an Experimental Design and Application for Paraquat Adsorption. Journal of Hazardous Materials 171(1–3) pp 465–470.

[7] Haryanto B, Rondang T, Herman H, Firmanto P and Samuel S 2017 Investigation on the Ability of a Natural Adsorbent Corn Stalk in Removing Heavy Metal Ions From Aqueous Solution ARPN Journal of Engineering and Applied Sciences vol 12 issue18 pp 5263 - 5270

[8] Haryanto B, Binod W S, Ertina S B, Ahmad R and Rifai M R 2017 Pseudo Order Kinetics Model to Predict the Adsorption Interaction of Corn-Stalk Adsorbent Surface with Metal Ion Adsorbate Cu (II) and Fe (II) Journal of Physics: Conference Series. vol. 801 pp 1-7

[9] Alexander D, Ellerby R, Hernandez A, Wu F and Amarasiriwardena D 2017 Investigation of Simultaneous Adsorption Properties of Cd, Cu,Pb and Zn by Pristine Rice Husks using ICP-AES and LA-ICP-MS Analysis Microchemical Journal 135 pp 129–139

[10] Tuas M A and Ali M 2019 Treatment of Copper-Contained Jewellery Wastewater by Precipitation and Adsorption Using Rice Husk Charcoal Journal of Ecological Engineering, vol 20 Issue 4 pp 94-103