Nanochemistry and biotechnology

Adsorption of Pb^{2+} ions from human plasma by Fe_3O_4/SiO_2 nanocomposites

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The aim of the research is the acquisition of magnetosensitive biocompatible nanocomposites Fe_3O_4/SiO_2, the study of their adsorption activity regarding protein substances and ions of Pb^{2+} in the human blood plasma, considering the high toxicity of Pb^{2+} ions on the human body and the ability of albumin to connect cations of toxic metals. The unmodified magnetite Fe_3O_4 and magnetite that was adsorptively modified by tetraethoxysilane – Fe_3O_4/SiO_2 were used. To clarify the all picture of the interaction of Fe_3O_4/SiO_2 with plasma components the adsorption of protein substances (PS) by surface of composites was determined. Saline, 5% solution of dimethyl sulfoxide (DMSO) in saline were used as a solvent and 15% solution of polyethylene glycol PEG 2000 was used as a stabilizer.

When using saline, Fe_3O_4 and Fe_3O_4/SiO_2 adsorb PS albumin to 0.12%. The use of DMSO as solvent changes the extraction of albumin by Fe_3O_4/SiO_2 (to 1.78%) and Fe_3O_4 (to 17.8%), and when adding the stabilizer, the degree of extraction for Fe_3O_4 is about 3.5%, whereas for Fe_3O_4/SiO_2 - 12,8%. The study of adsorption of PS from blood plasma by the surface of the composites gives a more complete picture of the surface interaction with the protein substances under the given experimental conditions. Under the saline environment, Fe_3O_4 adsorbs the PS to 8.7%, and Fe_3O_4/SiO_2 to 26.1%. The use of DMSO changes the degree of extraction of PS: by Fe_3O_4 (to 2.8%), Fe_3O_4/SiO_2 (to 3.15%). When adding stabilizer, the degree of extraction of PS decreases: for Fe_3O_4 (to 0.01%), and Fe_3O_4/SiO_2 (to 1.2%). When using saline as a solvent, Fe_3O_4 removes Pb^{2+} to 99.9% and Fe_3O_4/SiO_2 to 94.7%. When using DMSO, the degree of extraction of Pb^{2+} is different: Fe_3O_4 (to 81.2%), Fe_3O_4/SiO_2 (to 94.3%), and when adding the stabilizer - Fe_3O_4 (to 97.5%), and Fe_3O_4/SiO_2 (to 93.4%).

Stabilization of the particles of Fe_3O_4, Fe_3O_4/SiO_2 with PEG increases the residence time of magnetosensitive nanocomposites in a finaly divided state, and the use of DMSO as a solvent improves their adsorption parameters.