Curcumin@MgO/graphene oxide nanoadsorbents for the removal of fluoride from wastewaters

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Fluoride in drinking water has a narrow beneficial concentration range in terms of human health. A small quantity taken in water is commonly thought to be beneficial in the prevention of dental cavities, especially in youngsters (Mondal et al., 2016). In contrast, an excessive quantity absorbed in drinking water can cause a variety of ailments, the most frequent of which is fluorosis. The permissible level of fluoride in drinking water for general good health set by WHO is considered to be 1.5 mgL^{-1} (WHO 2006) (ideally between 0.8-1.2 mg/L). As a result, there is an urgent need to remove fluoride from drinking water. Several techniques have been developed in recent years, including adsorption, ion exchange, precipitation, membrane filtration, and electrocoagulation (Xu et al., 2020), for removing fluoride from water. Amongst the technologies available for its removal, adsorption is preferred because of ease of use, and no toxic by-products (Chufa et al., 2022).

The current study recommends the usage of adsorbents based on graphene oxide. Graphene oxide (GO) has recently been proved to be a viable adsorbent for wastewater treatment due to its superior mechanical, physical, and chemical characteristics (Kuang et al., 2017). Plain GO materials, on the other hand, have low adsorption selectivity in water, because they can only adsorb adsorbates through van der Waals forces (Zhang et al., 2017). Furthermore, they are excessively light and stable in water, making recycling problematic after adsorption. One viable solution is to alter other compounds and apply them on the surface of GO. For this reason, chitosan (Cs) and Mg/curcumin oxide nanoparticles (nps) were used. Chitosan is a natural polycationic linear polysaccharide holding both active amino groups and hydroxyl groups, which can be modified to obtain certain desired properties (Al-Gharabli et al., 2020). Curcumin (Cur) has been used as reducing and conjugating agent for metal oxide nanoparticles (Arab et al., 2022). Previous studies (Tolkou et al., 2023, 2019) have shown that Mg plays an important role for the removal of fluoride inions, and for this reason was chosen as the modification agent.

The composites‘ morphology and structure were characterized by FT-IR, SEM, BET and XRD analysis. The effect of the pH value, contact time, adsorbent’s dosage and initial fluoride concentration was examined in order to evaluate the adsorption efficiency of the materials. According to the results, the modification of Cs/GO@ with Mg/Cur oxide nps increased the removal of fluoride ions, by using 1.0 g/L of the adsorbent. Experimental data of equilibrium were used to calculate adsorption isotherms at temperatures of 30°C, 45°C and 60°C and the obtained data were fitted to the Langmuir and Freundlich adsorption isotherm models. Two kinetic models were examined to fit the kinetics of fluoride sorption pseudo first order and pseudo second order models. According to thermodynamics the spontaneous nature of their adsorption was confirmed. Overall, the results indicate that Cs/GO@Mg/Cur oxide can be effectively employed for removal of fluoride from aqueous solutions.

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