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Removal of Reactive Black 5 from Aqueous Solution using Banana Peel Ash as an Adsorbent

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Structured Abstract

Background: In recent years, the dye industry has developed rapidly. The color associated with textile dyes not only taints water bodies but also prevents light from penetrating the water which negatively affects the entire aquatic biota. Among these textile dyes, Reactive Black 5 (RB5) has garnered significant attention due to its toxicity. This study explores the potential of mesoporous silica materials made from banana peel ash as an eco-friendly and cost-effective adsorbent for the removal of RB5 from aqueous solutions.

Methods: Banana peels were prepared by cutting and sieving them after rinsing them with distilled water. The peels were then dried in an air oven at 70-105°C, resulting in banana peel ash. The ash was kept in storage. In this study, the sol-gel method was utilized to extract silica from banana peel ash to synthesize a mesoporous silica adsorbent. The banana ash was mixed with NaOH, boiled, and blended to create a sodium silicate solution. Precipitation of silica was induced with 3 M of H_2SO_4 at pH 7, followed by centrifugation, washing, and drying at 80°C for 24 hours.

Results: This study shows the successful adsorption of RB5 from an aqueous solution using banana peel ash as an adsorbent. Removal efficiency rises with lower RB5 concentrations, peaking at 94.32% at 6 mg/L. However, at higher concentrations (8 mg/L and 10 mg/L), the efficiency drops slightly to 93.38% and 87.13%, respectively. This concentration-dependent behavior indicates that at lower concentrations, the active sites on the adsorbent and dye molecules interact more effectively. The adsorbent dosage experiment yields a peak removal of 99.12% at 0.03 g, indicating an equilibrium state beyond which no further adsorption takes place.

Conclusion: In conclusion, the findings of this study highlight the substantial potential for using banana peel ash as an adsorbent to remove RB5 dye from aqueous solutions. The findings indicate promising environmental benefits of using natural and easily available ingredients for color removal methods. Banana peel ash, as proven in this study, appears as a viable and sustainable alternative to RB5 adsorption, highlighting its potential use in wastewater treatment.

Keywords: Textile Dye, Reactive Black 5, Banana Peels, Mesoporous Silica Materials, Adsorbent

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