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Efficient removal of methylene blue dye using mangosteen peel waste: kinetics, isotherms and artificial neural network (ANN) modeling

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ABSTRACT

In this work, mangosteen peel (MP) waste was used as a new biosorbent for removal of methylene blue (MB) dye from aqueous solution. Surface area, surface functional groups, surface charge and surface morphology were analyzed through Brunauer Emmett Teller, Fourier transform infrared, pH_{zpc} and field emission scanning electron microscopy/energy dispersive X-ray spectroscopy techniques, respectively. The major functional groups were –CO, –COO and –OH. Batch adsorption experiments were conducted with varying MP dose (0.01–0.08 g), pH (2–12), contact time (10–60 min), temperature (25°C–45°C) and concentration of MB solution (50–150 mg/L). The study examined the implementation of artificial neural network for the prediction of MB adsorption from aqueous solution by MP, based on 30 experimental sets of batch adsorption study. Optimum number of neurons determined was 4 for Levenberg–Marquardt training algorithm; at which the highest value of R^2 and lowest mean square error were found to be 0.997 and 2.972, respectively. Among the various kinetic models applied, the pseudo-second-order kinetic model was identified to be the most suitable to represent the adsorption of MB on the surface of MP. Langmuir, Freundlich, Temkin and Harkins–Jura isotherm models were employed to study the adsorption equilibrium. Langmuir isotherm model was identified as the most suitable. The calculated values of thermodynamic factors, $\Delta S°$, $\Delta G°$, $S*$, E_a and $\Delta H°$, showed that the adsorption phenomenon is spontaneous, feasible and endothermic in nature.

Keywords: Mangosteen peel; Methylene blue; Artificial neural network; Adsorption capacity; Kinetic models; Thermodynamic parameters

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