Bio-Waste *Aloe vera* Leaves as an Efficient Adsorbent for Titan Yellow from Wastewater: Structuring of a Novel Adsorbent Using Plackett-Burman Factorial Design

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Abstract:

Titan yellow (TY), a triazene azo dye, was removed from contaminated wastewater samples using a green adsorbent recycled from *Aloe vera* leaves (AV) waste. Two adsorbents were developed—air-dried *Aloe vera* (ADAV) and thermally treated *Aloe vera* (TTAV). Adsorption efficacy of both adsorbents was assessed in terms of percent removal (%R) of TY and adsorption capacity (q_e). ADAV had a better performance compared to TTAV. Plackett–Burman design (PBD) was exploited to establish the experimental pattern of the study. Four variables were studied: pH, adsorbent dose (AD), dye concentration (DC), and stirring time (ST). Analysis of variance (ANOVA) at 95.0 confidence interval (CI), control, and quality charts helped establish regression model(s). Characterization of both adsorbents was performed using FT-IR/Raman spectroscopy together with TGA/*d*TGA and SEM/energy dispersive X-ray spectroscopy (EDX) analyses. Textural properties were determined using nitrogen adsorption isotherms at 77 K. Results showed that the surface areas of ADAV and TTAV300 were 3.940 and 7.076 m^2/g, respectively. Raman analysis showed that the TTAV had clear D- and G-bands. Equilibrium studies revealed that data were well fitted to Freundlich isotherm with a maximum adsorption capacity of 55.25 mg/g using Langmuir equation, and the adsorption was physisorption. Adsorption followed a pseudo-second order that occurred in two steps—diffusion and then adsorption.

Keywords: *Aloe vera* (AV) leaves; Plackett–Burman Design (PBD); Titan yellow (TY); %removal and adsorption capacity (q_e); characterization; equilibrium; kinetics