Influence of size and surface coating on silver nanoparticles uptake by Gammarus fossarum

Kahina Mehennaoui*†[1,2], Sébastien Cambier[1], Tommaso Serchi[1], François Guérold[2], Laure Giamberini[3], and Arno Gutleb[1]

[1]Environmental Research and Innovation departement, Luxembourg Institute of Science and Technology (ERIN LIST) – 5 Avenue des Hauts-Fournaux, L-4362 Esch/Alzette, Luxembourg
[2]Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC) – CNRS : UMR7360, Université de Lorraine – Campus Bridoux - 8, rue du Général Delestraint, F-57070 METZ, France
[3]Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC) – CNRS : UMR7360, Université de Lorraine – Campus Bridoux - 8, rue du Général Delestraint, F-57070 METZ, France

Abstract

The increasing production and use of silver nanoparticles (AgNPs) will inevitably lead to their release in aquatic environments where they represent a potential threat to aquatic species. Therefore, there is still a need of better understanding the mechanisms underlying the potential toxicity of AgNPs.

Being a widespread and an important component of the aquatic macroinvertebrate assemblage, Gammarus fossarum will certainly be exposed to AgNPs if they reach the water courses. Therefore, G. fossarum was selected as model organism to assess AgNPs effects.

This study evaluated the acute effects of three different sizes of AgNPs (20, 40 and 80 nm), either stabilized with citrate (CIT-AgNPs) or coated with polyethylene glycol (PEG-AgNPs), on adult male G. fossarum. AgNPs tested concentrations ranged from 0.5 to 50 mg.L-1. AgNO3 was used as a positive control to assess silver ion effects.

Size distribution of CIT-AgNPs and PEG-AgNPs in exposure medium was characterized using nanoparticle tracking analysis. CIT-AgNPs 40 nm and CIT-AgNPs 80 nm were stable whereas CIT-AgNPs 20 nm aggregated to NPs of 53 nm. In contrast, all PEG-AgNPs were stable.

Uptake of silver by G. fossarum, assessed by ICP-MS, revealed a surface-coating dependent effect with CIT-AgNPs being taken up to a greater extent than PEG-AgNPs. Additionally, a size dependent uptake was observed with CIT-AgNPs 40 nm being more taken up than CIT-AgNPs 20 nm and CIT-AgNPs 80 nm. The same tendency linking the size to the uptake was observed for PEG-AgNPs with higher uptake of PEG-AgNPs 20 nm than PEG-AgNPs 40 nm and PEG-AgNPs 80 nm.
These results show effects at low and environmentally realistic concentrations of AgNPs for G. fossarum and confirm the hypothesis that silver uptake is dependent on size and surface coating of AgNPs.

*Speaker
†Corresponding author: kahina.mehennaoui@list.lu

Keywords: Silver nanoparticles, Gammarus fossarum, silver uptake