

Feasibility study on the utilization of low-cost sawdust for adsorption of caffeine: equilibrium, optimization, and response surface modeling

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Received 3 May 2022; Accepted 22 September 2022

ABSTRACT

The study focuses on the adsorption of caffeine (CAF) from aqueous solutions onto sawdust (SD), a naturally available, eco-friendly, and low-cost adsorbent. The influence of various operating parameters such as; CAF initial concentration (5–20 mg/L), SD dosage (0.5–3.0 g/L), and pH (3.0–9.0) was investigated in detail. The experimental results of the adsorption process showed the maximum CAF removal efficiency of 94.5% at optimized conditions (CAF initial concentration 5 mg/L, SD dosage 2.0 g/L, and pH 7.0). The applicability of adsorption isotherm models for CAF removal by SD has also been revealed. The R^2 values obtained for Langmuir and Freundlich isotherms (0.9371 and 0.9966) showed that the Freundlich isotherm model with the higher R^2 value of 0.9966 had better suitability than the Langmuir isotherm model. The suitability of experimental data was analyzed with response surface methodology using Design-Expert software. The obtained analysis of variance results with a coefficient of determination; $R^2 = 0.9643$ and adjusted R^2 value = 0.9516 demonstrated good agreement between experimental and predicted data. The 3D surface plots confirm the significance of all the three parameters investigated.

Keywords: Caffeine; Sawdust; Adsorption; Langmuir isotherm; Freundlich isotherm
