

Direct Functionalization of Algal Nanocellulose to Enhance Biosorption for Lead(II) Remediation

Xing, Michelle (School: William A. Shine Great Neck South High School)

Lead pollution caused by industrial runoff can have a severe impact on the environment as well as on human health. This study evaluated the use of algal biomass as an ecologically friendly and cost effective means to adsorb lead(II) ions from water. TEMPO (2,2,6,6-tetramethylpiperidine-1-oxyl)-mediated oxidation and nitric acid oxidation were evaluated as surface modification treatments for algal biomass in order to enhance lead(II) adsorption. Both methods resulted in the successful conversion of primary hydroxyl groups on the surface of algal cellulose to negatively charged carboxylate groups necessary for lead(II) binding as revealed by Fourier transform infrared spectroscopy (FTIR) and conductometric titration. Moreover, Scanning Electron Microscopy (SEM) showed the formation of cellulose nanofibers, on average 10-15 nm in width, dramatically increasing available surface area for lead(II) binding. Thermogravimetric analysis (TGA) suggested that the nanofibers, having a greater purity in cellulose content, had higher thermal stability than the untreated fibers, and Energy Dispersive X-ray Spectroscopy (EDX) analysis confirmed the successful coagulation of lead(II) on the newly formed cellulose nanofibers. Finally, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) determined high lead(II) adsorption efficiencies of 0.94 for both types of oxidized nanofibers. This study demonstrates that both TEMPO and nitric acid oxidative treatments make relatively inexpensive algal biomass a feasible and efficient biosorbent for lead(II) ions.

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