UNIVERSITI TEKNOLOGI MARA

ADSORPTION OF METHYLENE BLUE BY COCONUT (*Cocos nucifera*) LEAVES AND ITS CHEMICALLY TREATED DERIVATIVES WITH KOH AND H_3PO_4

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of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research

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ABSTRACT

Fallen coconut (*Cocos nucifera*) leaves (CL) are agricultural wastes largely available in Malaysia. In this study, CL was utilized as a low-cost adsorbent and the precursor to prepare activated carbon by pyrolysis using KOH and H_3PO_4–activation method for adsorptive removal of methylene blue, a cationic dye from aqueous solution. The physical properties of the prepared coconut leaves powder (CL), coconut leaves–KOH activated carbon (KAC) and coconut leaves–H_3PO_4 activated carbon (PAC) were calculated through bulk density, ash content, moisture content and iodine test. The characterization of CL, KAC and PAC were carried out using Elemental analyser (CHNS-O), The Brunauer-Emmet-Teller (BET) surface area, Scanning Electron Microscope (SEM), Fourier Transform Infra-Red Spectrometer (FTIR) and point of zero charge (pH_{pzc}) method. Batch adsorption experiments were performed to assess the influence of the adsorbent dosage (0.02–0.25 g), initial pH (3, 4, 5, 6, 7, 8, 9, 10 and 11), initial dye concentration (30, 50, 100, 150, 200, 250, 300, 350 and 400 mg/L), contact time (1–300 min) and temperature (303, 313 and 323 K) on the adsorption of the methylene blue. The results showed that the percentage removal of methylene blue was the highest at dosage of 0.2 (CL), 0.1 (KAC) and 0.06 g (PAC) under unadjusted pH (5.6). The Langmuir model describes the adsorption behaviour at equilibrium. The maximum adsorption capacities of CL are 133.33 (303 K), 138.89 (313 K) and 135.14 mg/g (323 K). Meanwhile, the adsorption capacities of KAC increased with temperature where q_{max} varied as follows; 147.1 (303 K), 151.5 (313 K) and 151.5 mg/g (323 K). Lastly, q_{max} of PAC obtained are 357.14, 370.37 and 370.37 mg/g at temperature of 303, 313 and 323 K respectively. The adsorption kinetics for CL, KAC and PAC followed the Pseudo-Second-Order model. BET surface area and total pore volume of CL corresponded to 2.17 m^2/g and 0.002 cm^3/g. Meanwhile, KAC had shown the BET surface area of 682.86 m^2/g and total pore volume of 0.45 cm^3/g. As for PAC, the BET surface area was 981.79 m^2/g and the total pore volume of 1.37 cm^3/g. Thermodynamic parameters such as standard enthalpy ($\Delta H°$), standard entropy ($\Delta S°$) and standard free energy ($\Delta G°$) showed that the adsorption of methylene blue onto CL, KAC and PAC was spontaneous and endothermic in nature under examined conditions. The results showed the potential use of activated carbon developed from waste coconut leaves for the removal of methylene blue.

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