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Effects of size and surface chemistry on the uptake of Au ENPs into sediment-dwelling *Lumbriculus variegatus*

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Considerable efforts have being made to study the potential toxicity of engineered nanoparticles upon the uptake by aquatic organisms. It is often stated that the uptake is related to physiochemical properties of engineered nanoparticles (ENPs), such as particle size and surface coating. However, these claims are not sufficiently backed up with the evidences where conflicting results are obtained in the published data. This study is hence focused on illustrating how these physiochemical properties of Au ENPs affect the uptake of the ENPs in the sediment-dwelling *Lumbriculus variegatus*. The experiment was composed of the uptake and depuration study of Au ENPs in sediment dwelling *Lumbriculus variegatus* as well as respective sedimentation process in natural sediment. Studied Au ENPs were coated with either citrate (Au CIT), mercaptoundecanoic acid (Au MUDA) or bovine serum albumin (Au BSA) and featured the size of 5 nm or 30 nm. Surface coating and particle size were both found to be factors affecting the uptake and persistence of ENPs into the *Lumbriculus variegatus*. Comparing with Au3+, the results showed that Au ENPs took more time to settle in the sediment, had more uptake during exposure and also had more elimination during depuration. Eventually the persistence of Au in *Lumbriculus variegatus* ranked in regards to the ENP size in the following order Au3+ > 5 nm > 30 nm. Surface coating influenced the uptake and persistence of Au ENPs in *Lumbriculus variegatus* through the sedimentation efficiency and tissue affinity. The persistence of the Au ranked with regards to ENP surface coating is Au BSA > Au CIT > Au MUDA. However, synchrotron XRF images showed that *Lumbriculus variegatus* exposing to Au CIT has more uptake of Au and healthy tissue, while ones exposing to Au MUDA have less uptake but damaged tissue. It suggests that more and persisting ENPs uptake in the organism do not necessarily produce more extensive tissue damage.

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