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Oxidative stress and histological changes following exposure to diamond nanoparticles in the freshwater Asian clam *Corbicula fluminea* (Müller, 1774)

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HIGHLIGHTS

- We assess the toxicity of NDs in the bivalve *Corbicula fluminea*.
- Exposure to NDs cause a stress oxidative response.
- Stress oxidative enzymes increase following exposure to nanodiamonds.
- Increase in lipid peroxidation suggests damage in cells membranes.
- Histopathology reveals alterations in digestive gland cells.

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ABSTRACT

Recently, the scientific community became aware of the potential ability of nanoparticles to cause toxicity in living organisms. Therefore, many of the implications for aquatic ecosystems and its effects on living organisms are still to be evaluated and fully understood. In this study, the toxicity of nanodiamonds (NDs) was assessed in the freshwater bivalve (*Corbicula fluminea*) following exposure to different nominal concentrations of NDs (0.01, 0.1, 1, and 10 mg l^{-1}) throughout 14 days. The NDs were characterized (gravimetry, pH, zeta potential, electron microscopy, and atomic force microscopy) confirming manufacturer information and showing NDs with a size of 4–6 nm. Oxidative stress enzymes activities (glutathione-S-transferase, catalase) and lipid peroxidation were determined. The results show a trend to increase in GST activities after seven days of exposure in bivalves exposed to NDs concentrations (>0.1 mg l^{-1}), while for catalase a significant increase was found in bivalves exposed from 0.01 to 1.0 mg l^{-1} following an exposure of 14 days. The histological analysis revealed alterations in digestive gland cells, such as vacuolization and thickening. The lipid peroxidation showed a trend to increase for the different tested NDs concentrations which is compatible with the observed cellular damage.

1. Introduction

The use of nanomaterials such as nanoparticles (NPs) offers new and important opportunities in industrial production, daily consumable products, medicine, biotechnology, electronics, and to other numerous and important commercial areas [1]. Hence, applications of nanomaterials underwent a great increase in the last several years. However, the legislation and regulations concerning nanomaterials applications at the European level did not allow for such a rapid development [2]. Nanoparticles are commonly defined as particles having at least one dimension and size up to 100 nm [3], exhibit specific properties and characteristics that give them a high potential for being used in biomedicine, chemistry, and materials engineering, computing [1,4]. Yet it is precisely their unique characteristics and behavior that make these nanomaterials potentially toxic to living organisms, by increasing chemical reactivity and

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