

Chemical modifications of lignocellulosic materials and their application for removal of cations and anions from aqueous solutions

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ABSTRACT: This review discussed the last 10 years progress in the use of lignocellulosic materials chemically modified as low-cost biosorbents. Thus, the chemical modifications, such as chemical pretreatment, oxidation, as well as the grafting of carboxyl groups, amines, amides, etc., on lignocellulosic fibers, that aim to increase the number of adsorption sites and maximize toxic metal ion adsorption capacity have been addressed. The literature presents results that indicated performances of biosorbents equal to or even higher than conventional methods and adsorbents. Many efforts have been concentrated on the improvements of these biosorbents through chemical modifications. However, some difficulties still exist, including the discharge of colored organic compounds resulting from the pretreatments and the development of fast, clean, and low-cost synthesis of selective and multifunctional adsorbents. Thus, the challenge for future research is to find solutions to these difficulties in order to finally make lignocellulosics biosorbents that can replace conventional adsorbent materials. © 2015 Wiley Periodicals, Inc. *J Appl Polym Sci* 2016, 133, 43286

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INTRODUCTION

A considerable interest in the pollutants removal from water and wastewater has been subject of various studies using adsorption methods. The biosorption has been presented as an economical and effective method to adsorb metal ions of water bodies over traditional treatment methods.

Agricultural wastes, mostly lignocellulosic materials, are an abundant biomass consisting of cellulose, hemicellulose, pectin, lignin, and protein. These compounds have a large number of functional groups that can adsorb certain contaminants present in water.¹ In addition, to improve the physical and chemical properties of a biosorbent and thus to enhance its efficiency in ion adsorption, chemical modifications are carried out on its surface. These modifications include coating or grafting an ion exchanger or chelating agent onto a sorbent, oxidation using mineral acids, charcoal preparation, and the production of activated carbons, among others.

It has been reported that metals such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), and zinc (Zn) are essential nutrients that are required for various biochemical and physiological functions.² Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes.² Heavy metals are also considered as trace elements because of their presence in trace concentrations (ppb range to <10 ppm) in various environmental matrices.³ Their bioavailability is influenced by physical factors such as temperature, phase association, adsorption, and sequestration. It is also affected by chemical factors that influence speciation at thermodynamic equilibrium, complexation kinetics, lipid solubility, and octanol/water partition coefficients.⁴ Metal ions such as lead, copper, cadmium, iron, nickel, mercury, zinc, and chromium are considered potentially toxic due to their tendency to bio-accumulate and persist in the environment.⁵

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