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Covalent Binding of Cysteine to a Sol-Gel Material for Cadmium Biosorption from Aqueous Solutions

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Abstract : Heavy metal pollution has become a more serious environmental problem in the last several decades as a result of its toxicity and insusceptibility to the environment. Methods for removing metal ions from aqueous solution mainly consist of physical, chemical and biochemical procedures. Biosorption is defined as the removal of metal or metalloid species, compounds and particulates from solution by a biological material. Biosorption represents a very attractive method for the removal of toxic metal ions from aqueous effluents because it uses the ability of various biomass to bind the metal ions without the risk of releasing other toxic chemical compounds into the environment. The problem with using biomass or living cells as biosorbents is that their regeneration/reuse is often either impossible or very laborious. One of the most common chelating group found in biosorbents is the thiol group in cysteine. Therefore, we immobilized cysteine using covalent binding using glutaraldehyde as a linker on a synthetic sol-gel support obtained using 3-amino-propyl-trimetoxysilane and trimetoxysilane as precursors. The obtained adsorbents were used for removal of cadmium from aqueous solutions and the removal capacity was investigated in relation to the composition of the sol-gel hybrid composite, the loading of the biomolecule and the physical parameters of the biosorption process. In the same conditions, the bare sol-gel support without cysteine had no Cd removal effect, while the adsorbent with cysteine had an adsorption capacity up to 25.8 mg Cd/g adsorbent at pH 2.0 and 119 mg Cd/g adsorbent at pH 6.6, depending on cadmium concentration and adsorption conditions. We used atomic adsorption spectrometry to assess the cadmium concentration in the samples after the biosorbtion process. The parameters for the Freundlich and Langmuir adsorption isotherms where calculated from plotting the results of the adsorption experiments. The results for cysteine immobilization show a good loading capacity of the sol-gel support which indicates it could be used to immobilize metal binding proteins and by doing so boosting the heavy metal adsorption capacity of the biosorbent.

Keywords : biosorbtion, cadmium, cysteine covalent binding, sol-gel
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