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Bioactive Polymers from Marine Diatoms: A Multifunctional Platform for Lead Removal and Water Treatment Applications

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Abstract

The increasing need for sustainable water treatment solutions, especially for heavy metal removal, has focused attention on bio-based functional materials. Extracellular polymeric substances (EPS) from marine diatoms, notably *Amphora coffeiformis* and *Navicula salinicola*, are promising biopolymers composed of polysaccharides, proteins, and sulfated groups, offering high chemical reactivity and environmental compatibility.

EPS extracted from these species demonstrated exceptional lead (Pb^{2+}) adsorption capacities, exceeding 2000 mg/g for *N. salinicola*. Spectroscopic and kinetic analyses identified functional groups (carboxyl, hydroxyl, phosphate, carbonyl) as key in metal binding. Additionally, these EPS showed strong flocculation (~70% removal of kaolin at 15 mg/L) and emulsifying (>88%) activities across various pH values. Optimization *via* response surface methodology enhanced their multifunctionality.

These results underscore diatom-derived EPS as renewable, biodegradable materials for integrated water treatment, combining metal adsorption, turbidity reduction, and emulsion stabilization. Their low cost and electrochemical compatibility make them attractive for green technologies. The presentation will explore EPS structure–function relations, production scale-up, and integration into hybrid systems like electrochemical treatment and membrane filtration.

Keywords: Marine diatoms, Extracellular polymeric substances, Lead biosorption, Flocculation, Emulsification, Environmental biotechnology.

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