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Effectiveness of HDTMA-Br Surfactant Modified Jackfruit Peel Activated Carbon Adsorption on Methylene Blue

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ABSTRACT

Jackfruit peels are usually considered as waste and cause environmental pollution. However, banana peels can be used as an adsorbent material to reduce the impact of methylene blue dye use because they contain high lignocellulose. This study aims to determine the characterization, optimum mass and optimum time. Adsorbents are made using dried and carbonized jackfruit skin at a temperature of 400°C for 2 hours. After the carbonization process, the adsorbent was activated using 5 M potassium hydroxide for 4 hours. . Based on the research results, it shows that the optimum mass of carbon is found at a mass of 0.16 grams and the optimum mass for activated carbon and HDTMA Br activated carbon occurs at a mass of 0.07 grams. Meanwhile, the optimum time for carbon was 60 minutes and for activated carbon and HDTMA Br activated carbon was 45 minutes.

Keywords: jackfruit peel, adsorbent, methylene blue, surfactant,characterization

1. INTRODUCTION

Industry in Indonesia is currently developing. With the development of this industry, the use of chemicals in the process of making a product will definitely increase. The Indonesian textile industry is growing rapidly to meet people's clothing needs[1]. The development of the industrial sector has had a major impact on increasing the use of dyes, most of the textile industry uses synthetic dyes.

One of the synthetic dyes commonly used in the textile industry is methylene blue which is very dangerous for human health. Methylene blue can cause irritation to the skin and gastrointestinal tract, and can cause cyanosis if inhaled[2]. To reduce environmental pollution due to the use of methylene blue dye, textile industry liquid waste must be treated first before being discharged into the environment.

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Various methods have been developed to reduce these dyes, such as adsorption, electrolysis, precipitation, ion exchange, chemical oxidation, and various other biotechnologies. One alternative to reduce dye contamination is adsorption. Adsorption is the best method for adsorbing dyes because it is safe, does not cause dangerous side effects, and the equipment used is simple, easy to operate, recyclable, efficient and cost-effective3. Adsorption is the absorption of substances (molecules or ions) on the surface of an adsorbent1. One of the adsorbents commonly used in the adsorption process is jackfruit peel activated carbon.

Jackfruit skin can be used as an adsorbent for metal compounds because its cellulose content is quite high3. The high effectiveness of jackfruit peel is caused by the high content of cellulose (27.75%), pectin (17.63%), protein (6.27%), and 4% carbohydrates [4]. The use of activated carbon as an adsorbent has been applied in the processing of waste fluids. industry and has been proven capable of absorbing ions in industrial waste, although its absorption capacity is not very effective. Therefore, efforts to increase the absorption capacity of activated carbon can be modified by adding surfactants[5]. Based on research by Laksono (2017), modification with the cationic surfactant HDTMA-Br was carried out and succeeded in adsorbing nitrate anions with an adsorption yield of 75.13%. Furthermore, modification of algal biomass was also carried out using HDTMA-Br surfactant, which succeeded in adsorbing methylene blue and Coomassie brilliant blue dyes in solution with a yield of more than 70%[6].

Based on previous research, in this research, jackfruit skin will be used with modified HDTMA-Br surfactant as active carbon raw material and a carbonization process will be carried out. Then the jackfruit skin carbon with HDTMA-Br surfactant modification was activated using 5 M KOH by varying the mass of carbon, KOH activated carbon and HDTMA-Br surfactant modified activated carbon, carbon contact time, KOH activated carbon and HDTMA-Br surfactant modified activated carbon. Its adsorption ability towards methylene blue will be tested using UV-Vis spectrophotometry.

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

Jackfruit skin, potassium hydroxide (KOH) 5 M, distilled water, filter paper, Whatman paper No. 1, Hexadechyltrimethylammonium Bromide and Methylene Blue and the equipment used includes a grinder, 120 mesh sieve, centrifuge, furnace, porcelain crucible, thermometer, oven, glassware, stir bar, desiccator, pH meter, suction ball, spatula, aluminum foil, and spectrophotometer UV-Vis and SEM (SEM TM3000).

2.2. Research Procedure

2.2.1 Jackfruit Skin Preparation

Each jackfruit skin has been cleaned, cut into thin strips and dried in the sun for 2 × 24 hours or until dry, then ground using a grinder and sifted using a 120 mesh sieving.

2.2.2 Making Jackfruit Peel Activated Carbon

Making active carbon from jackfruit skin by carbonizing jackfruit skin using a furnace at a temperature of 400˚C for 2 hours and sifting. Then the jackfruit skin is soaked with KOH activator 5M with a ratio of 1:4

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and stirred on a hotplate using a magnetic stirrer with a rotation of 200 rpm until evenly mixed at a temperature of 80˚C for 4 hours.

2.2.3 Modification of Jackfruit Peel Activated Carbon with HDTMA-Br Surfactant

Modification of jackfruit peel activated carbon with 300 ppm HDTMA-Br surfactant. by putting 1 gram of activated carbon into a glass beaker then adding 25 mL of 300 ppm HDTMA-Br surfactant for 4 hours at room temperature. Then filtered and separated. The separated residue was dried in an oven and cooled in a desiccator for 15 minutes.

2.2.4 Characterization of Jackfruit Peel Adsorbent

Characterization using SEM to determine the pore surface morphology of carbon, activated carbon and surfactant modified active carbon and characterization using a UV-Vis spectrophotometer to determine the efficiency of carbon adsorption on methylene blue.

2.2.5 Making a Calibration Curve for Methylene Blue Solution

Preparing a standard solution of methylene blue with concentrations of 0, 5, 10, 15, 20 and 25 ppm, then measuring its absorption using a UV-Vis spectrophotometer at a wavelength of 665 nm.

2.2.6 Determination of the Optimum Mass of Jackfruit Peel Adsorbent

Determination of the optimum mass for each unactivated carbon, KA and KA-HDTMABr using the batch method. Each mass of unactivated carbon, KA and KA-HDTMABr was varied from 0.04; 0.07; 0.10; 0.13; 0.16 grams is put into 20 mL of 25 ppm Methylene Blue solution. Next, stir with a contact time of 60 minutes. After that it was filtered and analyzed using UV-Vis at a wavelength of 665 nm.

2.2.7 Determination of Optimum Contact Time for Jackfruit Peel Adsorbent

Determination of the optimum contact time for each unactivated carbon, KA and KA-HDTMABr using the batch method. 0.1 gram each of unactivated carbon, KA and KA-HDTMABr was added to 20 mL of 25 ppm Methylene Blue solution. Stirred with variations in the contact time used, namely 30, 45, 60, 75, and 90 minutes. After that it was filtered and analyzed using UV-Vis at a wavelength of 665 nm.

3. RESULTS AND DISCUSSION

3.1. Analysis of Characterization Results

3.1.1 SEM Characterization

Carbon, KA, and KA – HDTMA-Br were characterized using a Scanning Electron Microscope (SEM) to see the surface morphology of carbon, KA, and KA-HDTMA-Br pores at 2000x magnification. In Figure 1, carbon (A) can be seen that on the surface the carbon has a relatively large pore size and the pores are still blocked by impurities and the structure is irregular, whereas on activated carbon (B) the surface is relatively larger and rougher, but in the pores that are still clogged due to impurities, they begin to break down into smaller sizes. This occurs due to the activation process, the activator will react with carbon which will oxidize and erode hydrocarbons, tar and other compounds attached to the carbon surface so that it can expand the surface and form new pores. Then on HDTMA-Br activated carbon (C), the surface of HDTMA-Br surfactant modified active carbon has varying pore sizes and is more numerous than carbon and activated

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carbon, as well as the appearance of new, fine pores. It is proven that modification of activated carbon with surfactants can increase the surface area of the carbon, so that it experiences physical changes, namely the number of pores formed and a large surface area.

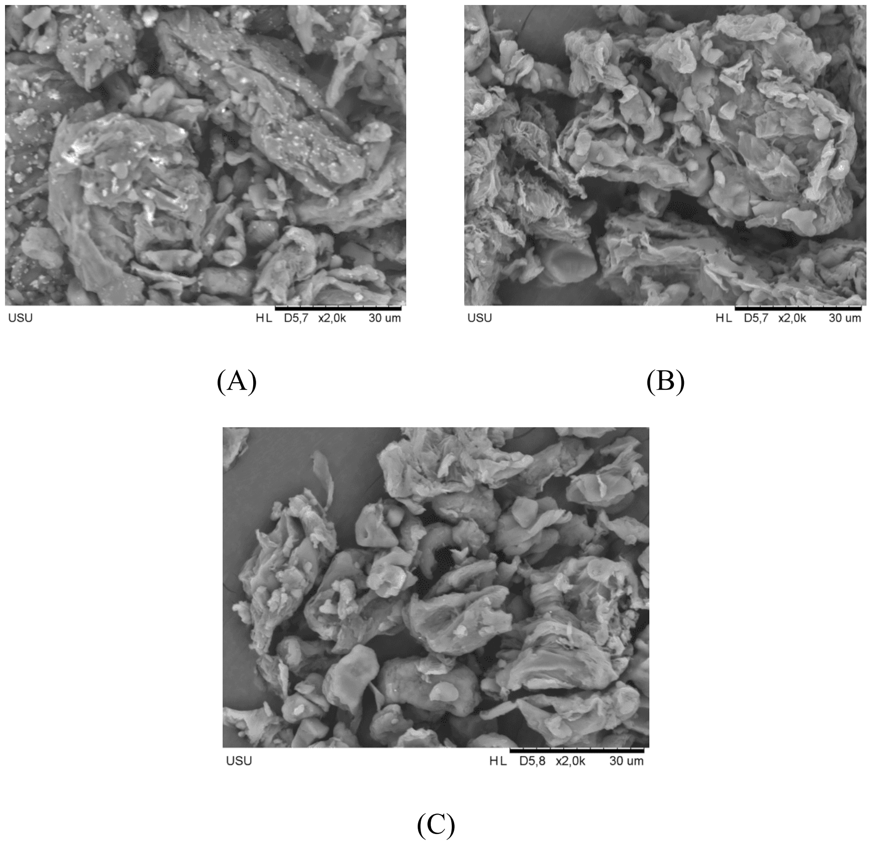

Figure 1. SEM characterization results of carbon (A), KA(B), and KA-HDTMA-Br

3.2 Calibration Curve Results

Figure 2 shows that the absorbance value increases with the concentration of the methylene blue solution used. This is caused by a decrease in color absorption at dense concentrations. The results of creating a calibration curve for the methylene blue solution fulfill Lambert Beer's law which was proposed previously[7]. From the calibration curve, a linear regression equation is obtained, namely $y = 0.0528x + 0.0114$ with $R^2 = 0.9989$ where y is the absorbance and x is the concentration of methylene blue. Based on the value of the regression coefficient R2 which is almost close to 1, the relationship between absorbance and concentration is very linear and in accordance with the Lambert-beer law.

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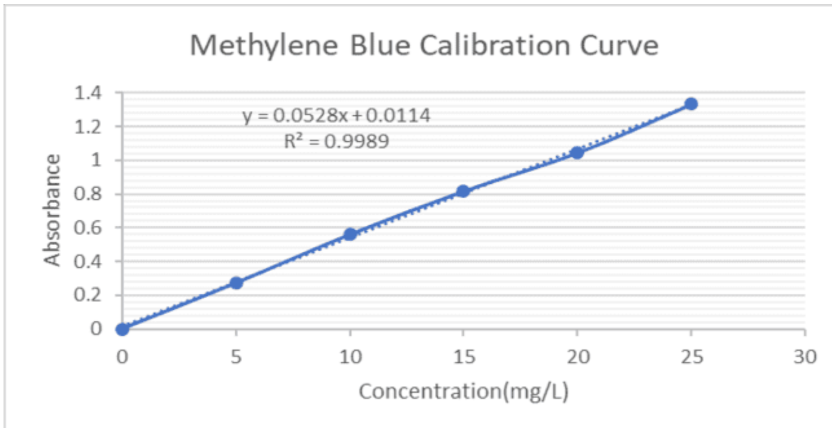

Figure 2. Calibration curve for Methylene Blue solution

3.2.1 Determination of the Optimum Mass of Jackfruit Peel Adsorbent for Methylene Blue Adsorption

From Figure 3, it can be seen that the concentration of adsorbed methylene blue increases with increasing adsorbent mass. This happens because by increasing the amount of adsorbent, there is an increase in the active side on the surface of the adsorbent8 so that the greater the amount of adsorbent, the more methylene blue will be absorbed. Based on the data above, it was found that the optimum mass for carbon was found at a mass of 0.16 grams with an adsorption efficiency of 92.84%, the optimum mass for activated carbon and HDTMA Br activated carbon occurred at a mass of 0.07 grams where active carbon had an adsorption efficiency of 96. 14% and for HDTMA Br activated carbon it is 99.63%.

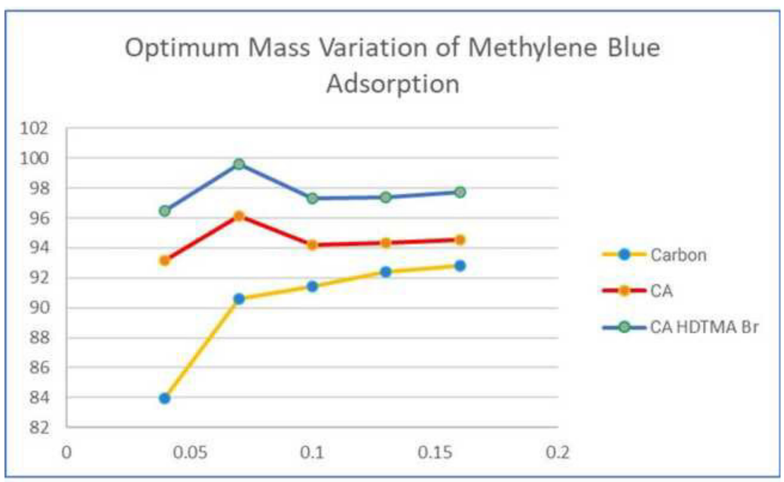

Figure 3. Relationship between the mass of jackfruit peel adsorbent and the efficiency of adsorbing methylene blue

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3.2.2 Determination of Optimum Contact Time of Jackfruit Peel Adsorbent for Methylene Blue Adsorption

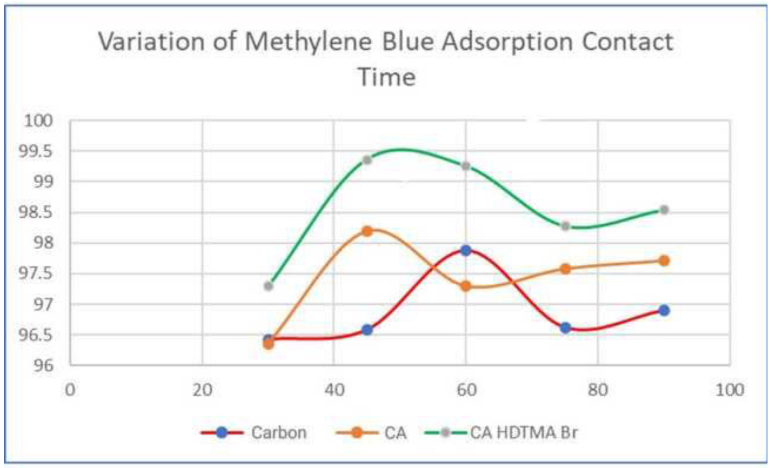

Figure 4. Relationship between Jackfruit Peel Adsorbent Contact Time and Methylene Blue Adsorption Efficiency

Based on Figure 4, it shows that the longer the contact time, the lower the adsorption efficiency. From the graph above it can be seen that a significant increase in carbon only occurs at contact times from 30 to 60 minutes and at contact times above 60 minutes the adsorption efficiency decreases. Overall it can be seen from 30 minutes to 60 minutes with an adsorption efficiency of 96.42% to 97.87%. Meanwhile, for activated carbon and HDTMA Br activated carbon, there was a significant increase only at 30 to 45 minutes and at contact times above 45 minutes, the adsorption efficiency decreased. Therefore, it can be seen in the graph that from 30 to 45 minutes there was an increase in both carbons, namely active carbon with an adsorption efficiency of 96.35% - 98.20% and HDTMA Br active carbon with an adsorption efficiency of 97 .29% - 99.36%.

4. CONCLUSION

The conclusion of this research is the result of SEM characterization, namely that there are differences in the three carbons due to the addition of activator substances and modification of the HDTMA-Br surfactant. The optimum mass for carbon was found at a mass of 0.16 grams with an adsorption efficiency of 92.84%, the optimum mass for activated carbon and HDTMA Br activated carbon occurred at a mass of 0.07 grams where activated carbon had an adsorption efficiency of 96.14% and for carbon active HDTMA Br of 99.63%. The concentration of adsorbed methylene blue increased along with increasing adsorbent mass. The optimum time on carbon occurred at 60 minutes with an adsorption efficiency of 97.87%. Meanwhile, the optimum contact time for activated carbon and HDTMA Br activated carbon occurs at 45 minutes. with an adsorption efficiency of 98.20% and on HDTMA Br activated carbon with an adsorption efficiency of 99.36%.

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REFERENCES

1. Oko, S., Harjanto, H., Kurniawan, A., & Winanti, C. (**2022**). Penurunan Kadar Zat Warna Remazol Brilliant Blue R Dengan Metode Adsorpsi Menggunakan Serbuk CaCO3 Dari Cangkang Telur Dan Karbon Aktif. Media Komunikasi Rekayasa Proses dan Teknologi Tepat Guna (Metana), 18(1), 39-45.
2. Raganata, T. C., Aritonang, H., & Suryanto, E. (**2019**). Sintesis Fotokatalis Nanopartikel ZnO Untuk Mendegradasi Zat Warna Methylene Blue. Chemistry Progress, 12(2).
3. Hayu, LDR, Nasra, E., Azhar, M., & Etika, SB (**2021**). Adsorpsi Zat Warna Methylene Blue Menggunakan Karbon Aktif dari Kulit Durian (Durio zibethinus Murr.). Berkala , 11 (1), 8-13.
4. Hanifah, H. N., & Hadisoebroto, G. (**2021).** Perbandingan Efektivitas Bioadsorben Berbagai Serbuk Kulit Buah Terhadap Logam Pb Dari Limbah Cair Laboratorium Farmasi. Al-Kimia, 9(2), 188-200.
5. Apriyani, T. (**2022**). Adsorpsi Zat Warna Kristal Violet Dan Metil Oranye Oleh Adsorben Biomassa Alga Sargassum sp. Yang Dimodifikasi Dengan Surfaktan *Hexadechyltrimethylammonium Bromide* (HDTMA-Br). *Jurnal Kimia Sains dan Aplikasi,* 23(11), 377-382.Aprilia, Y., Amelli, & Astuti, Y. (2020) Modification of Actived Carbon from Ric Husk using Hexadecyltrimethylammonium Bromide (HDTMA-Br) Surfactant and ZnCL2 Activator and Microwaves for Nitrate Ion Adsorpsion. Jurnal Kimia Sains dan Aplikasi, 23(11), 377-382.
6. Guler, U. A., Ersan, M., Tuncel, E., & Dugenci, F. (**2016**). Mono and Simultaneous Removal of Crystal Violet and Safranin Dyes from Aqueous Solution by HDTMA-Modified Spirulina sp. Process safety and Environmental Protection, 99, 194-206.
7. Falahiyah, F. (**2015**). Adsorpsi methylene blue menggunakan abu sabut dan tempurung kelapa teraktivasi H2SO4. Skripsi. (Doctoral dissertation, Universitas Islam Negeri Maulana Malik Ibrahim).
8. Mondal N.K., R. Bhaumik, B. Das , P. Roy, K. C. Pal, C. Das, A. Banerjee, And J.K. Datta. (**2011**). Eggshell Powder as an Adsorbent for Removal of Fluoride from Aqueous Solution: Equilibrium, Kinetic and Thermodynamic Studies, Department of Environmental Science, The University of Burdwan, WB, India.

