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Removal of microelemental Cr(III) and Cu(II) by using soybean meal waste – Unusual isotherms and insights of binding mechanism

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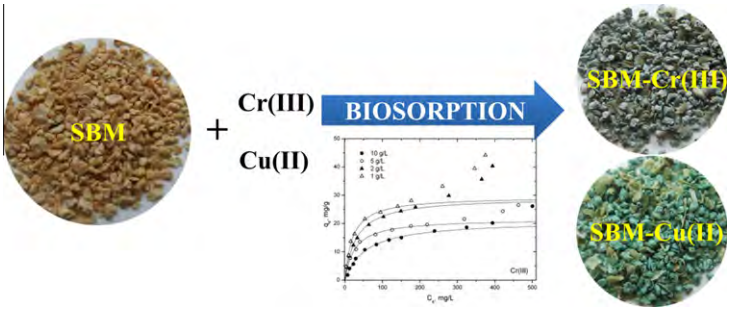
HIGHLIGHTS

- Waste soybean meal biomass biosorbent was used for removal Cr(III) and Cu(II) ions.
- Effect of pH, contact time and initial concentrations on metal removal were investigated.
- Pseudo-second-order and Sips models best described the Cr(III) and Cu(II) biosorption.
- Unusual isotherms and biosorption mechanism was fully explored by characterization.
- The results recommend that soybean meal as potentially low-cost biosorbent.

GRAPHICAL ABSTRACT



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ABSTRACT

In the present study soybean meal (SBM) waste has been used for the removal Cr(III) and Cu(II) from aqueous solutions. Effect of variable parameters including pH, contact time, biomass dose and initial concentration of metal ions were studied. Biosorption kinetics was very fast and the kinetics data were successfully modeled using nonlinear pseudo-second-order model. A series of isotherm experiments revealed that pH 5 favored Cr(III) and Cu(II) biosorption and the affinity order of SBM was Cu(II) > Cr(III). Biosorption mechanism was confirmed by the functional group blocking, FTIR and scanning electron microscopy/energy-dispersive X-ray results. The biosorption mechanism was due to (i) ion-exchange, (ii) chelation by carboxyl and hydroxyl groups present on the SBM surface, (iii) further precipitation of metal ions on the surface of biomass. Our results revealed that SBM could be employed as an effective and low-cost biosorbent for removal of Cr(III) and Cu(II) from contaminated effluents.

1. Introduction

Biomass is currently the most abundant material (Valdez-Vazquez et al., 2010), originated from forestry, agriculture and from bio-industries. However most of this biomass was discarded as waste throughout the world. Due to the ever growing environmental pollution recycling and/or treatment of this waste biomass before disposal is necessary. In this regard several scientific communities have shown great interest towards the utilization of these waste biomaterials for energy production, preparation of bio compounds and also in water treatment etc., (Chiban et al., 2011a; Hayashi et al., 2010; Iakovou et al., 2010). One of the effective applications of waste biomass that has gained much attention over the last decade is the preparation of biosorbents and their utilization for various toxic pollutants removal (Witek-Krowiak, 2011; Witek-Krowiak et al., 2010b). Several reviews on this subject are available, with applications including removal of heavy metals, organic compounds and

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