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VALORISATION OF BANANA PSEUDOSTEM (BPS) WASTE FOR DEFLUORIDATION OF DRINKING WATER

J. De Silva, P.G.A.P.T. Piyumanthi, B.D.I.M. Batugedara and S.A.M.A.I.K. Senanayake*

Department of Zoology, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.
***indunil@sci.sjp.ac.lk**

Dental and skeletal fluorosis are prevalent in the dry zone of Sri Lanka, among people who utilise drinking water with high fluoride levels. This study investigated the possibility of banana pseudostem (BPS) derived fibres and cellulose to remove fluoride in drinking water. BPS fibres and cellulose were extracted through sequential mechanical and acid hydrolysis methods, respectively. They were characterised using; scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and physicochemical analysis. Fluoride removal efficiency was studied following batch adsorption experiments using SPADNS spectrophotometric method. The extraction yields of BPS fibres and cellulose resulted in 5% and 3%, respectively. SEM images confirmed successful extraction and fibrous morphology, which aligned with macrofibrils in BPS fibers (width ≈ 87 µm) and aggregated rod-like structures in microcrystalline cellulose (10 – 25 µm width). FTIR spectra highlighted hydroxyl, alkene and ether, as functional groups essential for fluoride binding. XRD confirmed the semi-crystalline nature of cellulose I allomorph, supporting structural integrity during adsorption. Physicochemical analysis emphasised the adsorptive dominance of BPS fibres; higher water holding capacity (16.96±0.02 g g^{-1}), higher swelling capacity (5.00±0.02 mL g^{-1}) and lower moisture content (13.16±0.08%) compared to those of cellulose. Adsorption optimisation identified 0.4 g adsorbent dosage, 0.5 mg L^{-1} fluoride concentration, pH 2 and 10, and 90 min contact time as the ideal conditions. However, 1.5 mg L^{-1} fluoride concentration and pH 7 were used, in accordance with WHO guidelines and to depict typical fluoride levels and pH in groundwater (7.2 – 8.2) of Sri Lanka. Under these optimised conditions, BPS fibres achieved a removal efficiency of 63.19±0.03%, outperforming cellulose (35.81±0.07%). Post-adsorption SEM-EDX analysis confirmed the fluoride adsorption by the detection of fluorine (F) peaks. According to the results, BPS fibre is highlighted as a promising defluoridation biomaterial by serving as a blueprint for future development of bio-waste-based adsorbents for sustainable water purification.

Keywords: Banana pseudostem, BPS cellulose, BPS fibres, Defluorination, Waste valorisation