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Assessment of Acute Toxic Effects of Zinc Oxide Nanoparticles in Zebrafish (*Danio rerio*) Embryos**Senarathne J.D.A.U., Peiris L.D.C.***

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Abstract

The extensive application of zinc oxide nanoparticles (ZnO-NPs) in industrial, cosmetic, and pharmaceutical sectors has led to their continuous release into the environment, primarily in wastewater effluent. Excessive dumping has led to the issue of their accumulation and toxicity towards aquatic life. To facilitate effective waste management and pollution control policies, it is necessary to understand the biological responses of such nanoparticles in aquatic organisms. The current research aimed to investigate the acute toxic effects of ZnO NPs on zebrafish (*Danio rerio*) embryos, a well-established and sensitive vertebrate model in ecotoxicology. Zinc oxide nanoparticles were synthesized using the sol-gel method and characterized before exposure. The average width of the synthesized nanoparticles was in the range of 75-96 nm. The acute toxicity assay was performed in accordance with OECD guidelines, where zebrafish embryos at 2 hours post-fertilization (hpf) were exposed to varying concentrations of ZnO-NPs (0.5-100 ppm) for 96 hours in a controlled laboratory environment. Mortality, hatching, and developmental abnormalities like pericardial edema, yolk sac edema, spinal deformity (bent spine) and reduced eye size were recorded and observed at each 24-hour interval to determine the concentration-dependent effects and the 96-hour LC₅₀ value. The results showed evidence of increased mortality and malformations with higher concentrations of nanoparticles, with the most critical deformities being pericardial edema, yolk sac edema, retardation of hatching, and curvature of the spine. The LC₅₀ value of ZnO-NPs was determined to be 5.721 ppm, showing extremely high acute toxicity to *D. rerio* embryos. These findings highlight the onset of ecological risks associated with nanoparticle pollution and underscore the need for strict regulation, proper waste management, and the inclusion of nanotoxicity testing within environmental monitoring programs. Strengthening policies for managing nanoparticles is crucial in safeguarding aquatic ecosystems and promoting long-term ecological sustainability.

Keywords: *Zinc oxide nanoparticles, Danio rerio, Acute toxicity, Environmental pollution, Waste management*