The use of bio-tools for nanomaterials development: how to assess the release of ionic silver from different silver nanoparticles using algae

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Abstract

The use of a very well calibrated biological answer against Ag+ (here the algal photosynthesis of Chlamydomonas reinhardtii) has been used to assess the influence of different coatings and protein composition on the ionic Ag+ release from AgNPs under biotic conditions.

Because of their biocide properties [1], silver nanoparticles (AgNP) are present in numerous consumer products. During recent years, an increasing number of works demonstrated their toxicity to different microorganisms as bacteria [1-4] or algae [5-8]. Biocide properties of AgNP have been suggested to relate with both the release of ionic silver (Ag^+) and interactions between AgNP and cell membranes [2, 7, 9-11]. The determinant role of dissolved silver ions, in explaining the observed toxicity of AgNP to microorganisms, has been experimentally evidenced by evidenced by the fact that complexation of Ag+ ions by thiol ligands as well as anaerobic conditions prevent toxicity of AgNP [12-15]. These results emphasize the importance for disentangling the contribution of AgNP and Ag^+ to the observed toxicity.

There are only a few works available, focusing on the influence of coatings on ionic silver release from AgNP [17-19].These studies emphasize their role in complexing and storing silver ions suggesting a potential control of silver bioavailability by the coatings. However, desorption and release of ionic silver will ultimately depend on the affinity of membrane transporters to Ag^+. Although some comparative studies with various coatings have indeed reported on differences in AgNP toxicity to aquatic organisms [7, 20, 21] none have systematically examined how coatings influence Ag^+ bioavailability to organisms. In this study we have assessed the role played by citrate, lactate, gelatin, chitosan, carbonate, dexpanthenol, polyvinyl pyrrolidone, polyetheleneglycol, sodium dodecyl benzenesulfonate, and the influence of different amounts of caseine, on the release of ionic silver.

Even if coatings are commonly used to mininimize nanoparticle aggregation in liquids [13, 16], our results shown that coatings may also optimize the delivery of ionic silver from nanomaterials. This information would support a more precise design of AgNPs depending on the intended use.

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