



Comparative analysis of magnetic tamarind kernels and GO-grafted magnetic tamarind kernels for the mitigation of Congo red dye

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ABSTRACT

The present study focuses on the fabrication of magnetized tamarind kernel powder (MTKP) nanocomposites and graphene oxide-blended tamarind kernel powder (MTKP-GO) nanocomposites via co-precipitation method, and were employed for their application in the removal of Congo red dye from wastewater. Several physico-chemical techniques were investigated to analyse the surface morphology and structural identification of these nanocomposites. FE-SEM, XRD, and FTIR tests yielded distinctive findings, demonstrating the successful fabrication of magnetic TKP-GO with a sizable surface area and favourable magnetic response. Batch adsorption tests revealed a relatively greater adsorption potential for M TKP-GO ($q_{\max} = 236.795 \text{ mg/g}$) compared to M TKP ($q_{\max} = 150.8045 \text{ mg/g}$). The pseudo-second-order model best fitted the data for adsorption kinetics with R^2 value of 0.9952 and 0.99604 for MTKP AND MTKP-GO respectively. Of all the isotherm models investigated, interestingly it was found that the Langmuir model best fit the adsorption data for M TKP, while the Freundlich isotherm model best explained the adsorption behaviour for M TKP-GO.

1. Introduction

Water pollution has become one of the major global challenges in today's world. One of the major sources of water pollution is industrial pollution primarily due to expansion of tannery sector [1,2]. The quantity of industrial wastewater is so huge that it is even speculated to become two-fold by 2025 which has also been resulting in a spike in the quantity of contaminated freshwater resources, a matter of grave concern, as the demand for fresh water is increasing with increasing population. Tannery dyes are poisonous by nature associated with harmful effects such as rashes on skin, irritation of eyes, and even cancers of various kinds [3,4]. They may also have a severe influence on marine animal and plant life as well. To lessen the negative effects of dyes and industrial waste water on the environment, it is essential to develop cost-effective and ecologically acceptable technology for the removal of these dyes from polluted effluents [5,6]. For the treatment of effluents polluted with dyes, several standard methods have been

developed. Eco-friendly absorbing substances made from trash have drawing much curiosity and attention of many researchers recently [7]. Of the several methods for removal of dissolved organic contaminants, such as pigments, from industrial wastewater, adsorption technique is the most widely employed [8,9]. Adsorption refers to a phenomenon by virtue of which extremely small amounts of a substance (referred to as the adsorbate) cling to the surface of another (called the adsorbent). The attraction between the adsorbent and the adsorbate caused by molecular forces like van der Waals forces or electrostatic interactions may be the pivotal force responsible for this process. Graphene oxide (GO) and its composites have been proven to be outstanding adsorbents as GO possesses a large surface area, making it an versatile adsorbent for a broad spectrum of materials. Additionally, when other materials are combined with GO to form composites, it often shows higher adsorption performance owing to synergistic effects [10,11]. The integration of hybrid nanomaterials such as Fe_3O_4 /Graphene Oxide/Chitosan [12], $\text{AC}/\text{Fe}_3\text{O}_4$ [13], Fe_3O_4 /SSIP/GO [14], $\text{BT}-\text{Fe}_3\text{O}_4/\text{GO}$ [15], $\text{GO}-\text{Fe}_3\text{O}_4-\text{CeO}_2\text{-CTAB}$

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