Toxicity of differently sized and coated silver nanoparticles to the bacterium Pseudomonas putida: risks for the aquatic environment?

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Abstract

Aim of this study was to describe the toxicity of a set of different commercially available silver nanoparticles (AgNPs) to the gram-negative bacterium Pseudomonas putida (growth inhibition assay, ISO 10712) in order to contribute to their environmental hazard and risk assessment. Different AgNP sizes and coatings were selected in order to analyze whether those characteristics are determinants of nanoparticle toxicity. Silver nitrate was tested for comparison. In general Pseudomonas putida reacted very sensitive towards the exposure to silver, with an EC05 value of 0.043 µg L^{-1} for AgNO3 and between 0.13 and 3.41 µg L^{-1} for the different AgNPs (EC50 values 0.16 µg L^{-1} for AgNO3, resp. between 0.25 and 13.4 µg L^{-1} for AgNPs).

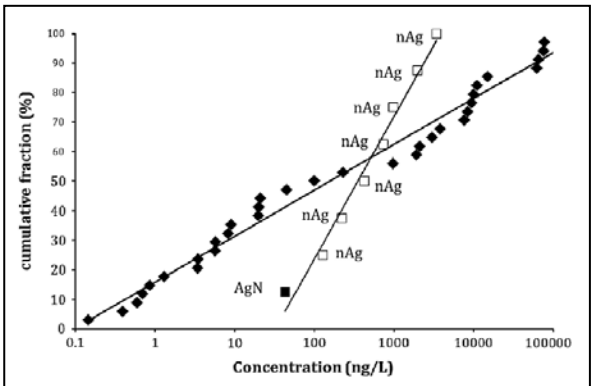

Fig. 3 Graphical overview of the recorded EC_{05} values for $AgNO_3$ and the seven tested AgNPs in this study in relation to the silver concentrations found in surface waters of various geographical regions (numerical data and references for the surface water concentrations of the silver are given in the supporting information)

As the ionic form of silver is clearly the most toxic, an environmental hazard assessment for microorganisms based on total silver concentration and the assumption that AgNPs dissolve is sufficiently protective. Neither specific coatings nor certain sizes could be linked to increasing or decreasing toxicity. The characterization of particle behavior as well as the total and dissolved silver content in the medium during the exposures was not possible due to the high sensitivity of Pseudomonas (test concentrations were below detection limits), indicating the need for further development in the analytical domain. Monitored silver concentrations in the aquatic environment span six orders of magnitude (0.1–120,000 ng L^{-1}), which falls into the span of observed EC05 values and might hence indicate a risk to environmental bacteria.

Reference

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