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Toxic effect of iron oxide nanoparticles, silver nanoparticles and their mixture on heart, brain and lung of male rats

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Humans are exposed to nanoparticles (NPs) from ambient air and certain workplaces. The data on the potential health hazards of NPs exposure is limited. From the literature, there is not enough data on cardiotoxicity, neurotoxicity, and lung toxicity induced by the co-exposure to iron oxide nanoparticles (Fe₂O₃NPs) with silver nanoparticles (AgNPs). Therefore, the present study aimed to investigate the toxic effect of Fe₂O₃NPs, AgNPs alone or in combination on the brain, heart, and lungs of male rats. Animals were divided into 4 equal groups. Group 1 served as control, group 2 was administered orally with Fe₂O₃NPs (5 mg/kg BW; >50 nm), group 3 was treated intraperitoneally with AgNPs (50 mg/kg BW; >100 nm) and group 4 was administered with the mixture of Fe₂O₃NPs plus AgNPs. Animals were treated every day for 79 days. The present results showed that at the molecular level Fe₂O₃NPs, AgNPs, and their mixture showed marked DNA fragmentation as a hallmark of cell death. At the gene expression level Fe₂O₃NPs, AgNPs, and their mixture showed significant suppression of the mitochondrial transcription factor A (mtTFA) gene, while showing significant induction of peroxisome proliferator activator receptor gamma-coactivator 1 α (PGC-1 α) gene. Both genes; mtTFA and PGC-1 α are involved in the regulation of mitochondrial biogenesis and function. Fe₂O₃NPs, AgNPs, and their mixture caused a significant decrease in final body weight, body weight gain, serotonin, dopamine, acetylcholine esterase, paraoxonase 1, antioxidant enzymes (GST, SOD, CAT, and GPX), total antioxidant capacity, and reduced glutathione in brain, heart, lung, and plasma. Whereas, Fe₂O₃NPs, AgNPs, and their mixture resulted in a significant increase in norepinephrine, acetylcholine, creatine kinase, thiobarbituric acid-reactive substances, nitric oxide, tumor suppressor gene p53, tumor necrosis factor- α , interleukin-6, and lipid profiles. Fe₂O₃NPs, AgNPs, and their mixture showed histology changes alteration in the brain, heart, and lung. In conclusion, the obtained data showed that Fe₂O₃NPs, and AgNPs alone and in combination induced neurotoxicity, cardiotoxicity, and lung toxicity.

The toxic effects of the combination of Fe₂O₃NPs with AgNPs were more pronounced than each one.

Keywords: Iron oxide nanoparticles; Silver nanoparticles; Male rats; Oxidative stress; Antioxidants; cardiotoxicity, neurotoxicity, and lung toxicity, Cytokines; Mitochondrial transcription factor A peroxisome proliferator activator receptor gamma-coactivator 1 α , Biochemical and histology changes.

Recent Publications

1. Mosa IF, Abd HH, Abuzreda A, Yousif AB, Assaf N. (2021) Chitosan and curcumin nanoformulations against potential cardiac risks associated with hydroxyapatite nanoparticles in Wistar male rats. *International Journal of Biomaterials*. Jul 29;2021
2. Yousif AB, Mosa IF, Abd HH, Abuzreda A, Assaf N.,(2020) Bio-evaluation of the role of chitosan and curcumin nanoparticles in ameliorating genotoxicity and inflammatory responses in rats' gastric tissue followed hydroxyapatite nanoparticles' oral uptake. *Toxicology Research*. Jul;9(4):493-508.
3. Yousef MI, Abuzreda AA, Kamel MA, (2019). Cardiotoxicity and lung toxicity in male rats induced by long-term exposure to iron oxide and silver nanoparticles. *Experimental and therapeutic medicine*. Dec 1;18(6):4329-39.
4. Yousef MI, Abuzreda AA, Kamel MA (2019). Neurotoxicity and inflammation induced by individual and combined exposure to iron oxide nanoparticles and silver nanoparticles. *Journal of Taibah University for Science*. Dec 11;13(1):570-8.

Biography

Abdelsalam Abuzreda is a Ph.D. graduate in Nanotoxicity on Molecular and Physiological Characteristics and he is the Assistant Professor and Postdoctoral Research fellow at Benghazi University. Currently, he is a researcher in the Department of Health Safety and Environmental (HSE), Arabian Gulf Oil Company (AGOCO). He has contributed to various conferences and many publications in his research interests such as Material Characterization, Nanoparticle Synthesis, Nanoparticle Preparation, Nanomaterials Synthesis, Nanomaterials, Nanoscience, Nanostructured Materials, Nanobiotechnology, Polymers, and Biomaterials.

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