Toxicity to meiobenthic copepods by polyvinylpyrrolidone coated silver nanoparticles (PVP-AgNPs)

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As commercial and industrial uses for silver nanoparticles (AgNPs) increase principally as biocides, environmental releases through sanitary waste discharge and degradation of Ag-nano containing products are growing. Most silver-induced toxicity in aquatic systems is from the release of Ag ions from AgNPs. This question of Ag-nano toxicity due to release of dissolved Ag species was addressed here using full-lifecycle comparative exposures of copepods to seawater-dissolved reference AgNO₃ (0, 20, 30, 45, 75 µg.L⁻¹) versus treatment PVP-AgNPs (0, 20, 30, 45, 75 µg.L⁻¹) using the meiobenthic copepod Amphiascus tenuiremis per ASTM E2317-04(2012) methods. Over the full lifecycle, AgNO₃ dissolved in 30S seawater at only 30 µg.L⁻¹ was significantly lethal to copepods (45% of test population dead in 26 days) with mating success cut in half and fecundity reduced by 40%. In contrast, Ag-PVP at 30 µg.L⁻¹ produced only 19% population death by 26 days with no negative effects on mating success or fecundity. Response data for stage-specific survival rates, sex ratios, mating success and fecundity were modeled via Leslie (Lefkovich) matrices to project an integrated population response model for these two forms of seawater Ag (i.e. AgNO₃ vs. PVP-AgNPs). PVP-AgNPs produced a population doubling time of 3-4 generations across all test concentrations except the control (i.e. 2 generations doubling time). AgNO₃ at 20 µg.L⁻¹ pushed population doubling-time to 4 generations versus 2; and >30 µg.L⁻¹ pushed copepod populations to extinction in 9-12 generations. PVP-AgNPs appears to confer population-relevant protection by modulating the release of Ag ions in seawater compared with AgNO₃ during exposure.

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