EXPOSURE OF TILAPIA TO IRON OXIDE NANOPARTICLES: EFFECTS PARTICLE MORPHOLOGY ON ACCUMULATION, ELIMINATION AND HEMATOLOGICAL RESPONSES

Mehmet Ates¹, Veysel Demir¹, Zikri Arslan², Hasan Kaya³, Sevdan Yılmaz³

¹Tunceli University, Engineering Faculty, 62000 Tunceli, Turkey
²Department of Chemistry and Biochemistry, Jackson State University, Jackson, MS 39217, USA
³Canakkale Onsekiz Mart University, Faculty of Marine Sciences and Technology, 17100 Çanakkale, Turkey

Abstract: Effects of chronic exposure to alpha and gamma iron oxide nanoparticles (α-Fe₂O₃ and γ-Fe₂O₃ NPs) were investigated through exposure of tilapia (Oreochromis niloticus) to 0.1, 0.5 and 1.0 mg/L suspensions for 60 days. Accumulation was largest in spleen followed by intestine, kidney, liver, gills, brain and muscle. γ-Fe₂O₃ NPs showed higher Fe in all organs. Accumulation in spleen was fast and independent of NP concentration reaching to maximum levels by the end of the first sampling. Despite negligible ranging dissolved Fe levels in water, gills showed accumulation of through dissolved Fe from metastable γ-Fe₂O₃ polymorph. Ingested NPs cleared from the organs completely within 30-day elimination period, except the liver and spleen. Liver contained about 31% of α- and 46% of γ-Fe₂O₃, while spleen retained about 62% of α- and 35% of the γ-polymorph. No significant disturbances were observed in hematological parameters, including hemoglobin, hematocrit, red blood cell and white blood cell counts (p > 0.05). Serum glucose (GLU) levels decreased in treatments exposed to 1.0 mg/L of γ-Fe₂O₃ NPs at day 30 (p < 0.05). In contrast, GLU levels increased during the elimination period for 1.0 mg/L α-Fe₂O₃ NPs treatments (p < 0.05). Transient increases occurred in glutamic oxaloacetic transaminase (GOT), glutamic pyruvic transaminase (GPT), and lactate dehydrogenase (LDH). Serum Fe levels did not change during exposure (p > 0.05), but increased significantly within elimination period due to mobilization of ingested NPs from liver and spleen to blood. Though respiratory burst activity was not affected (p > 0.05), lysozyme activity (LA) was suppressed suggesting an immunosuppressive effects from both Fe₂O₃ NPs (p < 0.05). In contrast, myeloperoxidase (MPO) levels increased significantly in treatments exposed to α-Fe₂O₃ NPs (p < 0.05), and the effect from γ-polymorph was marginal (p ≥ 0.05). The results indicate that morphological differences of Fe₂O₃ NPs could induce differential uptake, assimilation and immunotoxic effects on O. niloticus under chronic exposure.

Keywords: Iron oxide nanoparticles; Morphology; Accumulation; Elimination; Hematology; Immune parameters; Tilapia (Oreochromis niloticus)

Acknowledgments: This research is supported by Scientific Research Project Fund of Tunceli University under the project number MFTUB013-17. Partial support has been provided by NIH-RCMI Program at Jackson State University (Grant No: G12RR013459).