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Adsorption of Humic Substances by using Coconut Copra

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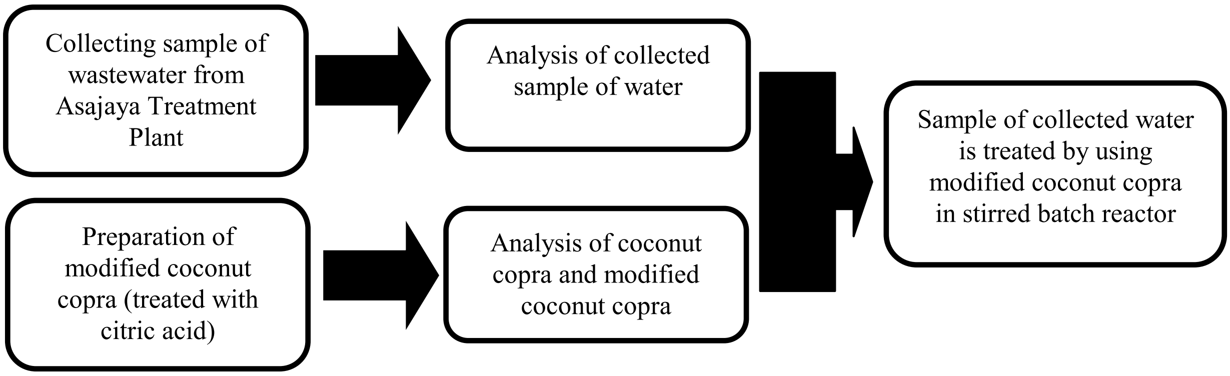
Abstract. Nowadays, consumers are concern about the quality of water that being supplied in order to ensure the water supplied is free from any harmful substances for example like Humic Substances (HS). High concentration of HS in drinking water can cause disease for human such as stomach cancer. Thus, it is important to develop a new technique to improve the quality of drinking water. Therefore, the objective of this research is to investigate the potential of using coconut copra treated with citric acid as activated carbon in adsorbing HS contained in wastewater collected from Asajaya Treatment Plant situated in district of Samarahan, Sarawak. In this research, the optimum condition of adsorption process need to determined. As such, there are two types of parameters which are considered as constant; temperature and pH of activated carbon and variable; solid liquid ratio and residence time. As a result, this research has shown that coconut copra possess the capacity to adsorp 97.5% of HS contained in wastewater.

Introduction

Environmental pollution has extremely increased in Malaysia especially in water pollution. Water is one of the important needs of human on this earth. Consumers nowadays stress on the quality of water which is supplied to them in order to ensure that the water supplied is free from any harmful substances for example Humic Substances (HS). HS are the most widely distributed products from biosynthesis that contained in soil. Apart from soil, it also can be found at different level of concentrations in different sources like rivers, lakes, oceans, compost, sediments, peat bogs and soft coal. HS are formed by a process called humicification [1]. HS are divided into three main fractions which are Humic Acid, Fulvic Acid, and Humin. It can be classified based on solubility in acids and alkaline [2]. High concentration of Humic Acid in drinking water can cause some serious diseases on human health for example stomach cancer which is due to the disinfection caused by by-products namely trihalomethanes [3, 4, 5]. Humic Acid contains relatively high amount of basic Amino; combination of functional groups of Amine and Carboxylic Acid, becomes poisonous if the molecular weight of Amines is relatively low [6, 7]. On the other hand, Amines are not totally harmful but when it reacts with the other compounds, it will form nitrosamines and nitramines which have an irreversible effect on environment, human and animals. Some of the amino compounds have also been known or suspected carcinogen*s* due to the aromatic amine which can cause disease like bladder infection [8]. Therefore, it is important to remove HS especially Humic Acid from drinking water. As mentioned by Hatam et al, high amount of Humic Acid can become one of the etiological factors for Blackfoot disease [6]. Therefore, the objective of this research is to investigate the potential of using coconut copra as activated carbon in adsorbing humic substances contained in wastewater collected from local wastewater treatment plant namely Asajaya Treatment Plant located in district of Samarahan.

Methodology

The methodology of this research is summarized by using the following flow chart:



During the adsorption process, the temperature and pH of activated carbon are remained constant throughout the experiments with the intention of remaining the sustainability of the design. However, in order to find the optimum condition of this adsorption process, residence time and solid liquid ratio are varied throughout the experiments. Finally, the treated water will be analyzed by using spectrophotometer. Meanwhile, the modified activated carbon will be analyzed by using Fourrier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscope (SEM).

Result and Discussion

This part is divided into two parts; firstly, analysis of modified coconut copra before adsorption process by using FTIR and followed by using SEM after the adsorption process and secondly, analysis of treated water.

Analysis of modified coconut copra before adsorption process by using FTIR

The results are shown in Figure 1 and 2.

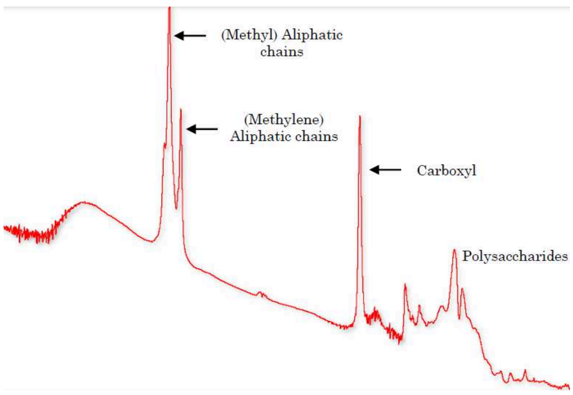


Figure 1: Characterization of raw coconut copra

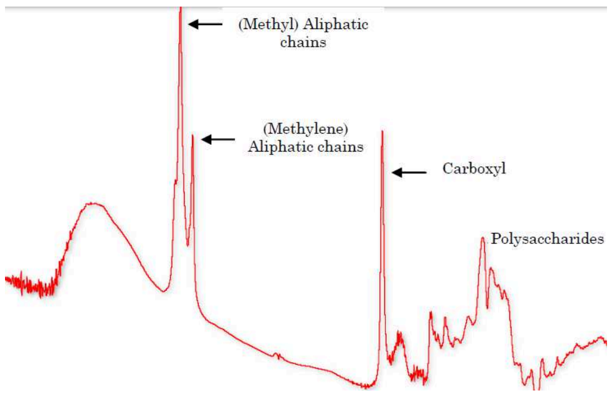


Figure 2: Characterization of modified coconut copra

The main Functional group for the HS is consisted of aliphatic, carboxylic, aromatic, and hydroxylic groups. The peak that shows the wavelength between 2850 – 2900cm^{-1} indicated the C–H stretching of methyl and methylene group of aliphatic chains. Next, the peak at wavelength between 1700 – 1710cm^{-1} shows the C=O bond of carbonyl and carboxylic and C=C aromatic bonds. Finally, band peak around 1100 – 1150cm^{-1} shows the C–O stretch of polysaccharide. The modified coconut copra is mix with citric acid, which make the pH of the coconut copra become more acidic. The presence of citric acid in the process may cause reaction between citric acid itself with cellulose or known as acetylatic reaction which form ester linkage. By observing the wavenumber of modified coconut copra at 1150cm^{-1}, it shows the glycosidic linkage where degradation of hemicelluloses is occurred.

Analysis of modified coconut copra after adsorption process by using SEM

After the adsorption process has been carried out, two layers are observed in the reactor. These two layers can easily be differentiate due its different colour and intensity. The top layer of the coconut copra is more yellowish than the bottom layer. This is due to the non-homogeneity condition inside the reactor due to the mixing condition. In fact, The top layer adsorb more HS compared to the bottom layer as the stirrer is fixed at the middle of the reactor, thus the totality of the surface of the bottom layer does not get in contact with the wastewater througout the adsorption process. The results of this analysis are shown in Figure 3 and 4.

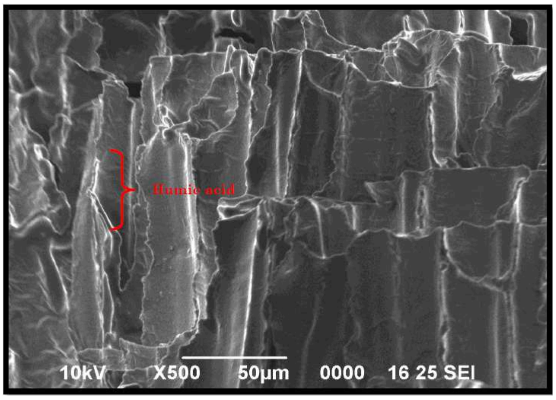


Figure 3: Top layer of modified coconut copra

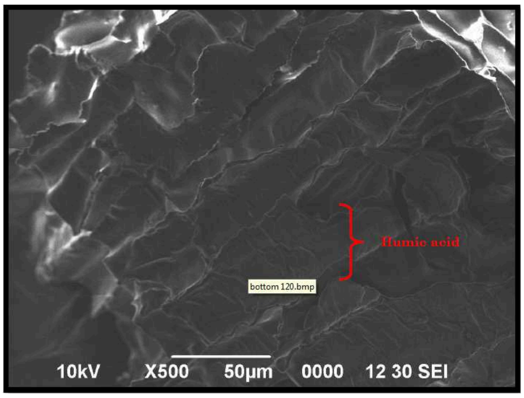


Figure 4: Bottom layer of modified coconut copra

The rough surface of the coconut copra indicates the amount of humic acid that being adsorbed. As the amount of coconut copra increases for the solid liquid ratio, the amount of humic acid being adsorb also will increase. This is due to the available surface area for the humic acid to be adsorbed.

Analysis of treated water by using spectrophotometer

The reading that being taken from the spectrophotometer at the wavelength of $465 cm^{-1}$, is the value for the concentration of the wastewater after going through the adsorption process. The smallest reading value of the concentration is 0.1mg/L for the sample C2. The smallest the reading, the higher is the rate of the adsorption process. Table 1 shows the reading that being obtained for each of the sample.

Table 1: The reading for concentration obtain from spectrophotometer

Sample	**Experiment Condition**		**Concentration,C (mg/L)**			
	Solid Liquid Ratio	**Residence Time (min)**	**#1**	**#2**	**#3**	**Average**
A1	80g : 2000ml	60	1.7	1.8	1.7	1.7
A2	80g : 2000ml	120	1.3	1.2	1.2	1.2
B1	100g : 1500ml	60	1.1	1.0	1.0	1.0
B2	100g : 1500ml	120	0.6	0.6	0.6	0.6
C1	120g : 1000ml	60	0.3	0.3	0.2	0.3
C2	120g : 1000ml	120	0.1	0.1	0.1	0.1
Untreated Water	N/A	N/A	4.1	4.0	4.0	4.0

The following formula is used to calculate the removal percentage of HS:

$$\text{Percentage of Removal} = \frac{C_{\text{untreated water}} - C_{\text{water treated by modified coconut copra}}}{C_{\text{untreated water}}} \times 100 \quad (1)$$

Overall results are shown in Table 2:

Table 2: Percentage of removal

Sample	**% Removal**	**Sample**	**% Removal**
A1	57.5	A2	70
B1	75	B2	85
C1	92.5	C2	97.5

The result shown in Table 2 demonstrate and prove that residence time and quantity of modified coconut copra play an important role in increasing the efficiency of the adsorption process of HS. More modified coconut copra is added, more HS is adsorbed and more wastewater is in contact with modified coconut copra, more HS is adsorbed as well. As a conclusion, the proportionality relation between residence time and quantity of modified coconut copra is exist. Lastly, the optimum condition for this adsorption process is at residence time of 120 minutes and at solid liquid ratio of 120g: 1000mL.

Conclusion

As a conclusion, this research demonstrates and proves the potential of using coconut copra as activated carbon in adsorbing HS contained in wastewater collected from Asajaya Treatment Plant with condition solid liquid ratio of 120g: 1000mL and residence time 120 minutes. For future work, this adsorption process will be scaling up to the real size of Asajaya Treatment Plant with the intention of supplying clean drinking water to Asajaya community.

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