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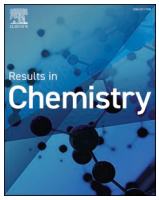

Activated carbon from pencil peel waste for effective removal of cationic crystal violet dye from aqueous solutions

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ABSTRACT

In this investigation, the pencil peel (PP) is utilized as a scavenger for adsorptive removal of crystal violet (CV) dye. Pencil peel activated carbon (PPAC) is produced through a straightforward physical activation method by annealing pencil peel in a muffle furnace at 300 °C. The prepared PPAC shows the mesoporous nature having specific surface area of 217.44 $m^2\ g^{-1}$. The highest uptake of CV dye was observed at equilibrium as working solution pH-8.0, CV dye concentration-100 mg L^{-1}, the PPAC dosage-0.25 g at 200 rpm speed. The observed experimental results align with the Freundlich adsorption isotherm model, suggesting of multilayer adsorption. The kinetic study attributes the uptake rate adheres to the pseudo-second-order kinetic rate model (regression coefficient, $R^2 = 0.99$).

1. Introduction

Water pollution constitutes a significant environmental challenge faced by developing nations. One of the major contributors to this issue is the textile industry [1]. Various processes in the textile industry, such as fiber production, sizing, desizing, scouring, bleaching, and dying, require considerable water [2]. The liquid waste generated from these processes is often contaminated with toxic substances including synthetic dye and heavy metals [3]. The application of synthetic dyes extends beyond the textile sector, encompassing various industries such as leather processing, paper production, plastics manufacturing, and pharmaceutical development. The global annual production of dyes exceeds 7×10^8 Kg [4]. Consequently, industrial effluents often contain high concentrations of artificial dyes, which are commonly released into aquatic ecosystems without adequate treatment. Water pollution caused by synthetic dyes from different industries presents a significant environmental and health hazard, endangering both aquatic ecosystems and human well-being [5,6]. Artificial dyes, even in trace amounts, can pose significant risks to environmental well-being. Due to their ability to withstand high temperatures, oxidation, and exposure to light.

Crystal violet (CV), a cationic dye is frequently utilized in textile manufacturing as a coloring agent. Its widespread use can be attributed to its accessibility, high performance, and cost-effectiveness [7]. The toxic effects of CV dye on both aquatic and land-based organisms are long-lasting, as it remains in the environment for extended periods. The use of CV dye has been shown to affect human health negatively, causing various symptoms and conditions. These adverse effects include elevated heart rate, feelings of sickness, circulatory collapse, bluish skin discoloration, yellowing of the skin and eyes, paralysis of all four limbs, and death of body tissues [8,9]. In severe situations, it can cause respiratory and renal failure as well as permanent corneal and conjunctival damage [10]. Nowadays the mitigation of such dyes is considered a burning research area [11] therefore there is an urgent need for decontamination from the aqueous stream. To address this concern, the adsorption technique is employed as an inexpensive, easy for handling waste to useful strategy. In literature, various methods are reported for water purification such as photocatalysis [12,13], solvent extraction [14], adsorption [15], flocculation/coagulation [16], ozonation [17], ion exchange [18], membrane filtration [19], electrochemical destruction [20]. Adsorption is considered a highly adaptable method for treating wastewater [21,22] owing to voluminous adsorbent material like natural material to synthetic lab-prepared materials as well as it has

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