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Radiolytic synthesis of non-toxic, size-homogeneous gold nanoparticles

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Radiolytic synthesis of nanoparticles is one of the successful examples of Green Chemistry (the use of non-toxic chemicals, environmentally benign solvents and renewable materials during the chemical processes), in which the reducing agents responsible for the particle nucleation are no other than the reactive species generated by the radiolysis of the solvent itself (i.e. water, acetone or alcohols). This study consists on the radiolytic synthesis and characterization of gold nanoparticles, as well as the assessment of their toxicity levels to Zebrafish embryos (Danio rerio), as an indication of a possible environmental effect. The nanoparticles were synthesized by mixing: NaAuCl4 2 x 10-3 M; polyvinylpyrrolidone 100 kDa 0.5% (as size stabilizer); propan-2-ol 0.2 M and acetone 0.06 M (for the generation of propyl radicals); and AgNO3 6 x 10-5 M (another size stabilizer), followed by 10 kGy of gamma radiation (5 kGy h-1) [1]. The particles were characterized by their absorption spectra in the UV and visible, and the dynamic light scattering (DLS) technique was used to assess their hydrodynamic size. Finally, the impact on the development of Zebrafish embryos was investigated for different dilutions of the nanoparticles suspension, according to the OECD protocol nº 236 (Guideline on Fish Embryo Acute Toxicity Test – FET), as a means of assessing the environmental impact of the nanomaterial. An acute (96 hours of exposition to gold nanoparticles) and a chronic (168 hours of exposition) assay were performed. The particles were successfully synthesized in a multipurpose gamma irradiator, with an absorption peak at 532 nm and a narrow size distribution (around 80 nm). There was no evident toxicity for the fish in any tested concentration, leading to the conclusion that this green method of nanoparticle synthesis generates a potentially environment-safe material, with good control of size and optical properties.