Cadmium bioavailability and biochemical response of the freshwater bivalve *Corbicula fluminea* – The role of TiO_2 nanoparticles

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Conservative market estimated 270,041 tons for metal oxide nanoparticles (NPs) in 2012, rising to 1663,168 tons by 2020. TiO_2 NPs ($nTiO_2$) largely account for this estimation with production volumes of approximately 50,000 tons/year [1, 2]. In fact these were the particles with the highest predicted environmental concentrations and risk coefficients in surface water, due to the outstanding numerous applications in a wide range of industries. Their nanoscale properties results in highly reactive and dynamic materials with large potential to adsorb other substances, including trace metals, and thus altering their bioavailability. The role of fine particles as carriers for other substances has been recognized but little research has been conducted on this issue [3].

The bioaccumulation and toxicity of Cd (112 µg L^{-1}) to the freshwater bivalve *Corbicula fluminea* was investigated in absence and presence of two different $nTiO_2$ (0.1-1 mg L^{-1}), P25 (20% rutile + 80% anatase, Evonik) and NA (100% anatase, NanoAmor). A 10 days semi-static bioassay was performed with synthetic freshwater at pH ca. 7.5 and ionic strength 0.01 M. The free Cd concentration was quantified by absence of gradients and nernstian equilibrium stripping (AGNES) technique. Several toxicological endpoints including Cd uptake and antioxidant enzymes activities (catalase, glutathione S-transferase and superoxide dismutase reductase) were quantified. Histological analysis was also assessed.

AGNES results showed that $nTiO_2$ are potential carriers for Cd; 63 and 59% of decrease in free Cd in the exposure solution where obtained after 24h of exposure for NA and P25 NPs, respectively. A linear increase of the internalized Cd was determined as a function of time until the 5th day of the bioassay regardless of the TiO_2 presence, being bioregulated afterwards (Figure 1). The histological analysis showed several changes in the bivalves digestive gland cells mainly in the Cd+$nTiO_2$ binary mixtures but antioxidant parameters did not show decisive responses to the NPs presence.

References

[1] Research and Markets; http://www.researchandmarkets.com/reports/1651709/; **2011**

[2] U.S. Environmental Protection Agency; EPA/600/R-11/097; **2011**

[3] Hartman, N.B., Legros, S., Von der Kammer, F., Hofmann, T., Bauns, A.; Aquatic toxicology, **2012**, 1-8

Figures

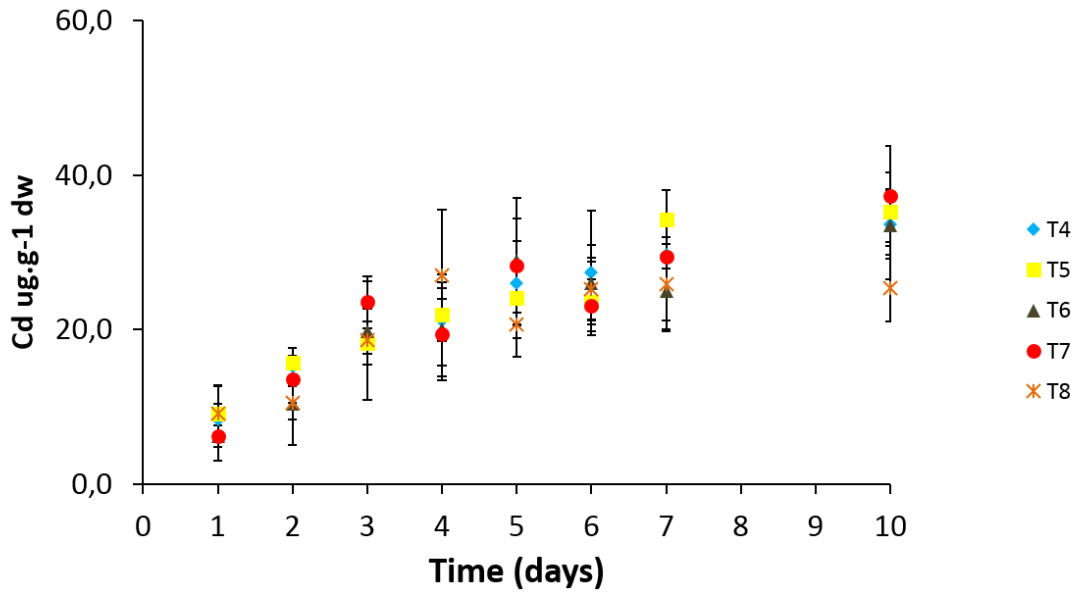

Figure 1 - Cadmium concentration (mean ± SD) in the bivalve soft tissues during the 10 days bioassay. **T4** - Cd (112 µg L^{-1}); **T5** - $nTiO_2$-NA (1 mg L^{-1}) + Cd (112 µg L^{-1}); **T6** - $nTiO_2$-NA (0.1 mg L^{-1}) + Cd (112 µg L^{-1}); **T7** - $nTiO_2$-P25 (1 mg L^{-1}) + Cd (112 µg L^{-1}) and **T8** - $nTiO_2$-P25 (0.1 mg L^{-1}) + Cd (112 µg L^{-1}).