TOXICITY ASSESSMENT OF ENGINEERED NANOPARTICLES TO FRESH WATER FISH: A COMPARISON OF NANOMETALS VERSUS METAL IONS USING CERTAIN BIOMARKERS AS ENDPOINTS.

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EXECUTIVE SUMMARY

Recently, nanotechnology has expanded considerably, primarily due to the growing use of nano-sized particles in industry and research (Hoseini *et al.*, 2016; Gautam *et al.*, 2018). Among the nanoparticles, metal oxide nanoparticles are largely manufactured and find its application in sunscreens, paints, construction materials and cosmetics (Tavares *et al.*, 2014). Metal oxide NPs may leak into natural bodies of water in their life cycles, but relatively little is known about the potential for toxic effects to aquatic species (Alkaladi *et al.*, 2015). Therefore, there is an urgent need for information on the ecological risks of metal oxide NPs (Krishnapriya and Ramesh, 2018).

Copper nanoparticles (CuNPs) have distinctive characters and commonly used as a substitute for noble metal catalysts (Zhou *et al.*, 2006; Chang *et al.*, 2012) and there is a high risk of copper nanoparticle toxicity to aquatic organisms. ZnO NPs have a bright future in agriculture in terms of crop bloom production (Batsmanova *et al.*, 2013; Pandurangan and Kim, 2015). However, information on the ecotoxicological effects of ZnO NPs has been very limited across all taxa (Kahru and Dubourguier, 2010). The toxicity of metal and metal oxide NPs on the health condition of the aquatic organisms can be evaluated by monitoring the biological responses (Lu *et al.*, 2011). Hence in the present study, copper sulphate ($CuSO_4$) as bulk copper ($CuSO_4$ BPs) and copper nano particles (CuNPs) and zinc sulphate as bulk zinc and zinc nanopaticles respectively is used to compare the toxic effects on the haematological parameters, plasma electrolytes (Na^+, K^+ and Cl^-), Na^+/K^+-ATPase activity and histopathological studies in the vital organs like gill, liver and kidney of a fresh water fish, *Labeo rohita*.

The leaves of *Carica papaya* were collected from Bharathiar University and the dried leaves were grinded and the obtained powder was weighed for the methanolic extraction. Zinc oxide (zno) nanoparticles were synthesized using standard procedure and were confirmed by sampling the reaction mixture UV -Vis Spectra analysis, FT-IR characterization, X-Ray Diffraction analysis, Field Emission- Scanning Electron Microscope (FE-SEM) and Energy Dispersive X-ray Spectroscopic Analysis (EDX). *Labeo rohita* were exposed to three different concentrations of both CuNPs and bulk Cu (20, 50 and 100 µg/L) based on the environmental level of CuNPs (0.06 mg/L). Experiments were conducted for 35 days with 7 days sampling frequency. Hematological parameters, sodium potassium ATPase

activity, plasma electrolytes, antioxidants and histopthology were estimated following the standard procedure.

In the present study significant changes in hematological parameters, sodium potassium ATPase activity, plasma electrolytes, antioxidants and histopthology were observed in fish treated with bulk and nanoparticles. A dose and toxicant specific alterations of these parameters were observed. From this study, it is evident that both nanoparticles (Cu and Zn) and metal have different mechanism of inducing toxicity. The fish exposed to CuNPs and Zn NPs seem to be active but the nano form is inducing toxicity inside the organisms. Though the fish survive, fish exposed to CuNPs and Zn NPs are under stress and mortality may occur in prolonged exposure (after 35 days).CuNPs and Zn NPs exhibit size, dose and time-dependent toxicity when compared with the Cu and Zn and control fish. Hence CuNPs and Zn NPs showed an enhanced toxicity than Cu and Zn in the fresh water fish *Labeo rohita.* The outcome of the results may give sound considerations to build an adequate testing strategy for the ecotoxicological effects of nanoparticles.

Publications

Kaliappan Krishnapriya and Mathan Ramesh, 2018. Comparative risk assessment of copper nanoparticles with their bulk counterpart in the Indian major carp *Labeo rohita*. In: Vineet Kumar, Nandita Dasgupta and Shivendu Rajah (Eds), Environmental Toxicity of Nanomaterials, CRC Press, USA, Chapter 7, pp. 159-178. ISB NO: 13:978-0-8153-6652-2