Abstract

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In vitro toxicity of silver nanoparticles at noncytotoxic doses to HepG2 human hepatoma cells.

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Abstract

Although it has been reported that silver nanoparticles (Ag-NPs) have strong acute toxic effects to various cultured cells, the toxic effects at noncytotoxic doses are still unknown. We, therefore, evaluated in vitro toxicity of Ag-NPs at noncytotoxic doses in human hepatoma cell line, HepG2, based on cell viability assay, micronucleus test, and DNA microarray analysis. We also used polystyrene nanoparticles (PS-NPs) and silver carbonate (Ag2CO3) as test materials to compare the toxic effects with respect to different raw chemical composition and form of silver. The cell viability assay demonstrated that Ag-NPs accelerated cell proliferation at low doses (< 0.5 mg/L), which was supported by the DNA microarray analysis showing significant induction of genes associated with cell cycle progression. However, only Ag-NPs exposure exhibited a significant cytotoxicity at higher doses (> 1.0 mg/L) and induced abnormal cellular morphology, displaying cellular shrinkage and acquisition of an irregular shape. In addition, only Ag-NPs exposure increased the frequency of micronucleus formation up to 47.9 +/- 3.2% of binucleated cells, suggesting that Ag-NPs appear to cause much stronger damages to chromosome than PS-NPs and ionic Ag+. Cysteine, a strong ionic Ag+ ligand, only partially abolished the formation of micronuclei mediated by Ag-NPs and changed the gene expression, indicating that ionic Ag+ derived from Ag-NPs could not fully explain these biological actions. Based on these discussions, it is concluded that both "nanosized particle of Ag" as well as "ionic Ag+" contribute to the toxic effects of

Ag-NPs.

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