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In-vitro synthesis of marble apatite as a novel adsorbent for removal of fluoride ions from ground water: An ultrasonic approach

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Abstract:
Marble waste powder consisting of calcium and magnesium compounds was used to synthesize a novel biocompatible product, marble apatite (MA) primarily hydroxyapatite (Hap) for applications in defluoridation of drinking water. Synthesis of marble apatite was carried out by using calcium compounds (mixture of hydroxide and nitrate) extracted from marble waste powder which was treated with potassium dihydrogen phosphate at 80 °C under alkaline conditions using conventional precipitation method (CM) and ultrasonication method (USM). Qualitative analysis of synthesized marble apatite from both the methods was carried out using FTIR, phase analysis by XRD and microstructure analysis by SEM and TEM. When ultrasonication (USM) method was used, the yield of marble apatite was improved from 67.5% to 78.4%, with reduction in crystallite size (58.46 nm), lesser agglomeration and comparatively well-defined spherical morphology compared to the CM method. Studies also include estimation of the defluoridation capacity of MA as an adsorbent for drinking water treatment and effects of process parameters such as pH, contact time, initial fluoride concentration, dosage and presence of other co-ions on fluoride removal capacity. The results showed that the experimental adsorption capacity of the marble apatite synthesized using USM method was significantly higher (1.826 mg/g) than marble apatite synthesized using conventional method (0.96 mg/g) at pH 7 with a contact time of 90 min. The mechanism of adsorption was studied, and it was observed that Langmuir isotherm model fitted best to the experimental data, while the kinetic studies revealed that the process followed pseudo-second order model.
This novel compound, marble apatite synthesized from marble waste powder is found to be promising for defluoridation of drinking water and will help in alleviating the problems of fluorosis as well as reduce the problems of disposal of marble waste.

Keywords:
Marble waste, Biomaterial, Marble apatite, Defluoridation, Ultrasonication.

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