NATURAL TRANSFORMATION OF SILVER and CERIUM OXIDE NANOPARTICLES and SUBSEQUENT TOXICOLOGICAL EFFECTS IN AQUATIC ENVIRONMENTS

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Once released in the receiving environment, engineered nanoparticles (NPs) can undergo major transformation and their initial properties can be modified under natural conditions. Transformation processes, such as aggregation or degradation, control the environmental fate and behavior of NPs released into the environment. Such changes in forms and properties may influence significantly their potential toxicity. Size distribution of nanoparticles has a tremendous impact on the evaluation of their potential effects. This study investigated the fate then the effects of silver (Ag) and cerium oxide (CeO) nanoparticles where fish were exposure to NP transformation products in different types of natural water. Following a transformation period, size distribution of NP forms in waters was determined by ultrafiltration and SP-ICP-MS techniques and NP shape and size were confirmed by electronic microscopy. Particle size distributions changed significantly under different experimental conditions where most material was also found in coarse colloidal fractions (< 100kDa). Water chemical properties such as organic carbon had significant impacts on the fate and changes in forms of both NP Ag and CeO. AgNPs formed aggregates in water with relatively high values of organic carbon (3-7 mg C/L) and pH (˃ 7.5). AgNPs were also degraded as observed with the stars formation. In contrast , no Ce was found in the truly dissolved fraction indicating no evident NP degradation for CeO. More than 90% of NPs CeO was found as large colloids. NPs CeO were preferably accumulated in fish gills, likely adsorbed onto gill surface, and accumulation was the highest in green waters. Significant bioaccumulation of Ce was also observed in liver of fish exposed to NPs in brown waters. Different effects were observed in exposed fish as enzymatic and immune system responses. Even NPs CeO were less accumulated than NPs Ag, NPs CeO were more harmful as they induced fish mortality. The high level of natural organic matter, including fulvic and humic substances, in water can reduce the global toxicity of the NPs Ag and CeO; nonetheless some of them in small aggregates induced toxic effects. Future research on nanotoxicity should consider exposure conditions, and then potential transformation, for risk assessment studies.