HYDROGEL BASED ON DURIAN RIND AS THE PEAT WATER PURIFIER

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ABSTRACT

The Clean water crisis still being problem that can't be resolved around the world, including in Indonesia. Indonesia having the biggest water sources, it's the peat water. However, unfortunately we can't use peat water as a source of clean water because of the high concentrations of natural organic compounds and Fe, which makes the colour of peat water is brown and have a terrible smell. One of the ways to reduce high concentrations of organic compounds and Fe is the adsorption techniques. In this study, researchers made hydrogel utilizing Durian Rind waste. The results showed that hydrogel based on Durian rind could be used as a peat water purifier. The results of FTIR analysis show that cellulose-based on durian rind has been successfully produced. The hydrogel that we made was able to expand (swelling ratio) of 857%. It means that the hydrogel is hydrophilic and capable of absorbing Fe^{2+} ions that pollute peat water. The measurement results of the degree of cross-linkage showed that the hydrogel strength was 98.23%. The AAS analysis also shows that the hydrogel could absorb Fe^{2+} ions was 25%. Thus, with hydrogel, it can be a great solution as a peat water purifier.

Keywords: adsorption, durian rind, hydrogel, peat water

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INTRODUCTION

Indonesia is a maritime country with a waters area of 93,000 km2. With this immense water sources, Indonesia is the ninth position of a country that has the most extensive waters resources in the world. However, more than 27 million Indonesians still lacked of clean water, and 51 million people do not have access to better sanitation facilities. The l to clean water in Indonesia is because existing water sources cannot be used immediately. After all, it does not meet clean water standards. One of the potential water sources used as a source of clean water and widely available in Indonesia, especially the islands of Kalimantan and Sumatra, is peat water [1].

Peat water is surface water that has high organic content, very low pH (3-5) because it has a lot of humic acids, humic acid, fulvic acid and humin, low turbidity and suspended content and low cation content [1,2]. The reddish-brown colour of peat water is a result of the high concentrations of organic substances in the peat water from the decomposition of organic matter such as leaves, trees and wood. These organic substances are in a dissolved state and are very resistant to microorganisms for a long time.

The high concentrations of organic substances cause peat water not to meet the requirements to the standard of drinking water, households, or as raw water for drinking water. In order to be used as a source of clean water, peat water must be purified, one of the way that we can do is by using The adsorption techniques. Adsorption is a water purification technique that is common because the process is relatively cheap. The success of using adsorption techniques in peat water purification has reported widely. Research by Notodarmojo et al. (2017)[3] shows that natural organic matter (NOM) can be absorbed by clay by 81.75%. Research by Zulfikar & Setiyanto (2013) [4] show that peat water adsorbed with 1 g of pyrophyllite can absorb 205.5 mg of humic acid.

The key to the success of peat water purification using adsorption techniques is the selection of adsorbents. Hydrogels are potential super adsorbents used to remove contaminants from aqueous solutions. Hydrogen is better at purifying water than other adsorbents [5]. The successful use of hydrogel as an adsorbent has been widely reported. Research Zhang et al. (2016) [6] showed that hydrogel based on soybean pulp could adsorb Zn (II), Fe (III), Cu (II) and Cr (III) metals with adsorption capacities of 121.2, 78.5, 75.4 and 41.7 mg g^{-1}, respectively. Tran et al. (2018) [5] also said that hydrogel could remove contaminants, such as metals, dyes, radionuclides in aqueous solutions. Hydrogel performance is very dependent on the hydrogel-forming compounds. In this study, the hydrogel will be made using Durian rind waste, which is an abundant agricultural waste in Indonesia. However, despite having an abundant source of durian rind, it has not used effectively. Durian rind contains cellulose and lignin, which can be useful in the process of making hydrogels. The advantages of hydrogel-based in durian rind are it able to absorb natural organic ingredients, and at the same time, it can also be useful as anti-bacterial.[7]

MATERIALS AND METHODS

Materials

The tools used in this research include glassware, filter paper, balance analytical, oven, electric heating, pH meter, centrifuge, *shaker*, UV Vis Cary spectrophotometer, FTIR spectroscopy, spectrophotometer atomic absorption Variants AA 240 FS, stative, furnace and thermometer. The materials used in this study include chitosan, H_2O, starch indicator, iodine, $H_2C_2O_4$, H_2SO_4, HNO_3, KI, $KMnO_4$, KOH, methylene blue, NaOH, $Na_2S_2O_3$, CH_3COOH, chitosan, $NaClO_2$, distilled water, peat water samples were taken at Sepakat Street II Pontianak, Indonesia and durian rind samples were taken from Durian Market waste on Teuku Umar Street, Pontianak, Indonesia.

Methods

Cellulose Extraction from Durian Rind

Extraction of cellulos from Durian rind was prepared using a two-step process, according to Tawakkal et al. (2012). The first step is the production of holocellulose using the chlorination method or the bleaching process. The second step of this process is to convert holocellulose to cellulose using mercerisation at room temperature. The extraction success was confirmed by FTIR spectroscopy.

Synthesis hydrogel

Cellulose is mixed with chitosan in a ratio of 7: 3. The polymer mixture was added to the NaOH / urea solvent system/water (7/11/81) and stirred for 1 hour at room temperature, after which it was cooled at −4 ◦C for 1 hour. The hybrid solution obtained was added with 250 mL of 2 M acetic acid solution, hydrochloric acid, and sulfuric acid solution, respectively. The hydrogel formed was stored in the coagulation medium for 2 hours, followed by further washing with aquadest until neutral conditions were reached. The hydrogel is stored in deionised water.

Hydrogel Characterization

Hydrogel characterisation of durian rind was carried out by determining the concentrations of water, ash content, iodine number, the absorption capacity of methylene blue and specific surface area.

Test of the Ability of Hydrogels to Absorb Fe on Peat Water

To determine how efficient the hydrogels to absorbing Fe was measured using atomic absorption spectroscopy. Peat water samples were measured before and after soaking with 0.1 g hydrogel.

RESULTS AND DISCUSSION

a. Extraction of Cellulose from Durian Rind

1) Holocellulose production.

Holocellulose production is carried out by the chlorination method, in this stage used NaClO2 to 5%. The product is formed white holocellulose. The purpose of adding NaClO2 to the sample is to remove lignin which is still contained in the durian rind. The changes in durian rind to holocellulose are shown in Figure 1.

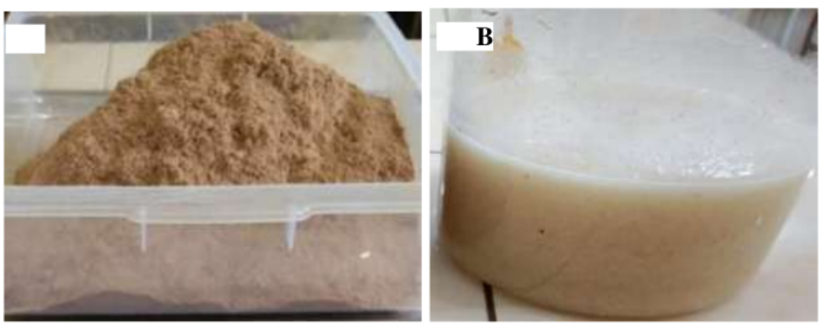

Figure 1. (A) Durian rind powder; (B) Mercerizing Holocellulose

The mercerisation process aims to convert cellulose into holocellulose (Tawakkal, 2012). The obtained holocellulose was added with 80 mL of 17.5% NaOH and distilled water. The result of the mercerisation process shows that cellulose is formed, which is characterised by the formation of fibres, intense attraction, colourless. The results of the formed cellulose are shown in Figure 2.

Figure 2. Cellulose

b. Characterisation of Cellulose

Formed cellulose was then characterised using FTIR Spectroscopy. The results of FTIR analysis are shown in Figure.

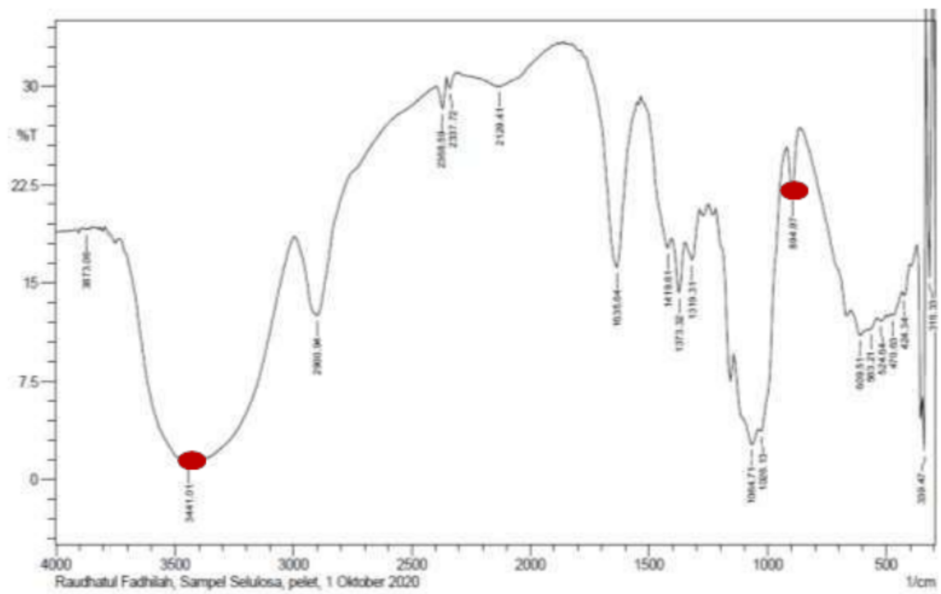

Figure 3.Spectrum of FTIR

The results of FTIR spectrum analysis (Figure 3) show that cellulose has been formed with the appearance of a peak at wave number 3441.01 cm-1 which indicates the presence of OH stretching vibrations for the OH group and intramolecular hydrogen bonds and intermolecular in cellulose molecules. No peaks were found at the wave number 1466-1421 cm^{-1}, which indicates that lignin and xylan were successfully removed from the durian rind. The peak at the 894.97 cm^{-1}, shows that there is a CH glycosidic bond which is a typical rocking vibration of cellulose.

c. Synthesis of Hydrogel

Cellulose mixed with chitosan and coagulant. This procedure aims to produce a gel (Trivedi et al., 2018). As a coagulant used: NaOH / urea/water with a ratio of 7:11:81. The results of the synthesis show that a hydrogel has been formed, which is characterised by a gel form and when it dries the gel forms like cotton. Wet and dry hydrogel images are shown in Figure 3.

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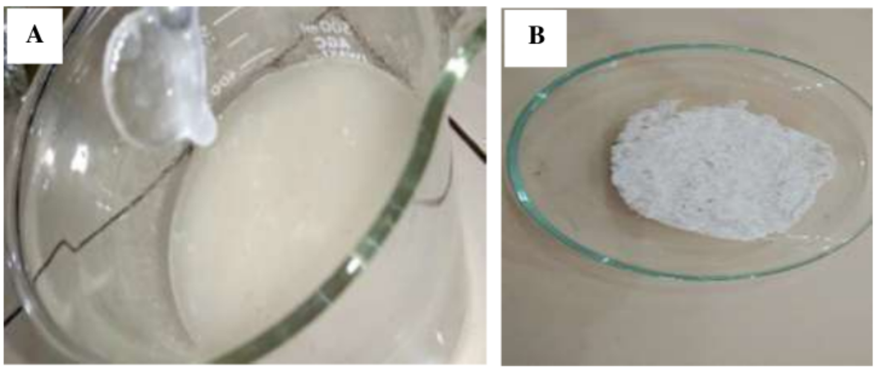

Figure 3. (A) Wet hydrogel; (B) Dry Hydrogel

d. Characterisation Hydrogel

Characterisation of hydrogel was carried out by measuring the degree of crosslinking and the swelling ratio. Cross degree measurement is done by immersing the hydrogel in acetic acid. From the immersion results obtained *Wa* (dry hydrogel weight after immersion) of 0.511 g and *Wb* (weight of dry hydrogel before immersion) of 0.502 g. The calculation result shows the percentage of cross-tie degree of 98.23%**.** These indicate that the hydrogel formed has a binding strength of 98.23%. This indicates that the hydrogel is able to bind Fe^{2+} ions which pollute peat water. Measurement of the ratio is *swelling* done by immersing the hydrogel in aqua bides. The dry hydrogel weight (Wd) was obtained: 0.503 g, while the expanding hydrogel weight (Ws) was: 4.814 g. The results of calculations swelling show that the synthesised hydrogel can absorb water up to 857%. The high swelling ratio indicates that the hydrogel formed is very hydrophilic because it can absorb a lot of water. (Chang et al , 2010).

e. Hydrogel Adsorption Ability

The adsorption of Methylene in blue this research, UV Vis spectrometry was used to determine the amount of methylene blue dye that could be absorbed by the hydrogel. Measurements were made at a wavelength of 664 nm. The measurement results showed that the hydrogel was able to absorb 98.23% of methylene blue. The standard curve and measurement table for methylene blue adsorption are shown in Figure 4 and Table 1, respectively.

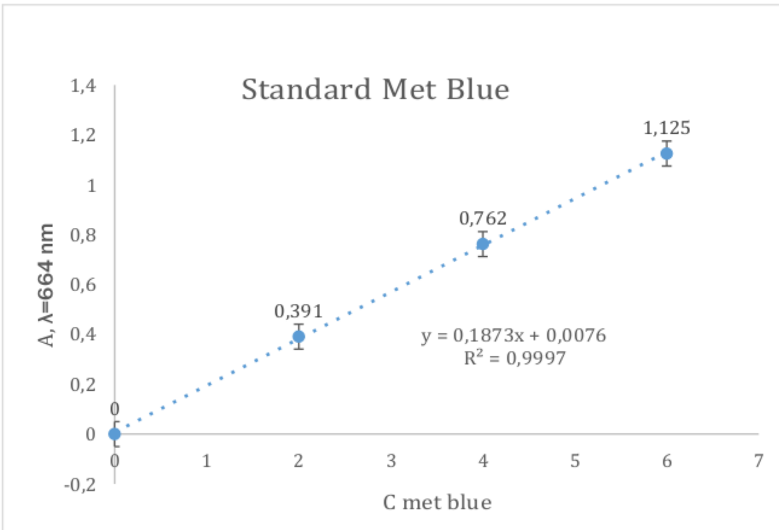

Figure 4. The curve of a standard solution of Methylene Blue. Error bars indicate standard of deviation (n=3)

Table 1. The Measurement of Adsorption Methylene Blue by The hydrogels

Co	After immersion 0.1 g Hydrogel	Ce	Co-Ce	Percentage absorption
25	0.043	0.189001602	24.8109984	99.24399
50	0.177	0.904431393	49.09556861	98.19114
100	0.192	0.984516818	99.01548318	99.01548
200	1.033	5.474639616	194.5253604	97.26268
500	0.487	12.79765083	487.2023492	97.44047
			The average of adsorption	**98.23075**

Table 1 shows that the average adsorption capacity of methylene blue by hydrogel based on durian rind is 98.23% with the highest adsorption capacity at a methylene blue concentration of 25.0 ppm. Thus, the maximum adsorption capacity when the methylene blue concentration is 25 ppm. The adsorption capacity at various hydrogel concentration variations is shown in Figure 5.

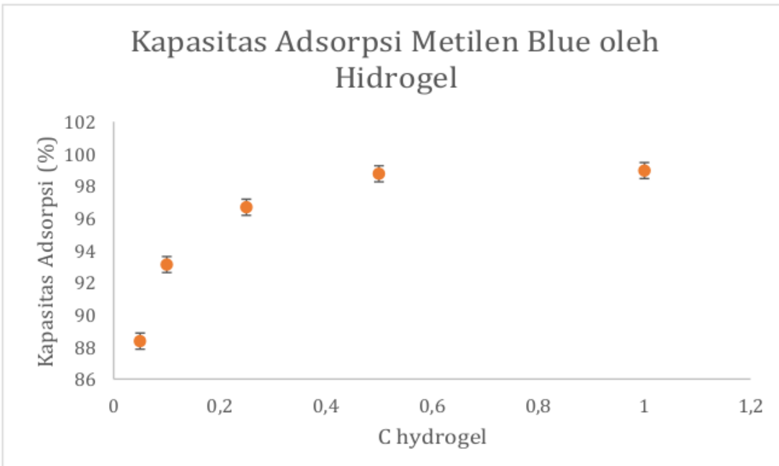

Figure 5. Methylene Blue Adsorption Capacity at various hydrogel concentrations. Error bars indicate standard of deviation (n=3)

Figure 5 shows that the higher the hydrogel concentration, the adsorption capacity will increase. The highest adsorption capacity was when the hydrogel concentration was 1 g with Q at 98.96%. The high adsorption capacity of methylene blue by hydrogel indicates that the hydrogel is able to absorb 98.96% organic content in peat water.

f. Adsorption of Fe in peat water by The hydrogels

One of the main problem if we use peat water as a source of clean water is the high concentration of Fe . Measurement of Fe adsorbs in peat water using atomic absorption spectroscopy (AAS). The results of measurements using SSA explained the initial level of Fe in peat water was 2.17 ppm. Fe concentration decreased to 1.92 ppm after soaking with 1 g hydrogel for 1 hour. Thus hydrogel is able to absorb Fe by 25%.

CONCLUSIONS

Durian rind-based hydrogel can be a a great solution for new adsorbent in purifying peat water, Fe content can be reduced by 25% while the organic matter is absorbed by hydrogel untill 98.96%

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