ABSTRACT

Zebrafish is utilized as a bioindicator to assess the impact of iron oxide nanoparticles on aquatic ecosystems which attracted the special attention due to their unique properties. Conversely, a notable number of studies have reported the physiological and pathological role of iron oxide nanoparticles on aquatic environment. So, the present study has studied with the comparative impact of haematological, histopathological, biochemical, ionic regulation (sodium, potassium and chloride), sodium potassium ATPase activity, antioxidant and tissue damaging enzymes, accumulation and modulation of functional groups of green (aswagandha leaf extract used as a reduced and capping agent) and chemical synthesized iron oxide nanoparticles on zebrafish. The synthesized iron oxide nanoparticles were preliminary characterized through UV-Vis spectroscopy (UV-Vis) for confirmation of iron oxide nanoparticles, followed by X-Ray Diffraction (XRD) for average crystal size between 21.34 ± 2 nm and 15.58 ± 2 nm. Aggregated crystal and spherical in shape with a relatively uniform morphology through High-Resolution Transmission Electron Microscopy (HRTEM) and Energy Dispersive X-Ray Spectroscopy (EDAX) was recorded only iron and oxygen compound peaks and further nanoparticles morphology were confirmed through Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Spectroscopy (EDAX). Vibrating Sample Magnetometer (VSM) were confirmed magnetic property resulted the 1.7150 emu and 2.3575 emu indicates the ferromagnetism of green and chemical synthesized iron oxide nanoparticles. Functional group of synthesized iron oxide nanoparticles were characterized through Fourier Transform Infrared Spectroscopy (FTIR). Zeta potential and Dynamic Light Scattering (DLS) analysis. The Characterized iron oxide nanoparticles were evaluated for lethal toxicity up to 96 hours. Based on this lethal concentration (158.55 and 35.611ppm ) green and chemical synthesized iron oxide nanoparticles were tested in six sub lethal concentrations such as T1-0, T2-3.96, T3-7.92, T4-15.85, T5-31.71 were selected in different & T6-63.42 and T1-0, T2-0.89, T3-1.78, T4-3.56, T5-7.122 & T6-14.244 ppm respectively for a period of 21 days and triplicates were through the experiment period. The heamatological parameters such as
hemoglobin (Hb), hematocrit (Hct), red blood cells (RBC) and white blood cells (WBC) were significantly (P<0.05) decreased and erythrocyte indices *viz.*, MCV (Mean Cell Volume), MCH (Mean Cell Hemoglobin) and MCHC (Mean Cell Hemoglobin Concentration) were significantly (P<0.05) increased when compared to control groups. The Histological studies showed the cellular damage in T1-control, T2-3.96 ppm (green synthesized nanoparticles) & 0.89 ppm (chemical synthesized nanoparticles), T4-15.85 ppm (green synthesized nanoparticles) & 3.56 ppm (chemical synthesized nanoparticles) and T6-63.42 ppm (green synthesized nanoparticles) & 14.244 ppm (chemical synthesized nanoparticles) of gill, muscle and intestinal tissues of zebrafish. The Biochemical characteristics such as protein, carbohydrate and lipids of gill and muscle were gradually decreased with increasing concentration of iron oxide nanoparticles when compared to control. Acetylcholine esterase activity were significantly higher in T4-15.85 ppm & 3.56 ppm of both green and chemical synthesized iron oxide nanoparticles exposed to gill and muscle of zebrafish. Plasma sodium, potassium and chloride significantly (P<0.05) decreased when compared to the control group in both green and chemical synthesized iron oxide nanoparticles. High Na⁺/K⁺ ATPase activity observed in T4 [15.85 ppm (green) & 3.56 ppm (chemical)] and significantly (P<0.05) decreased super oxide dismutase, total glutathione, glutathione peroxidase, glutathione-s-transferase, acid phosphatase, alkaline phosphatase and significantly (P<0.05) increased catalase, lipid peroxidase when compared to control. The Accumulation of iron oxide nanoparticles in muscle and gills was gradually increased with increasing the concentration of iron oxide nanoparticles. The significant difference at genetic (DNA and RNA) level changes was analyzed by using the FT-IR spectrometer. There for it may be concluded green synthesized iron oxide nanoparticles have five fold less toxic when compared to chemical synthesized iron oxide nanoparticles during a period of 21 days under exposure. This results reinforce the need of additional molecular tests to be established for identification of discharge of the safe concentration of green and chemical synthesized iron oxide nanoparticles to aquatic ecosystem and the importance of physiological route of iron oxide nanoparticles in human and as well as aquatic organisms.