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Removal of dye waste from Batik home industries using low-cost agricultural waste: Areca nut peels as a natural adsorbent

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The discharge of poorly treated industrial waste into water bodies significantly contributes to water pollution. This study investigates the potential of areca nut peels, an agricultural waste product as a natural, eco-friendly adsorbent for the removal of Fast Salt Red B, a synthetic dye commonly used in the textile industry. Batik textile dyeing is an ancient art form, practiced on a small-scale, home-based industry in Sri Lanka, characterized by the application of wax to fabric before dyeing. While being culturally significant, traditional batik practices often involve synthetic dyes that pose considerable environmental and health risks. To address this issue, the current study explores sustainable and cost-effective alternatives for dye removal. Thirteen natural materials were initially tested for their dye adsorption efficiency, with areca nut peels being shortlisted based on their availability, low cost, environmental friendliness, and high dye absorption capacity. To test the dye adsorption efficiency, the dye solution was prepared by using Fast Salt Red B and Napthol solution. The materials were washed and heated to remove moisture. After keeping the material in dye solution and filtering, the absorbance of the material samples was measured. UV-Vis spectroscopy was used to assess adsorption performance under varying conditions. Laboratory assessments focused on two main criteria: the dye adsorption rate over time and the variation in adsorption with changes in the mass of the material used. These were used to determine the saturation point, the point at which the material can no longer absorb additional dye, and the optimal mass for maximum dye removal. Using the results, the adsorption kinetics were investigated. The results showed that areca nut peels reach optimal saturation within 40 minutes. The optimal adsorption was obtained when using 50 mg of areca nut peels for 40 ppm concentrated dye solution of 10.0 mL. The peak dye removal efficiency was 95.3%. The adsorption isotherm for Fast Salt Red B with areca nut peels using Langmuir model showed a correlation coefficient of 0.998. The findings demonstrate promising potential for the use of areca nut peels in dye removal applications. Further analysis of the desorption process is essential to evaluate the reusability and long-term sustainability of the material. Thus, future studies should explore methods for regenerating and reusing areca nut peels after dye adsorption.

Keywords: Areca nut peels, Batik textile dyeing, Dye adsorption, Eco-friendly wastewater treatment, Fast Salt Red B