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ORIGINAL RESEARCH

Biosorption of cadmium using a novel, renewable and recoverable modified natural cellulose bearing chelating Schiff base ligand based on 2-hydroxy-5-methyl benzaldehyde

Atena Naeimi[1] · **Malihe Amini**[2]

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Abstract
Natural cellulose was extracted from *Sesbania sesban* plant. A novel approach toward chemically modified cellulose, bearing active chelating Schiff base, was synthesized using 2-hydroxy-5-methyl benzaldehyde. The chemical and structural features of the adsorbent were characterized by Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and energy dispersive analysis of X-ray (EDAX) observations, elemental analysis, and thermogravimetric analysis (TGA). It was used as a cheap and renewable biosorbent for removal of cadmium (II). SEM image confirmed the microfibril structure of microcomposite. TGA showed that the stability of modified cellulose was increased to 700 °C. EDAX showed the elements of C and O of cellulose and Si, Fe and Cl of modified cellulose-based ligand of 2-hydroxy-5-methyl benzaldehyde. The elemental analysis confirmed the presence of Schiff base ligand in the structure of microcomposite. The experimental conditions and adsorption parameters, including pH, initial metal ion concentration and adsorbent dosage were optimized. The cellulose biomass exhibited the highest metal ions uptake capacity (9.39 mg/g) at pH value of 4.0, biomass dosage of 0.01 g/L and cadmium concentration of 150 mg/L.

Keywords Microcomposite · Renewable biosorption · Cadmium · Cellulose · Schiff base

Introduction

Industries generate 2.4 million tons of toxic metals annually [1]. Among these metals such as As, Cd, Cr, Cu, Hg, Ni, Pb, Se, V, and Zn, easy mobility in the environment and high toxicity of cadmium can be dangerous and are of much environmental concern [2, 3]. It causes renal dysfunction, bone degeneration, lung insufficiency, liver damage, and hypertension in humans [4, 5].

Numerous processes exist for removing dissolved heavy metals, including ion exchange, precipitation, phytoextraction, ultrafiltration, reverse osmosis, and electrodialysis [6]. The need for expensive equipment and monitoring systems, high reagent or energy requirement or generation of toxic sludge or other waste products were significant disadvantages of these techniques [7]. On the other hand, when metal ion concentration in aqueous solution is as low as ppm (parts per million), they are believed ineffective. Hence, the practical and simplest process is biosorption, which uses various natural materials of biological origin, including bacteria, fungi, yeasts, algae, molds, and composting materials [8]. Adsorption techniques have been widely used because of their simplicity and facile accessibility. Hence, adsorption has become one of the alternative treatment techniques for wastewater laden with heavy metals recently [9]. Basically, adsorption is a mass transfer process by which a substance is transferred from the liquid phase to the surface of a solid, and it is bounded by physical and/or chemical interactions [10]. Various low-cost adsorbents, derived from agricultural wastes, industrial by-products, natural materials, or modified biopolymers, have been recently developed and applied for the removal of heavy metals from metal-contaminated wastewater. Technical applicability and cost-effectiveness are the key factors that play major roles in the selection of the most suitable adsorbent to treat inorganic effluent [11]. Hence, the synthesis of cellulosic

✉ Malihe Amini
m.amini@ujiroft.ac.ir; amini.malihe@gmail.com

[1] Department of Chemistry, Faculty of Science, University of Jiroft, P.O. Box: 8767161167, Jiroft, Iran

[2] Department of Environmental Science, Faculty of Natural Resources, University of Jiroft, P.O. Box: 8767161167, Jiroft, Iran