

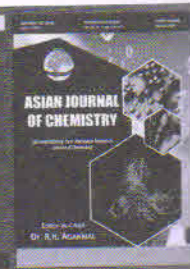


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## Utilization of Bengal Quince Leaf Biomass in Adsorptive Removal of Toxic Methylene Blue Dye: Influence of System Parameters and Kinetic Study

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Methylene blue (MB) has been identified as harmful to human health, potentially causing various adverse effects, including gastritis, irritation of the eyes, irritation of the skin, leptomenigeal inflammation, neuronal apoptosis, increased heart rate, nausea, vomiting and diarrhoea. Therefore, the treatment of wastewater that contains such dye is crucial due to its detrimental impact. Herein, in a batch setup, Bengal quince leaf powder (BQLP) was assessed for its capacity in removing MB from aqueous medium along with the impacts of some influential factors. The equilibrium data fit well ( $R^2 = 0.9931$ ) with Langmuir isotherm model, confirming the viability of BQLP as an adsorbent. The maximum monolayer adsorption efficacy ( $q_{max}$ ) of the bioadsorbent was emerged as  $175.44 \text{ mg g}^{-1}$  with a Langmuir isotherm constant of  $41.83 \text{ L mg}^{-1}$ , highlighting the efficiency of BQLP in dye removal. The kinetics study indicated that the observed data aligns with pseudo-first-order kinetics ( $R^2 = 0.9714$ ) and intraparticle diffusion models ( $R^2 = 0.9797$ ) with a pseudo-first-order rate constant of  $4.2 \times 10^{-2} \text{ min}^{-1}$ . The study demonstrates that BQLP as an effective biosorbent in removing MB dye from the aqueous medium. The enhanced is attributed to stronger electrostatic attractions, hydrogen bonding,  $n-\pi$  interactions and  $\pi-\pi$  stacking. Overall, the findings of this investigation indicate that BQLP is a promising, facile and eco-friendly adsorbent for wastewater treatment, offering an effective means of mitigating the environmental hazards posed by synthetic dyes such as MB. Future study should focus on evaluating the regeneration efficiency, reusability and scalability of BQLP to support its potential deployment in large-scale industrial wastewater management.

**Keywords:** Bioadsorbent, Adsorption, Bengal quince leaf, Dye, Methylene blue.