Title: Removal of fluoride from contaminated groundwater using suitable adsorbent

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Abstract

Fluoride (F^-) contamination in groundwater is a critical environmental issue with potential adverse effects on human health, when consumed above the permissible limit > 1.5 mg/l. The paradoxical nature of F^- is often described as a "double-edged sword" because while its consumption in lower amounts helps to prevent dental caries, excessive intake can lead to detrimental dental and skeletal fluorosis. Unfortunately, many regions in India are also affected by F^- contamination, exacerbating the issue. Since there is currently no cure for fluorosis, the most feasible solution is to provide water with a desirable and safe amount of F^-. Water sources containing F^- level (>1.5 mg/l) exceeding the permissible limits must be treated to ensure safe consumption. By implementing appropriate water treatment measures, it can mitigate the risks associated with both F^- deficiency (< 0.5 mg/l) and excessive F^- intake (>1.5 mg/l), thus promoting overall well-being in the affected communities. This study explores the efficacy of seashell ($CaCo_3$) and dolomite ($CaMg(Co_3)_2$) as adsorbents for the removal of F^- from contaminated groundwater. A certain ratio of seashells and dolomite in various contaminated regions makes them promising and cost-effective materials for F^- remediation. The experimental setup was prepared by using a 1:1 ratio of seashells and dolomite as an adsorbent. The adsorption process was investigated through batch experiments under varying parameters, including initial F^- concentration, adsorbent dosage, contact time, and pH of the groundwater. The results determine that maximum removal efficiency was found at 75% in contaminated groundwater (20 mg/l). The adsorbent dose of mixture was found at 20g/l, optimum temperature was 600°C and contact time was 20 min with 200 rpm. The maximum removal efficiency was significantly responsible at optimum pH at 6.5- 7.5. The adsorption kinetics followed pseudo-second-order behavior, suggesting chemisorption as the predominant mechanism. Equilibrium studies revealed that Langmuir and Freundlich isotherm models fitted well with the adsorption data, indicating monolayer adsorption and heterogeneous surface characteristics of the adsorbents, respectively. Additionally, the presence of competing ions minimally affected the F^- adsorption capacity of seashell and dolomite, signifying their suitability for real-world applications. This study proposes an eco-friendly and economically viable approach for F^- removal from groundwater, utilizing a ratio (1:1) of seashell and dolomite as efficient adsorbents. The combined application of these natural materials could potentially enhance the F^- removal efficiency and extend the lifespan of the adsorption system. However, further research is necessary to optimize the long-term performance, and consider the practical implementation of this technology at a larger scale.

Keywords: Fluoride (F^-), Groundwater, Adsorption, Seashell, Dolomite, Water Treatment