Potential use of *Momordica charantia* (bitter gourd) waste as a low-cost adsorbent to remove toxic crystal violet dye

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Received 5 March 2017; Accepted 8 June 2017

**Abstract**

*Momordica charantia* (bitter gourd) waste (BGW) was investigated for its potential as an adsorbent in removing crystal violet (CV) dye. Batch adsorption isotherm studies analyzed using six isotherm (Langmuir, Freundlich, Temkin, Dubinin-Radushkevich, Redlich-Peterson and Sips) models showed that both the Langmuir and Sips models fitted well to the experimental data, with the Langmuir-model giving a higher $R^2$ (0.9924) than Sips (0.9899) but the Sips model having lower overall error values. The maximum adsorption capacity ($q_{max}$) of BGW for CV dye is 244.8 mg g$^{-1}$ (Sips) and 261.8 mg g$^{-1}$ (Langmuir), demonstrating BGW is a good adsorbent as compared to many reported adsorbents.

Further, adsorption of CV on BGW is exothermic and spontaneous in nature, with an average $\Delta H^o$ of $-10.2$ kJ mol$^{-1}$. Except at pH 2, BGW was able to adsorb CV at higher medium pH with >80% removal. The pseudo second order kinetics model fitted the adsorption of CV with $R^2$ close to unity for all the three concentrations of CV tested. Performance of BGW toward CV removal was affected by the presence of salt, with NaCl being the most influential as compared to KCl and KNO$_3$. Regenerated spent BGW still maintained excellent CV adsorption even after the 5th cycle, removing 82% and 96% CV using acid and base treatment respectively, further supporting the strong potential of BGW as a low-cost adsorbent.

**Keywords:** *Momordica charantia* (bitter gourd) adsorbent; Adsorption isotherm; Cationic crystal violet dye; Regeneration