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SUMMARY

The aim of this study was to investigate the interaction of nano- and micro-sized materials with model organisms, to find out its possible mechanisms and to assess the consequences for the environment. Using physico-chemical, toxicological, physiological and biochemical methods, nanoparticles (ND) (cobalt ferrite (CoFe2O4) and quantum dots (QDs)), harmful cyanobacterial bloom (cyanoHAB) biomass, graphene oxide (GO), metals Cr (III), Cu (II), Ni (II) and Zn (II) mixtures (MIX); the effect of landfill leachate (SF) on the test organisms Desmodesmus communis, Daphnia magna and Lepidium sativum. An assessment of the ecotoxicological effects of multicomponent mixtures (SF)) and (cyanoHAB biomass) was performed based on the growth and mortality of organisms of different trophic levels and developmental stages. The study revealed different effects of SF and cyanoHAB biomass on aquatic organisms. The results obtained allow us to use the most sensitive test organisms of different trophic levels to assess the ecotoxicological risk in order to better understand the effects of anthropogenic pollution on the functioning of the food web. The effect of synthesized CoFe2O4 ND on the biological (morphological, physiological, and biochemical) parameters of Lepidium sativum was evaluated and the parameters studied (seed germination, relative growth and biomass of roots and above-ground parts of plants, amounts of chlorophylls a and b, carotenoids, malondialdehyde (MDA)) changes depending on the magnetic NP concentration and size. Thus, the results of the toxicological effects of CoFe2O4 NPs on L. sativum not only deepen the knowledge of the nanophytotoxicity of ferromagnetic NPs, but are also useful for ecotoxicological studies related to environmental risk assessment. The phytotoxicity of graphene oxide (GO) was investigated using L. sativum as a test organism and the ability of GO to modify metal uptake in plants exposed to a mixture of metals was evaluated. Our data show that MIX, GO and MIX + GO concentrations did not affect seed germination, root growth and root and shoot biomass in most cases, but they change photosynthetic processes, enhance the production of carotenoids and H2O2, also activate lipid peroxidation. The effect of GO on the accumulation of the investigated metals (Cu, Cr, Ni and Zn)

in the roots and shoots of L. sativum exposed to MIX was determined, and this is related to the ability of GO to adsorb metals from the medium, so GO at low concentrations may be a useful tool for water decontamination. These studies revealed that GO is a promising and advanced metal adsorbent and can be used to reduce the impact of metals in aquatic and terrestrial ecosystems. The effects of Cd-based QDs on the growth and population structure of the green alga D. communis grown in different media such as lake water, artesian water and artificial algal growth medium were also investigated. Inhibition of algal growth was found to be highly dependent on the test medium. Algal growth in artificial algal growth medium with QDs was significantly higher than in other media. Whereas, algae is a key part of the food chain in the aquatic environment, therefore, present study provides a useful information on how nanomaterials can affect the environment and how the environment can affect nanoparticles. Summarizing the results of the investigated effects of different types, different concentrations, stability and different sizes of NPs on aquatic and terrestrial plants, it was found that, depending on the environmental factors and media, the investigated NPs causes morphophysiological (growth, biomass, structure) and biochemical (pigments, carotenoids, MDA, H2O2 amounts) changes in plants, which clearly show the phytotoxic effect of NPs. Multicomponent mixtures (landfill leachate and cyanoHABs biomass) cause various growth and mortality changes in the model organisms, which depend on the concentration of the mixture and the trophic level of the test organism. According to their ecotoxicological potential, the tested mixtures were assigned to different ecotoxicity classes (ranging from low to high toxicity), which allowed assessing the risk of these mixtures to the aquatic and terrestrial environment. Traditional ecotoxicity assessment methods were found to be not suitable for assessing NPs toxicity, because environmentally significant concentrations of NPs do not cause death of model organisms but affect metabolic processes and cause oxidative damage.

Scientific publications published in journals indexed in the Clarivate Analytics Web of Science (CA WoS) database:

I. Kalnaitytė, A., Montvydienė, D., Januškaitė, E., Jurgelėnė, Ž., **Kazlauskas, M.**, Kazlauskienė, N., Bagdonas, S. (2024). The effects of CdSe/ZnS quantum dots on autofluorescence properties and growth of algae *Desmodesmus communis*: dependence on cultivation media. *Environmental Science: Nano*. https://doi.org/10.1039/D3EN00955F

II. Montvydienė, D., Jagminas, A., Jurgelėnė, Ž., **Kazlauskas, M.**, Butrimienė, R., Žukauskaitė, Z., Kazlauskienė, N. (2021). Toxicological effects of different-sized CoFe ($CoFe_2O_4$) nanoparticles on *Lepidium sativum* L. towards better understanding of nanophytotoxicity. *Ecotoxicology*, 30(2), 277–291. https://doi.org/10.1007/s10646-020-02340-y

III. **Kazlauskas, M.**, Jurgelėnė, Ž., Šemčuk, S., Jokšas, K., Kazlauskienė, N., Montvydienė, D. (2023). Effect of graphene oxide on the uptake, translocation and toxicity of metal mixture to *Lepidium sativum* L. plants: mitigation of metal phytotoxicity due to nanosorption. *Chemosphere*, 312, 137221. https://doi.org/10.1016/j.chemosphere.2022.137221

IV. Montvydienė, D., Šulčius, S., Jurgelėnė, Ž., Makaras, T., Kalcienė, V., Taraškevičius, R., **Kazlauskas, M.**, Kazlauskienė, N. (2020). Contrasting ecotoxic effects of landfill leachate and cyanobacterial biomass on aquatic organisms. *Water, Air, & Soil Pollution*, 231, 323. https://doi.org/10.1007/s11270-020-04684-x

Other scientific articles published in peer-reviewed continuous or non-periodical publications:

V. **Kazlauskas, M.**, Montvydienė, D., Jurgelėnė, Ž., Kazlauskienė, N. (2020). Toxicity assessment of different size cobalt ferrite nanoparticles on *Lepidium sativum* L. In *Proceedings of the Conference "Protection and Restoration of the Environment XV"*, July 7–10, 2020, Kalamata, Greece.

VI. **Kazlauskas, M.**, Jurgelėnė, Ž., Butrimienė, R., Kazlauskienė, N., Montvydienė, D. (2022). Risk assessment of nano- and micro-sized materials for terrestrial and aquatic ecosystems. In *Book of Proceedings of the Ninth International Conference on Environmental Management, Engineering, Planning and Economics (CEMEPE 2022)*. *(pabaigos dalis nutraukta – galiu papildyti, jei pateiksite likusį tekstą).*