

Parameter Optimization and Kinetics Modeling for Biosorption of Methylene Blue Dye on *Artocarpus nobilis* Fruit Peel

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Dye removal through biosorption has not been extensively investigated at the industrial level, partly due to the lack of correlation between laboratory findings and requirements of large-scale applications. Biosorbents possess unique desirable characteristics for dye molecules to be attracted on to. In this respect, the present study aimed to evaluate the effectiveness and suitability of the powdered dried peel of *Artocarpus nobilis* fruit ($710 \mu\text{m} < d < 1000 \mu\text{m}$) for biosorption of methylene blue (MB) dye from synthetic solutions under static conditions through parameter optimization and kinetics studies. The optimum experimental parameters for over 90% removal of MB, determined through absorption measurements of equilibrated MB in solution phase (initial concentration = 10 ppm; solution volume = 50.0 mL) at its characteristic wavelength of 62.5 nm, are 0.150 g biosorbent dosage, 60 min shaking time, 15 min settling time and pH 4.5 – 9.3. Kinetics studies performed by varying biosorbent dosage (1.000 – 5.000 g), adsorbate concentration (2.5 – 13.0

mg L⁻¹) and solution temperature (27.0 – 51.0 °C), with other parameters being kept constant, demonstrate that the biosorption of MB follows pseudo-first-order kinetics with high regression coefficient values when compared to the pseudo-second-order model. Moreover, the pseudo-first-order rate constant determined for the above solution temperature range increased from $4.10 \times 10^{-4} \text{ s}^{-1}$ to $1.03 \times 10^{-3} \text{ s}^{-1}$ leading to an activation energy of 30.2 kJ mol⁻¹ for the biosorption process. Further, the extent of adsorption of MB at equilibrium per unit adsorbent mass was found to increase with adsorbate concentration, decrease with biosorbent dosage, and remain almost constant with solution temperature in the above range. These are desirable characteristics for scaling-up of the proposed biosorption methodology for dynamic and proto-type studies for large-scale removal of MB.

Keywords: *Artocarpus nobilis*, biosorption, kinetics, methylene blue