

Advanced Nanoparticles; A Boon or a Bane to Environment and Aquatic System

Bhuvaneshwari Manivannan¹, Amitava Mukherjee², Hiroshige Matsumoto¹

International Institute for Carbon-Neutral Energy Research (I2CNER), Kyushu University, Japan

²Vellore Institute of Technology, Tamil Nadu, India

Nanoparticles are used in many fields of science because of their unique properties, including their small size and higher surface area-to-volume ratio. Whether intentionally or accidentally released into the environment, nanoparticles raise concerns about their potential impacts on ecosystems. Recent increases in metal oxide particle manufacturing and usage have raised worries about their potential environmental impact. The topic of nanoparticle toxicity is intricate and multifaceted, impacted by various factors such as the particles' size, shape, composition, chemistry, and interactions with biological systems. Despite current research into the ecotoxicological effects of different metal oxide nanoparticles on aquatic life, the contributions of particles and dissolved ions to toxicity in the case of metal oxide ZnO NPs remains unknown. ZnO NPs of different sizes 50 nm, 100 nm, and bulk particles are used to examine the toxicity towards freshwater daphnids, and alongside its topic transfer potential from algae to daphnia. The size of a particle played a significant role; smaller particles had higher biological interaction potential and therefore had more mortality, bioaccumulation (BAF), and biomagnification (BMF) potential. The 48 h LC₅₀ of ZnO NP_(total) was found to be 0.431, 0.605, and 0.701 mg/L for 50, 100 nm, and bulk particles. Zn ions' contribution to toxicity was higher at 50 nm, while the particle effect was significant in 100 nm and bulk particles. 50 nm ZnO NP concentration of more than 2.5 (μM) was found to pass through the food chain (algae to daphnia) with a BMF value of more than 1, compared to 100nm and bulk particles. At LC₅₀ concentrations, the NP_(particles) accumulated at 90-95% across the sizes used, whereas the NP_(ion) contributed only around 4-5% to the overall NP accumulation (total). The relative contribution of ZnO NP_(ion) to overall toxicity and accumulation was lower than that of ZnO NP_(particles) across the sizes tested. The toxicity mechanism exerted by ZnO NPs was direct ingestion, adsorption, membrane deterioration, intercellular dissolution, and ROS generation, by the toxicity factors are particle size, concentration, its solubility. Nanoparticles can either be tagged as boon or bane depending how it is utilized in day today's application.