

Study of the Possibility of Adsorption of Heavy Metal Ions on the Surface of Engineered Nanoparticles

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Abstract : The relevance of research is associated, on the one hand, with an ever-increasing volume of production and the expansion of the scope of application of engineered nanomaterials (ENMs), and on the other hand, with the lack of sufficient scientific information on the nature of the interactions of nanoparticles (NPs) with components of biogenic and abiogenic origin. In particular, studying the effect of ENMs (TiO₂ NPs, SiO₂ NPs, Al₂O₃ NPs, fullereneol) on the toxicometric characteristics of common contaminants such as lead and cadmium is an important hygienic task, given the high probability of their joint presence in food products. Data were obtained characterizing a multidirectional change in the toxicity of model toxicants when they are co-administered with various types of ENMs. One explanation for this fact is the difference in the adsorption capacity of ENMs, which was further studied in in vitro studies. For this, a method was proposed based on in vitro modeling of conditions simulating the environment of the small intestine. It should be noted that the obtained data are in good agreement with the results of in vivo experiments: - with the combined administration of lead and TiO₂ NPs, there were no significant changes in the accumulation of lead in rat liver; in other organs (kidneys, spleen, testes and brain), the lead content was lower than in animals of the control group; - studying the combined effect of lead and Al₂O₃ NPs, a multiple and significant increase in the accumulation of lead in rat liver was observed with an increase in the dose of Al₂O₃ NPs. For other organs, the introduction of various doses of Al₂O₃ NPs did not significantly affect the bioaccumulation of lead; - with the combined administration of lead and SiO₂ NPs in different doses, there was no increase in lead accumulation in all studied organs. Based on the data obtained, it can be assumed that at least three scenarios of the combined effects of ENMs and chemical contaminants on the body: - ENMs quite firmly bind contaminants in the gastrointestinal tract and such a complex becomes inaccessible (or inaccessible) for absorption; in this case, it can be expected that the toxicity of both ENMs and contaminants will decrease; - the complex formed in the gastrointestinal tract has partial solubility and can penetrate biological membranes and / or physiological barriers of the body; in this case, ENMs can play the role of a kind of conductor for contaminants and, thus, their penetration into the internal environment of the body increases, thereby increasing the toxicity of contaminants; - ENMs and contaminants do not interact with each other in any way, therefore the toxicity of each of them is determined only by its quantity and does not depend on the quantity of another component. Authors hypothesized that the degree of adsorption of various elements on the surface of ENMs may be a unique characteristic of their action, allowing a more accurate understanding of the processes occurring in a living organism.

Keywords : absorption, cadmium, engineered nanomaterials, lead

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