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**Removal of Fluoride in Water from Tea Waste: A Case Study with Selected Fluoride Concentrations**

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**Abstract**

The main objective of this study is to investigate the possible behavior of fluoride in tea waste under selected water types and to study chemical kinetics on the adsorption of fluoride by the tea waste with the necessary amendment. The physicochemical properties of tea waste were studied using a Scanning Electron Microscope (SEM), Atomic Absorption Spectroscopy (AAS), Brunauer-Emmett-Teller (BET) surface area analysis, Fourier-Transform Infrared spectroscopy (FTIR), and an elution test to determine the potential of tea waste as an adsorbent. The sorption behavior of tea waste was investigated under different fluoride concentrations in groundwater in the initial steps of the study and discovered that fluoride leaching behavior from tea waste with lower fluoride levels in the water. In contrast, tea waste absorbs fluoride when high fluoride levels are in the water. After batch experiments, laterite was selected to amend with tea waste to reduce possible desorption behaviors. Experiments proved the tea waste-laterite mixture containing 65% tea waste has maximum fluoride removal efficiency. The results obtained by batch experiments showed that the maximum removal efficiency attained was at pH 6, after 20 min of contact time, and with an adsorbent dose of 1.5 g. The adsorption mechanisms followed the Langmuir isotherm model, and the reaction followed the pseudo-second-order model. The observed adsorption capacity for tea waste-laterite mixture (TWL65) in an initial fluoride concentration of 2 mg/L was 0.0216 mg/g at pH 6. Further, it was found that phosphate ions as major competing anions, which have shown maximum influence on fluoride removal. Also, a fluoride removal filtering columns setup was prepared under selected influent fluoride concentrations of 1.5 ppm, 2.0 ppm, and 2.5 ppm to measure filtering performance. The results showed that each filter column had significant fluoride removal efficiency up to the WHO drinking water quality standard.

**Keywords:** Tea waste, Laterite, Fluoride, Sorption