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The use of nanomaterials for water splitting process: a safe solution or a risk for the environment?

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Abstract

Background: Humanity is facing challenges in a modern world of rapidly increasing demand for energy sources. The production of clean energy systems is a major challenge, prompting an urgent need to implement new sustainable technologies that can meet global society's needs. The energy solutions rely on renewable sources, cost-efficient and environmentally friendly such as hydrogen production by water splitting [1]. Efforts have been made to explore catalysts based on transition metal compounds - tungsten oxide (W) [2,3] and recently through nanotechnology with the application of tungsten nanoparticles (WNP) [4]. The use of W compounds results in environmental exposure to this metal. Ecotoxicological studies are limited, and a detailed investigation is crucial to evaluate the effect of this metal on the environment. **Objectives:** The aim of this work is to perform a toxicological comparative study of commercial W (Alfa Aesar) and WNP oxide (Sigma-Aldrich) exposure on terrestrial species (monocotyledonous *Zea mays* and *Avena sativa*, invertebrates (*Folsomia candida* and *Eisenia fetida*) and aquatic species (*Aiivibrio fischeri*, *Raphidocelis subcapitata*, *Lemna minor*, *Daphnia magna*, and *Thamos platyrus*). **Methods:** The tests with terrestrial species were performed with natural regosol (Estarreja, Aveiro, North of Portugal - 40°45′17″ N, 8°34′9″ W) contaminated with each one of the compounds (0 to 1000 mg W kg_{soil}^{-1}), tested individually. **Results:** For aquatic species, the effects of both compounds were tested at concentrations from 0 to 200 mg W L^{-1}. The results demonstrated that W negatively affected the fresh and dry biomass of plant species and the reproductive output of *F. candida*. All aquatic species were significantly affected after exposure to W, except *D. magna.* A reduction of *R. subcapitata* and *L. minor* growth rate, an inhibition of bioluminescence of *A. fischeri* and of *T. platyrus* ability to feed were also observed. **Conclusions:** Environmental safety studies showed risks for all species exposed to W and WNP.

Keywords: sustainable technologies; nanoparticles; transition metal; environmental safety

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