Impact of silver and gold nanoparticles on cell viability, secondary metabolite accumulation and gene expression in cells of *Hypericum perforatum*

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The response of *Hypericum perforatum* to silver nanoparticle (SNP) and gold nanoparticle (GNP) treatment was studied in cell suspension cultures. Parameters related to cell viability, changes in secondary metabolite profiles and gene expression pattern were assessed in *H. perforatum* cell suspension cultures after treatment with 25 mg/l of either SNP or GNP. Although a drastic reduction in cell viability was observed in the SNP- treated cultures, cell viability was not affected in the GNP- treated cultures. In addition, a rapid increase in intracellular reactive oxygen species (ROS) was observed with SNP treatment, in contrast to GNP treatment where no such response was observed for up to 24 hours. Both nanoparticles significantly induced the accumulation of secondary metabolites such as, xanthones, benzophenones and anthraquinones along with changes in accumulation of the signaling molecules. GNP induced the accumulation of both jasmonic acid and salicylic acid, while SNP elevated the accumulation of jasmonic acid. Abscisic acid content was reduced after both nanoparticle treatment. Transcriptome analysis revealed that genes associated with apoptosis, ROS, plant defense mechanisms and secondary metabolism were altered by nanoparticle treatment. In summary, our study concludes that *H. perforatum* cells recognize both SNP and GNP as threats and stimulate their defense response in various forms and that SNP plausibly affect cell viability by inducing a severe oxidative stress.