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The Combined Ecotoxicity of $nTiO_2$ and Coexisting Micropollutants in the Aquatic Ecosystem

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Extended Abstract

The number and diversity of products and technologies applying engineered nanomaterials including nano titanium dioxide (nTiO2) has increased dramatically in the past two decades. However, the potential benefits of their use to society require reconsideration regarding their potential adverse effects on the environment and human health. Engineered nanoparticles (NPs) drew growing interest in the past few decades due to their unique properties determined by their minute particle size. Due to the increased manufacture and use the growth of their environmental impact is inevitable [1]. Emerging micropollutants (EPs) are also in the focus of interest due to their potential secondary adverse effects on the aquatic ecosystem [2].

However the individual toxic effect of NPs and emerging micropollutants are well-studied, scarce data can be found investigating the combined effect of these aquatic pollutants [3]. Most toxicity data are available for freshwater species only, but in order to gain a comprehensive picture of the environmental effects of nanomaterials, more trials would be necessary with marine test organisms and terrestrial plants or other photosynthetic organisms [4].

Considering the scarce data in current literature on the combined effect of nanomaterials and coexisting aquatic micropollutants, our objective was to study the toxic effect of TiO2 NPs in combination with selected EPs: atrazine, diuron, chlorpyrifos, Na-diclofenac (DCF), 17β-estradiol, triclosan, 3,4-dichlorophenol (3,4diCP) and 4-chlorophenol (4CP).

In present study the Aliivibrio fischeri bioluminescent inhibition test with prolonged exposure time, the Lemna minor growth inhibition test with the determination of the total chlorophyll content and two unconventional ecotoxicity assays – the Daphnia magna heartbeat rate test and the Daphnia magna feeding activity test– were applied in order to assess the combined effect of nTiO2 and coexisting micropollutants at environmentally relevant concentrations (ng/L−mg/L). The Aliivibrio fischeri bioluminescence inhibition test, the Daphnia magna heartbeat rate test and the Lemna minor growth inhibition test were carried out as described by Fekete-Kertész et al. [5].

The applied $nTiO_2$ suspension is a HCl activated form of Degussa VP P90 titanium dioxide powder purchased from Evonik Resource Efficiency GmbH. Extensive characterization of the applied $nTiO_2$ suspension was carried out in MilliQ® ultrapure water and also in the applied test media. Electrical conductivity (EC) and pH was measured of each test suspension at the end of the applied contact time. The zeta potential and the hydrodynamic diameter of nano suspensions were measured by dynamic light scattering method (DLS) in the applied test media at the end of the applied contact time. The surface area (BET) values were provided by the manufacturer. The mean particle diameter of the applied $nTiO_2$ suspension was 89 nm, the crystalline phase was 90% anatase and 10% rutile, the specific surface area (BET) was 90 ± 20 [m^2/g].

We found that $nTiO_2$ significantly affected the availability of the tested chemicals indicating that nanoparticles may have not only direct but indirect impacts on aquatic organisms by modifying the toxicity of coexisting pollutants.

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