Ultrasonics Sonochemistry
Volume 37 | 2016 | ISSN: 1350-4177

Synthesis of hydroxyapatite nanorods for application in water defluoridation and optimization of process variables: Advantage of ultrasonication with precipitation method over conventional method

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Abstract:
This research work presents the synthesis of hydroxyapatite (Hap) nanorods for defluoridation of drinking water by using both conventional (CM) and ultrasonication with precipitation (USPM) methods. Calcium nitrate was reacted with potassium phosphate in presence of ammonia for controlled pH to synthesize Hap nanorods, which was characterized using FTIR, XRD, SEM, TG-DTA, and TEM/EDS for determining its phase composition, structural and thermal decomposition behavior. When USPM method was used for synthesis, the yield of the Hap nanorods was improved from 83.24 ± 1.0% to 90.2 ± 1.0%, and complete phase transformation occurred with formation of elongated Hap nanorods. Effects of process parameters such as solution pH, contact time and adsorbent dose were studied through response surface methodology (RSM). A simple quadratic model was developed using Central Composite Design (CCD) and optimum parameters for fluoride adsorption process were determined to be pH 7, contact time 3 h and adsorbent dose 7 g/L for maximum removal capacity. Fluoride removal efficiency was predicted to be 93.64% which was very close to the experimental value obtained at 92.86% using ultrasonically prepared Hap. Fluoride adsorption isotherms fitted the Freundlich isotherm with an adsorption capacity of 1.49 mg/g, while the kinetic studies revealed that the process followed pseudo-second order model. The treated water quality parameters such as residual fluoride, calcium leached, total hardness and alkalinity was investigated, and it was observed that all these parameters were within the permissible limits as per WHO and BIS standards.

Keywords:
Hydroxyapatite nanorods, Ultrasonication, Response surface methodology, Adsorption, Fluoride

Link: https://www.sciencedirect.com/science/article/abs/pii/S1350417716304746