P42

Sericin-based resins from silk degumming wastewater for the removal of heavy metal ions from water

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Chromium (VI) is a water pollutant categorized as 'likely to be a carcinogen to humans' compound when orally ingested with estimated cancer potency 0.5 mg/kg/day. The European Directive 2001/59/EC poses a 5 µg/L threshold concentration for Cr(VI) in groundwaters. In this work, a chemical process was devised to obtain heavy metal ion absorbing resins by the polyaddition of bisacrylamides and 1,2-diaminoethane with sericin using as reaction solvent raw waste-water from silk degumming processes. Silk sericin (SS) is a natural globural protein deriving from silk worm *Bombyx mori* with molecular weight ranging from 10000 to 300000. Following the alkaline degumming process, sericin is degraded to peptides with molecular weight 20000. These peptides contain lysine-deriving residues that participate in the polyaddition leaving to a resin. This resin is a hybrid one in which a substantial portion is constituted by sericin peptides. The rationale of this approach is that the guanidinum ion has the ability to strongly bind oxoanions, due to its geometrical Y-shaped, planar orientation, optimizing charge distribution and hydrogen bonds [1]. SS resins were evaluated for the removal of both positively charged (Cu^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}) and negatively charged heavy metals oxoanions (CrO_4^{2-}) from water. Different resins were obtained containing different amounts of sericin. These resins were characterized by elemental analysis and their structure confirmed by FT-IR/ATR spectroscopy. The swelling capacity of the new absorbents in different media and their thermal stability by DSC and TGA techniques were evaluated. The removal properties of resins towards Cu^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+} and CrO_4^{2-} ions in aqueous single metal dilute and concentrate solutions were performed in batch absorption experiments and evaluated by EDTA titration in the case of Cu^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}, and by the UV-VIS spectroscopy in the case of CrO_4^{2-}. The products showed different absorption capacities depending on the SS content in the resin. Treatment with 0.1 M HCl showed excellent regeneration with maintenance of the resins absorption capacity for 20 regeneration cycles.

In conclusion, sericin-based resins, besides being biocompatible, were endowed with environmental friendly preparation process; biodegradability; moderate cost; ability to fast and quantitatively absorb from aqueous solutions even at low pollutant concentration; full reversibility of the absorption process making it economically convenient both for regeneration and metal recovery.

References

1. P. Blondeau, M. Segura, R. Perez-Fernandez, J. de Mendoza, *Chem. Soc. Rev.*, **2007**, *36*, 198.