Gold nanoparticles: Their behaviour and effects on marine fish

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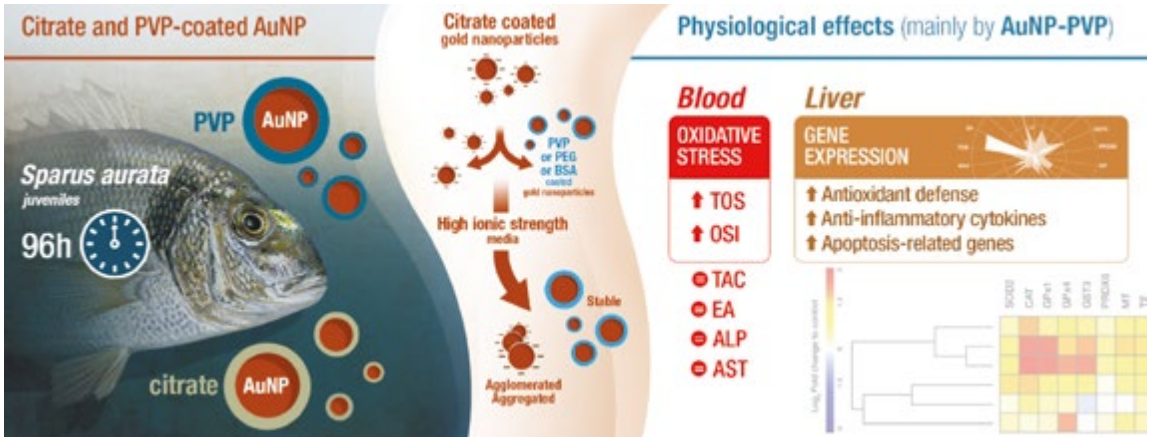

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FIGURE 1/2
Overall *S. aurata* hepatic mRNA response profile to AuNP represented as a heatmap. *sod2* (superoxide dismutase [Mn]), *cat* (catalase), *gpx1, gpx4* (glutathione peroxidase 1 and 4), *gst3* (glutathione-S-transferase 3), *prdx6* (peroxiredoxin 6), *mt* (metallothionein), *tf* (transferrin), *gr* (glutathione reductase), *il1β* (interleukin 1 β), il10 (interleukin 10), *tnfα* (tumour necrosis factor-α), *cox2* (cyclooxygenase 2), *hsp70* (heat-shock protein 70), *grp75* (glucose-regulated protein, 75 kDa), *casp3* (caspase 3), *bax* (Bcl-2 associated X protein).

Information on the potential hazardous effects of the increasingly used engineered nanoparticles is urgently required to ensure human and environmental safety and promote safe use of novel nanotechnologies. Among the most used nanoparticles, gold nanoparticles (AuNP) have been employed in high technology applications that include drug delivery and recently water remediation and aquaculture practices. For these applications, AuNP are coated with different agents that alter their stability and biological interactions. One of the prerequisites for its use is their non-toxic and biocompatible nature but little is known in terms of effects on estuarine/marine organisms. An ongoing collaboration between Aveiro University and Universitat Autònoma de Barcelona is studying the behaviour of AuNP with different surface coatings, under marine conditions, and its effects to economically relevant fish species, such as Sparus aurata (gilthead sea bream). This species, widespread in Atlantic and Mediterranean coastal waters, is one of the most commercially important (fishery and aquaculture) and consumed fish in south Europe.

Overall, data revealed that although citrate coated nanoparticles tend to aggregate in high ionic strength media, some molecules (e.g. polyvinylpyrrolidone, polyethylene glycol, bovine serum albumin) may provide them with stability that allow them to remain in suspension, in the nm size range. AuNP, even with biocompatible coatings and at low concentrations, can alter the expression of antioxidant, immune and apoptosis related genes (Fig. 1), thus presenting a potential impact to marine fish at the molecular level. AuNP may activate the fish hypothalamus-pituitary-interrenal (HPI) axis, reflected by an increased plasma cortisol levels, and thus represent a potential endocrine disrupting threat to fish due to its interference with endocrine function. Further studies are being performed under different conditions to evaluate AuNP impact in the environment and aquaculture facilities to provide information for the safe use of nanoparticles.