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The Use of Mango Seed Arum Manis Type (*Mangifera Indica L*) as Biosorbent

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Abstract. This research was conducted to study the effectiveness of mango seed Arum Manis type as biosorbent. Methods used in study were pre-treatment and activation process. The mango seeds were cleaned, dried under the sun and crushed to pass through 140 mesh. And then they were activated with 3N chloric acid at certain ratio. After heating at 70 °C for two hours, cooling under room temperature, they were washed with aquadest. At last, the powder was activated physically (calcinating) at several temperature. The best condition for chemical and physical activation were concluded by taking the highest Iodine Number of each sample. Comparing to the standard of activated carbon issued by SNI 06-3730-1995 it was found that the highest of the Iodium Number was 803, 79 mg/g, ash content was 8 % and moisture content was 13, 3 % at condition the ratio of mango seed to 3N chloric acid 1:4 (w/v) and calcinating temperature 110 °C which means biosorbent from mango seed has met the standard from these three parameters

1. Introduction

Adsorbent/biosorbent can be made from many varieties of biomass, including seeds of certain plants such as mango seeds Arum Manis type (*Mangifera Indica L*). In many places, the widely use part of mango is as foodstuffs, while the seeds are not used and disposed as waste.

According to strategic planning by Agriculture Ministry, the rate of mango production was the highest main commodity in horticulture for the decade of 2004 to 2014 which was 21, 95% per year in average.

Rao (2005) research showed that tannin in plant was an active material which can cause coagulation process. while natural polymer like starch functioned as flocculent [1]. Carbohydrate is an organic compound which is included in polymer material. This bond is formed along a group of -OH from glucose unit in cellulose molecule which has high potential to become an adsorbent because it contains of hydroxyl (-OH) that can make interaction with adsorbate compound [2].

Some researches have been reported using mango seed as adsorbent by activating it chemically. Some of them are Alencar, S *et al* (2012), Davilla Jamenez *et al* (2009) and Kwagher and Ibrahim (2013) [3, 4, 5].

This research was conducted to study the effectiveness of mango seeds Arum Manis type by activating them chemically and physically. According to Widya (2013), the content of carbohydrate and tannin in mango seeds Arum Manis are higher than in mango seeds of other types [6].

The best condition for chemical and physical activation were conclude by taking the highest Iodine Number of each sample.

2. Methods

The main material was mango seeds Arum Manis type that were obtained from markets in Medan city and several town around Medan. Chloric acid for activation process, iodine solution, starch solution, sodium thiosulphate and aquadest were used in analysis purpose bought from chemical distributors.

In the beginning, mango seeds were washed with water and dried in the sunlight. Then they were crushed to powder form and passed through 140 mesh. The powder then was activated using 3N chloric acid with the ratio of 1:1; 1:2; 1:3 and 1:4 (g/mL) and heated for two hours at 70 ºC. After cooling under room temperature, they were washed several times with aquadest to remove residual acid. To increase the surface area of adsorbent, the powder was activated physically (calcinating) by putting them in the oven for two hours at several temperatures (90 ºC, 100 ºC, 110 ºC, 120 ºC, 130 ºC, 140 ºC).

Finally it was conducted the measurement of iodine number of each biosorbent. Iodine Number is mass of iodium (mg) which is needed by 100g of chemical compound. It is often used to ensure the number of unsaturated bond in a compound. This unsaturated bond in double bond form reacts with iodium.

The datas were analyzed by plots the iodine number to calcinating temperature at several ratio of biosorbent to 3N chloric acid.

3. Results and Discussion

3.1. Iodine Number

Iodine number of biosorbent was analysed before and after activation process. The iodine number before activation was 469, 37 mg/g, while the influence of activating temperature to iodine number of biosorbent at some ratios of biosorbent to 3N chloric acid was showed in Fig. 1 below

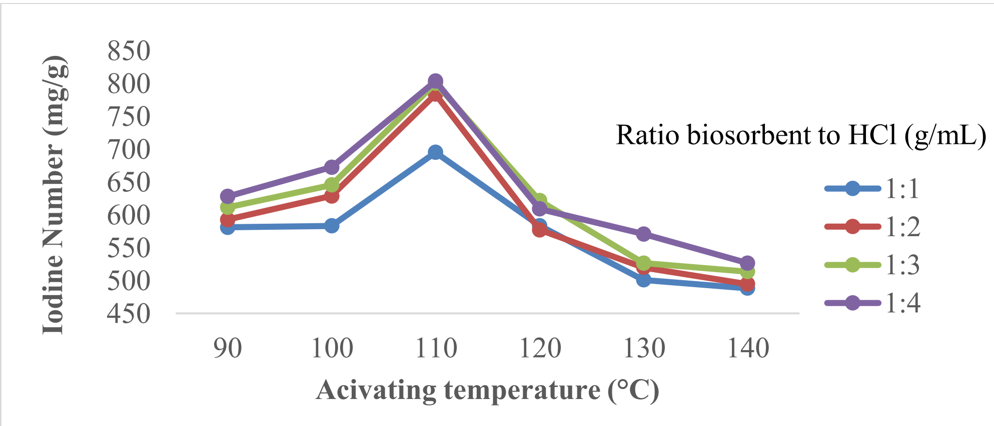

Figure 1. The influence of activating temperature to Iodine Number of biosrbent at some ratios of biosorbent to 3N chloric acid

From Figure 1, it can be seen that iodine number tend to increase by the increasing of calcinating temperature for all ratio of biosorbent to chloric acid 3N until 110 ºC. After that, iodine number decrease by the increasing of calcinating temperature for all ratio of biosorbent to chloric acid. This can be happened for some probabilities. Firstly, the treatment of biosorbent at temperature more than 110 ºC increases the pores area but on the other hand the pores could be damaged. Secondly, cracking is happened at the temperature more than 110 ºC which is caused the decrease of mesopores and micropores of biosorbent.

Chemical modification is usually carried out a lower temperature than the physical method. Furthermore the chemical treatment (activating) needs shorter time than physical treatment which will increase the surface area and micropores of biosorbent [7]. Higher temperature will increase the rate of reaction for the reduction of impurities and volatile compounds that filled the pores of biosorbent thereby optimizing the active pores formation. However, overheating may impact on the reduction of mesopres and micropores [8]. A very low concentration of activator may cause the incomplete formation of active sites. Whereas a very high ratio of activator may cause a damage to structure of the biosorbent [9]. The volume of activator will influence the quality of biosorbent. A very high volume of activator may eliminate active biosorbent properties due to the damage caused by dissolution and break up of pores on the biosorbent [10].

By comparing theory and results obtained from the research, it can be concluded that the most favorable conditions to produce the biosorbent from mango seeds Arum Manis type with the highest iodine number (803, 80 mg/g) is at the ratio of biosorbent to 3N chloric acid of 1:4 (g/mL) and at calcinating temperature of 110 ^{o}C.

According to standard of activated carbon by SNI 06-3730-1995, the minimal iodine number is 750 mg/g, moisture content is 15 % max and ash content is 10 % max [11]. After analysing the biosorbent, it was found that the moisture content of biosorbent from mango seed Arum Manis type was 13, 3 % and ash content was 8 %.

3.2. Infrared spectroscopy
The molecular structure of the mango seeds Arum Manis type before activation and after activation at condition the ratio of biosorbent to 3N chloric acid was 1: 4 (g/mL) at calcinating temperature of 110 ^{o}C. are shown in Fig. 2. below

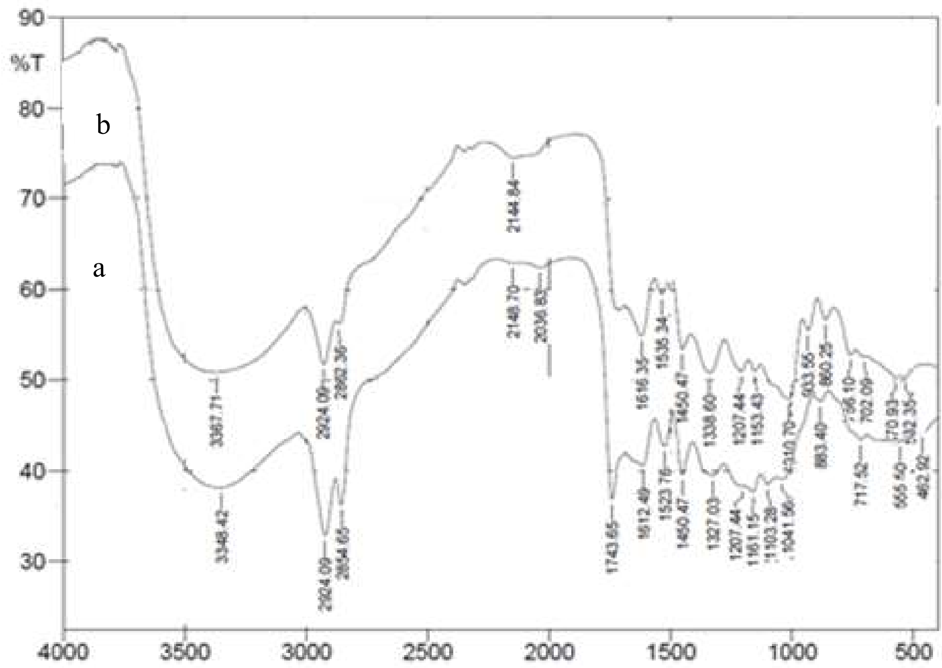

Figure 2. FTIR spectra of a. Mango Seeds Arum Manis type After Activation; b. Mango Seeds Arum Manis type before Before Activation

FT-IR spectra of the different samples of mango seeds Arum Manis type were recorded in the range of 4000-500 cm^{-1}. A slightly difference is observed in the region of the intermolecular hydrogen bonding (3200-3400 cm^{-1}).

From Fig. 2. could be seen that mango seeds Arum Manis type before and after activation have almost similiar behavior of spectrum. However, from the result of analyzing FT-IR mango seeds Arum

Manis type after activation it can be seen there is a peak occurs on the wavelength 1743, 65 $cm^{-1.}$ This wavelength shows the existence of C=O group which is unsaturated bond.

Furthermore in acid activation, there is cation exchange of minerals with H^+ was from acid that causes adsorbent becomes negatively changed and increases the adsorption capacity. In addition, this ion exchange will increase the surface area of the adsorbent [12].

4. Conclusion

The conclusion drawn from this study are:

- The highest iodine number of the biosorbent was 803, 80 mg/g and it was obtained at the ratio of biosobent to 3N chloric acid 1:4 (g/mL) and at the calcinating temperature 110 ^oC.
  By the point of view of activated carbon standard on SNI 06-3730-1995, the iodine number, the moisture content, and ash content of the biosorbent are fit the standard.
- Iodine number of the powder of mango seeds before activation was 469, 37 mg/g. After chemical activation was 596, 39 mg/g. And after chemical and physical activation became 803, 80 mg/g. It means that the activation process was successful to increase iodine number.

Acknowledgments

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References

[1] Rao N 2015 Use of Plant Material as Natural Coagulants for Treatment of Water *Environment: Waste Management.*
[2] Puspita, Yohanna V D, Mohammad S I and Surjani W 2013 Karakterisasi dan Uji Kemampuan Serbuk Ampas Kelapa Asetat sebagai Adsorben Belerang Dioksida (SO_2) Jurusan Kimia FMIPA Universitas Negeri Malang
[3] Alencar W S, Elie A, Eder C L, Betina R and Felipe E d S 2012 Application of Mangifera indica (mango) Seeds as a Biosorbent for Removal of Orange 3R dye from Aqueous solution and study of the Biosorption *Chemical Engineering Journal* **209** 577-588
[4] Davila-Jimenez, Martin M, Maria P. Elizade G and Virginia H M 2009 Performance of Mango Seed Adsorbents in the Adsorpstion of Antharaquinone and Azo Acid dyes in Single and Binary Aqueous Solutions *Biosource Technology.* **100** 6199-6206.
[5] Kwaghger, A and Ibrahim J S 2013 Optimization of conditions for The Preparation of Activated Carbon from Mango Nuts Using HC *American Journal of Engineering.* **2** 74-85.
[6] Widya D 2013 *Proses Produksi dan Karakteristik Tepung Biji Mangga Jenis Arumanis* (*Mangifera indica L.*). IPB Press : Bogor
[7] Abedi M and Zaker B 2010 Preparation of Carbonaceous Adsorbent from plant of Calotropis Gigantea by Thermo-Chemical Activation Process and its Adsorption Behavior for Removal of Methylene Blue *World Applied Sciences Journal* **11(3)** pp 263 – 268.
[8] Xin H, Liu J, Fan F, Feng Z, Jia G, Yang Q, and Li C 2008 Mesoporous Ferrosilicates with High Content of Isolated Iron Species Synthesized in Mild Buffer Solution and Their Catalytic Application *Microporous and Mesoporous Materials.* **113** pp 231-239.
[9] Johnson W M and Maxwell J A 1981 *Rock and Mineral Analysis Edisi kedua* New York: John Wiley & Sons Inc.
[10] Louise B 2002 Adsorption of Chromium (VI) by a Low-Cost Adsorbent *Chemosphere* vol **30(1)** 561-578.
[11] Standar Nasional Indonesia 1995 *Arang Aktif Teknis (SNI) 06-3730-1995)* Jakarta: Badan Standardisasi Nasional Indonesia
[12] Rajeshkannan R, Rajasimman M and Rajamohan N 2011 Decolourization of Malachite Green Using Tamarind Seed: Optimazation, Isotherm, and Kinetic Studies *Chemical Industry & Chemical Engineering Quarterly* **17 (1)** 67-79