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## Silver nanoparticles in fish embryos: uptake, growth, yolk sac and antioxidant induction impacts

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Silver nanoparticles (AgNPs) are widely used in commercial applications as antimicrobial agents but recently there have been regulatory restrictions due to concerns about possible environmental impacts of their post-utilization. In this study, zebrafish embryos were exposed to a dispersion of four and 10 nm sized AgNPs (S4 and S10) and silver ion alone to study their uptake and impact. Significant *in vivo* uptake was evident at a S4 AgNPs concentration of 1.925 mg/L, and resulted in significantly reduced body length and delayed yolk sac absorption compared to control embryos 72 hours post fertilization (HPF). Additionally, S4 AgNPs treatment at the same concentration resulted in significantly up-regulated hypoxia inducible factor and peroxisomal membrane protein 2 mRNA expression in exposed embryos 96 HPF. An increased trend in up-regulation of superoxide dismutase mRNA expression was also observed upon exposure to S4 AgNPs, while, catalase and mucosal secretion protein expressions remained unchanged. No significant differences in any of the gene expression levels were observed following S10 AgNPs and silver ion exposure alone. These results suggest that smaller sized S4 AgNPs are available for uptake, inducing developmental and gene expression perturbations in developing embryos.

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