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Reduction of Metal Density of Iron (Fe) and Copper (Cu) Using Corn Active Archarge and Commercial Active Archarge on Water from a Bali Well

Zul Alfian*, Fristiwayuni Dara Silvia
Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, 20155, Indonesia
*Corresponding Author: zul20@usu.ac.id

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ABSTRACT

Through the use of commercial and cassava peel activated charcoal, research was done on how to lower the levels of iron (Fe) and copper (Cu) in well water that had been excavated. X-ray diffraction (XRD) was utilized to conduct the activated charcoal test. The samples were collected from the wells of individuals residing in Kelurahan Sumber Karya Binjai Timur. Water samples were treated with concentrated nitric acid (HNO_3) and decomposed. The concentration of iron (Fe) and copper (Cu) was determined before and after adding activated charcoal made from cassava peel and commercially available activated charcoal, with masses of 1, 2, 3, 4, and 5 g. This was done using Atomic Absorption spectrophotometry (AAS) at specific wavelengths of 248.3 nm for Fe and 324.8 nm for Cu. The research findings indicate a decrease in iron (Fe) and copper (Cu) concentration before and after. The amount of activated charcoal made from cassava peel was varied from 1g to 5g. As the mass increased, the iron (Fe) concentration fell by 94.08%, 97.53%, 99.01%, 99.10%, and 99.07% respectively. The copper (Cu) content was reduced by 92.73%, 96.36%, 96.36%, 98.48%, and 97.12%. For commercial activated charcoal with varying masses of 1, 2, 3, 4, and 5 grams, the concentration of iron (Fe) was reduced by 0.27%, 52.41%, 72.70%, 98.85%, and 98.09%, respectively. The copper (Cu) content reduced by 32.22%, 71.25%, 95.31%, 98.18%, and 96.06%.

Keywords: Atomic Absorption Spectrofotometer, Cassava Activated Charcoal, Commercial Activated Charcoal, Copper, Iron.

ABSTRAK

Melalui pemanfaatan arang aktif komersial dan kulit singkong, dilakukan penelitian tentang cara menurunkan kadar besi (Fe) dan tembaga (Cu) pada air sumur yang telah digali. Difraksi sinar-X (XRD) digunakan untuk melakukan uji arang aktif. Pengambilan sampel dilakukan pada sumur warga yang berada di Kelurahan Sumber Karya Binjai Timur. Sampel air diolah dengan asam nitrat pekat (HNO_3) dan didekomposisi. Konsentrasi besi (Fe) dan tembaga (Cu) ditentukan sebelum dan sesudah penambahan arang aktif berbahan dasar kulit singkong dan arang aktif yang tersedia di pasaran, dengan massa 1, 2, 3, 4, dan 5 g. Hal ini dilakukan dengan menggunakan Spektrofotometri Serapan Atom (AAS) pada panjang gelombang spesifik 248,3 nm untuk Fe dan 324,8 nm untuk Cu. Temuan penelitian menunjukkan adanya penurunan konsentrasi besi (Fe) dan tembaga (Cu) sebelum dan sesudah. Jumlah arang aktif berbahan kulit singkong divariasikan mulai dari 1g hingga 5g. Dengan bertambahnya massa, konsentrasi besi (Fe) turun masing-masing sebesar 94,08%, 97,53%, 99,01%, 99,10%, dan 99,07%. Kandungan tembaga (Cu) berkurang sebesar 92,73%, 96,36%, 96,36%, 98,48%, dan 97,12%. Untuk arang aktif komersial dengan massa bervariasi 1, 2, 3, 4, dan 5 gram, konsentrasi besi (Fe) mengalami penurunan masing-masing sebesar 0,27%, 52,41%, 72,70%, 98,85%, dan 98,09%. Kandungan tembaga (Cu) berkurang sebesar 32,22%, 71,25%, 95,31%, 98,18%, dan 96,06%.

Kata Kunci: Arang Aktif Komersil, Arang Aktif Kulit Singkong, Besi, Spektrofotometer Serapan Atom, Tembaga

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1. Introduction

Water is one of the basic needs of living things, especially for humans. Water is used by humans for various activities in daily life, such as household needs, agricultural needs, industrial needs, and various other activities. Two-thirds of the earth consists of water, but not humans can consume all water on earth. The most considerable amount of water on earth comes from the sea, which is ± 97.5%, while the world's population can consume only ± 2.5% of all the water on earth. Water that can be consumed comes from lakes, rivers, groundwater, and so on [1].

The water needed by living things is clean water used for daily purposes whose quality meets health requirements and can be drunk when cooked (Permenkes RI No. 416 1990). One source of clean water utilized by humans is groundwater. Groundwater comes from rainwater that seeps into the ground. Groundwater is clearer than surface water. Groundwater has a reasonably high mineral content. The nature and mineral content of groundwater is influenced by the soil layer it passes through. The mineral content of groundwater includes Na, Mg, Ca, Fe, and O_2 [2].

Clean water can be polluted by various industrial, agricultural, and household wastes that can cause heavy metal pollution that can endanger the community and interfere with the survival of humans and other living things [3]. Heavy metals can disturb health depending on which part of the metal is bound in the body and the magnitude of the metal dose [3].

Heavy metals that seep into polluted groundwater are challenging to recover into clean water, requiring the correct treatment process. The decline in water quality is due to the entry of pollutants from various human activities, such as garbage and industrial waste containing hazardous toxic materials [4].

Water from wells has long been utilized for domestic purposes and by small, medium, and enormous businesses. Wells is a substitute for communities without access to services or not covered by the Regional Drinking Water Company (PDAM). The lack of advanced technology, insufficient funding, and limited capital hinders the potential for fair and equal distribution of clean and healthy water to the population. Dug wells extract water from shallow soil layers near the surface. Therefore, dug wells are easily contaminated through seepage. The people of Sumber Karya Village in East Binjai still use dug wells to fulfill their daily needs wells to fulfill their daily needs, namely for bathing, washing, and not consumed for drinking. This well water does not have good water quality, where the water is smelly, oily, and slightly cloudy in color and brownish yellow sediment. This area used to be a paddy field, and there is also a hospital near the settlement where the waste can contaminate the residents' healthy water. Hospital waste is hazardous waste. Hospital wastewater contains toxic and hazardous chemicals containing heavy metals and is infectious, causing environmental pollution [5], especially affecting the decline in well water quality in Sumber Karya Village, East Binjai.

Based on Alwiyah's research (2017), there are metals Fe, Zn, Co, Cr, and Na in hospital liquid waste . In Leonard's research (2013), hospital waste that wants to be destroyed is done by burning in the initiator, where the ash contains Zn, Pb, Cu, Cr, and Cd metals.

Iron metal in (Fe) in clean water can cause a metallic taste and odor, a red colloidal color (rust) in water due to oxidation by dissolved oxygen, and poisoning. Several studies have shown a link between excessive Fe and diabetes, cancer, increased risk of infection, rheumatism, and increased risk of heart disease. High levels of Fe can cause cell damage due to free radicals [6]. Based on Government Regulation No. 82 of 2001 for Raw Water Water Quality Criteria Based on Class, the allowable level for Iron (Fe) metal is 0.3 mg/L for drinking water treatment. Similarly, copper (Cu) metal is an essential element. However, if in excess concentrations, it can cause reproductive problems and reduce fertility, cause liver damage, and brain damage. Based on Government Regulation No. 82 of 2001 for Raw Water Water Quality Criteria Based on Class, the allowable level for copper metal (Cu) is 0.02 mg/L.

Various techniques and approaches are employed to treat well water and render it suitable for domestic use. This involves the addition of adsorbents, which serve to decrease the levels of various water parameters. The adsorbent used is activated charcoal, which has a carbon content that is high enough to absorb or bind polluting substances in well water. Cassava peel can be used as active charcoal because it contains 59.31% carbon [7]. Cassava is a high-carbohydrate plant that grows in Indonesia. Many businesses use cassava as the main ingredient. In the cassava processing industry, the main waste is the peel. The percentage of inner cassava skin can reach 15% of the total weight of cassava. So far, cassava peels have only been thrown away or are still limited to animal feed [8]. With a high carbon content, cassava peels can be utilized as activated carbon or natural charcoal. In Suprabawati (2018), which made adsorbents from cassava peels by heating in the sun, the absorption efficiency of lead metal ions (Pb) was 20.151% or equivalent to the adsorption of lead metal ions (Pb) 2.0152 mg/L. Therefore, the author is interested in conducting research on the use of cassava peel as an adsorbent that is first charred or carbonized and activated and then added to well water because the author wants to use materials that are simple and readily available around us, namely cassava peels [9].

The test method that the author will use is to compare the results of the decrease in presentation (%) of iron (Fe) and copper (Cu) levels before and after being added with cassava peel activated charcoal and commercial activated charcoal.

2. Materials and Methods

2.1. Equipment

The instruments employed in this investigation comprise atomic absorption spectrophotometry, beaker glass, glass funnel, Erlenmeyer flask, measuring flask, measuring cup, drop pipette, volumetric pipette, mortar and pestle, 100 mesh sieve, stirring rod, porcelain cup, oven, furnace, analytical balance, filter paper, hot plate, ph indicator, aluminum foil, desiccator, and aquadest bottle.

2.2. Materials

The materials used in this study include cassava peel, commercial activated charcoal, fe standard solution 1000 mg/L, Ca standard solution 1000 mg/l, HNO_3, aquadest, dug well water, NaOH 0.5 N, HCl 0.1 N.

2.3. Work Procedure

2.3.1. Preparation of Cassava Peel Activated Charcoal

Cassava peels are first peeled from the outer skin, then washed using clean water and cut into small pieces - small. Then, the cassava skin is dried using an oven at 110 ºC for 3 hours. The dried cassava skin was burned in a furnace at 400 ºC for 1 hour. After that, it was mashed using a mortar and pestle and then sieved with a 100-mesh sieve. Activated charcoal was activated using NaOH solution with a concentration of 0.5 N for 24 hours. Then, it is filtered using filter paper and neutralized with 0.1 N HCl and distilled water until the pH is neutral. Then dried in an oven at 100 ºC for 3 hours [10].

2.3.2. Well Water Sampling

Samples were taken from dug wells of residents of Sumber Karya Village, East Binjai. Sampling points are taken from 4 residents' houses with a distance of ± 5 m to ± 10 m, where well water is taken using a well water sampler tool with a depth of 20 cm below the water surface and mixed into one container using a plastic bottle that has been rinsed with distilled water and then dried. Then, it is coated with a black plastic bottle. Furthermore, the plastic bottle was rinsed with sample water taken as much as 600 mL, then added with $HNO_{3(p)}$.

2.3.2. Sample Preparation

A volume of 100 mL of the material was transferred into a glass beaker and supplemented with 5 mL of HNO_3. Next, the mixture is heated on a hotplate until the volume of water reaches around 15 mL. Then, 50 mL of distilled water is added to the mixture, filtered, and transferred into a 100 mL volumetric flask using filter paper. Subsequently, the solution was diluted with distilled water until it reached the limit line and thoroughly mixed to achieve homogeneity.

2.3.3. Addition of Activated Charcoal to the Well Water Sample

Exactly 1 g of activated charcoal made from cassava peel was placed in a glass beaker. 100 mL of a well water sample was added and left for 3 h. Subsequently, the sample was filtered using Whatmann filter paper No. 42. The mass variation of activated charcoal was measured at 2, 3, 4, and 5 g. Subsequently, the spectrophotometer was used to measure the absorbance of iron metal at a precise wavelength of 248.3 nm. The spectrophotometer was used to measure the absorbance of iron metal (Fe) at 248.3 nm and copper metal (Cu) at 324.8 nm.

3. Results and Discussion

3.1. X-Ray Diffraction (XRD) Analysis of Activated Charcoal

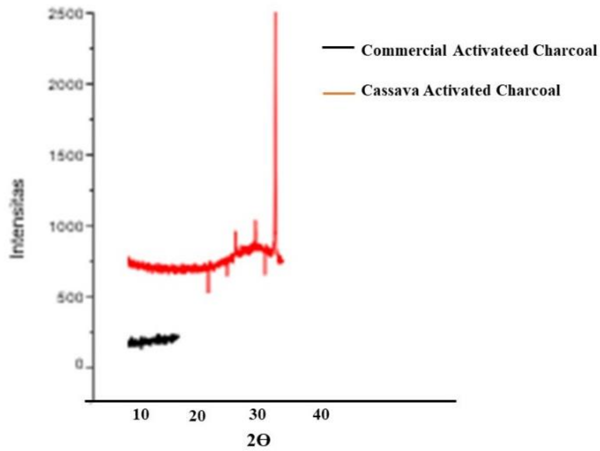

Figure 1. XRD diffractograms of cassava peel activated charcoal and commercial activated charcoal.

Figure 1. shows that the diffraction pattern of cassava peel activated charcoal is the same as commercial activated charcoal, where there is a broadened peak at 2θ angles ranging from 22 º - 25 º in the [002] plane and 43 º - 45º in the [100] plane [002] and 43 º - 45º in the [100] plane. This follows Mazelly (2017) in manufacturing and characterizing bamboo-activated carbon. The high and low peaks produced are influenced by the activation process, which causes a shift in the hexagonal plate, which initially had a high degree of regularity (crystalline), to become irregular (amorphous).

3.2. Effect of Activated Charcoal Addition on Percentage (%) Decrease in Iron (Fe) and Copper (Cu) Metal Concentration with Various Mass Variations

The results indicate that the cassava peel-activated charcoal leads to a higher percentage drop in the content of iron (Fe) and copper (Cu) metals compared to commercial activated charcoal. The initial concentration of Iron (Fe) metal in well water is 2.2030 mg/L. After adding cassava peel-activated charcoal, the concentration decreases to 0.1304 mg/L, 0.0544 mg/L, 0.0217 mg/L, 0.0171 mg/L, and 0.0203 mg/L. When using commercial activated charcoal, the concentration decreases to 2.1970 mg/L, 1.0484 mg/L, 0.6012 mg/L, 0.0252 mg/L, and 0.0420 mg/L. The mass variation of the activated charcoal used is 1g, 2g, 3g, 4g, and 5g, respectively. The Iron (Fe) metal concentration decreased by 94.08%, 97.53%, 99.01%, 99.07%, and 99.10% when cassava peel-activated charcoal was used. On the other hand, the decrease in concentration was 0.27% and 52.41% for commercial activated charcoal, respectively. Additionally, the concentration decreased by 72.70%, 98.09%, and 98.85% for commercial activated charcoal [11].

Percentage (%) decrease in Copper (Cu) metal concentration in well water before the addition of activated charcoal has a concentration of 0.0661 mg/L and after the addition of cassava peel activated charcoal the concentration is reduced to 0.0048 mg/L; 0.0024 mg/L; 0.0024 mg/L; 0.0010 mg/L; 0.0019 mg/L and for commercial activated charcoal the concentration was reduced to 0.0448 mg/L; 0.0190 mg/L; 0.0031 mg/L; 0.0012 mg/L; 0.0026 mg/L with mass variations of 1, 2, 3, 4, 5 g. In other words, the percentage reduction of Copper (Cu) metal concentration is (92.73, 96.36, and 96.36) %, respectively: (98.48 and 97.12)% for cassava peel activated charcoal and 32.22% for cassava skin active charcoal and 32.22%; 71.25%; 95.31%; 98.18%; 96.06% for commercial activated charcoal [12].

The graph of the percentage (%) decrease in the concentration of iron metal (Fe) in well water after the addition of activated charcoal based on mass variations can be seen in Figure 2 below:

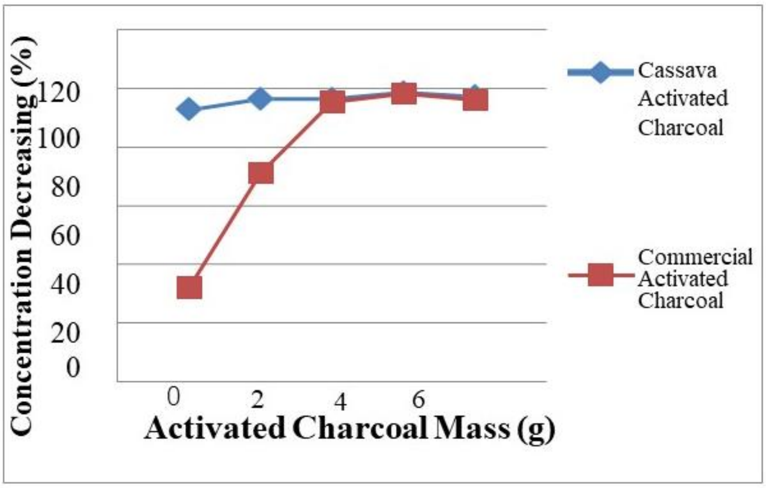

Figure 2. Percentage (%) decrease in iron (Fe) concentration after addition of activated charcoal

The graph of the percentage (%) decrease in copper (Cu) metal concentration after the addition of commercial activated charcoal can be seen in Figure 3.

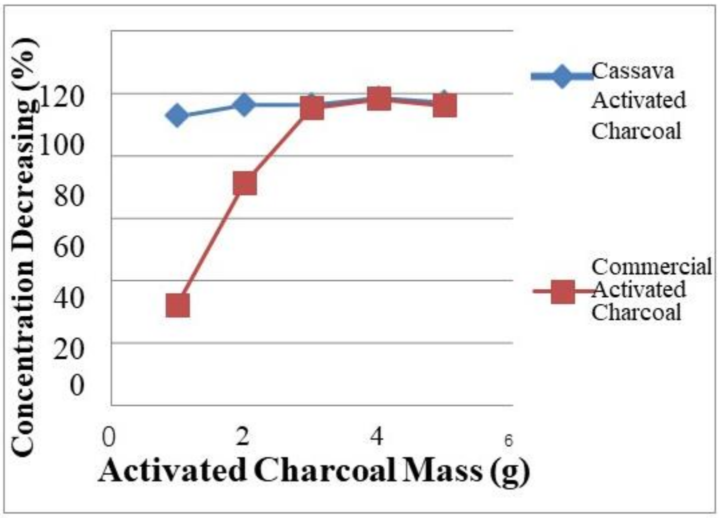

Figure 3. Percentage decrease in copper (Cu) metal concentration after addition of activated charcoal

The graph above shows that the more the mass of activated charcoal is used, the higher the % concentration reduction value.

The increase in the mass of activated charcoal is proportional to the rise in the number of particles and the surface area of activated charcoal so that the number of places to bind metal ions increases and the % decrease in concentration also increases. The percentage (%) decrease in both metals using cassava peel activated charcoal has a considerable value compared to commercial activated charcoal. Based on the picture above, it can be seen that when the surface of the solid is exposed to adsorbate molecules, the adsorbate will hit the surface of the solid so that some will stick to the surface of the solid and be absorbed, while others will be reflected [11].

From the results obtained at a mass of 1,2,3 g of activated charcoal, the resulting concentration is quite large because the solid particles of the sample have not fully attached to the adsorbent surface. At a mass of 4 g, the entire surface of the adsorbent is fully occupied. In comparison, at a mass of 5 g, the absorbed metal particles will come off the adsorbent surface and dissolve again to increase the metal concentration. The process of particle detachment from the adsorbent is called desorption. This process takes place because it has passed the saturation point of the absorption of activated charcoal [13].

The process of absorption might start when molecules of the adsorbate, or substances to be absorbed, collide with the solid's surface and adhere to part of the absorbed solid's surface. Initially, the adsorption rate is significant due to the vacant state of the entire surface. Nevertheless, with an extended duration of contact, the surface area occupied by molecules expands while the vacant area diminishes, reducing the adsorption rate. The adsorption process is affected by the pore structure and chemical properties of the surface of the adsorbent [14].

4. Conclusion

According to the findings of the performed research, the following conclusions can be drawn: Using activated charcoal reduces the content of Iron (Fe) and Copper (Cu) metals in well water. Cassava peel-activated charcoal can absorb Iron (Fe) metals by 94.08% - 99.10% and Copper (Cu) metals by 92.73% - 98.48%. At the same time, commercial activated charcoal can absorb iron (Fe) metals by 0.27% - 98.85% and copper (Cu) metals by 32.22% - 98.18%. The percentage (%) decrease in Iron (Fe) and Copper (Cu) metal concentrations using cassava peel activated charcoal is greater than commercial activated charcoal.

5. Acknowledgements

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6. Conflict of Interest

Authors declare no conflicts of interest

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