Chapter 14
Ecotoxicity Effects of Nanomaterials on Aquatic Organisms:
Nanotoxicology of Materials on Aquatic Organisms

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ABSTRACT

The increasing production and use of engineered nanomaterials raise concerns about inadvertent exposure and the potential for adverse effects on the aquatic environment. The aim of this chapter is focused on studies of nanotoxicity in different models of aquatic organisms and their impact. Moreover, the chapter provides an overview of nanoparticles, their applications, and the potential nanoparticle-induced toxicity in aquatic organisms. The topics discussed in this chapter are the physicochemical characteristic of nanomaterials (size, aggregation, morphology, surface charge, reactivity, dissolution, etc.) and their influence on toxicity. Further, the text discusses the direct effect of nanomaterials on development stage (embryonic and adult) in aquatic organisms, the mechanism of action as well as the toxicity data of nanomaterials in different species.f action as well as the toxicity data of nanomaterials in different species.

INTRODUCTION

Nanotechnology is an emerging multidisciplinary science that involves synthesis, characterization, and applications of nanomaterials (NMs). The nanomaterials have been defined as new materials and structures with at least one dimension between 1 and 100 nm. However, related materials of somewhat larger size also show new properties (Dowling et al., 2004). They have attracted a great interest during

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recent years, due to their many technologically interesting properties. Manufactured nanomaterials have numerous industrial applications including electronics, optics, and textiles, as well as applications in medical devices, drug delivery systems, chemical sensors, biosensors, and in environmental remediation. The rapid growth of nanotechnology applications in the past years has increased the release of nanoparticles (NPs) to the environment (Gottschalk & Nowack, 2011). Safe manufacturing and application of nanomaterials are an emerging issue with the bloom of nanotechnology. Understanding the interaction of nanomaterials with the biological system is essential for the realization of their safe applications. The nanoscale size of the particles can confer novel and significantly improved physical, chemical and biological properties (Ogden, 2013).

Experts agree with the fact that the environmental effects of nanoparticles cannot be predicted from the known ecotoxicity of the macroscopic material. Because of the production and use of engineered nanomaterials (ENMs) have increased exponentially during the last years, should be taken into account that these products may have impacts on environmental health. Moreover, in many circumstances, the exposure assessment or potential cannot be quantified, due either to limitations of measurement or because of technological limitations in measuring nanoparticle exposures (Ong et al., 2014). Hence, a new subdiscipline of nanotechnology called nanotoxicology has emerged (Oberdörster, Oberdörster, & Oberdörster, 2005). Nanotoxicology involves the study of the interactions of nanomaterials with biological systems with an emphasis on elucidating the relationship between the physical and chemical properties of nanomaterials with induction of toxic biological responses (Fischer & Chan, 2007). It is noteworthy that the absence of toxicity of the substance in the elemental or molecular state does not mean that the nanomaterial is harmless. The introduction of nanoparticles in aquatic ecosystems will bring about and new potentially toxic interactions in exposed organisms. Although the presence of nanoparticles in the aquatic environment is still largely undocumented, their release could certainly occur in the future and what is worrying is that little is known about of the effect on aquatic organisms or on their possible impacts (Chapman, 2006).

Aquatic ecosystems are one of the main final destinations of the released nanomaterials into the environment although the toxicology of nanotechnology products is virtually unknown. These nanomaterials may have harmful effects on the aquatic organisms, so the study of these effects is of great importance. Aquatic nanotoxicology is the assessment of toxic effects of nanomaterials on aquatic organisms. The NMs will enter, through numerous direct and indirect routes, into the water environment. For this reason, there is an urgent need to address several critical nanomaterials-associated ecotoxicological and environmental risks assessment issues, such as toxicology of NMs to aquatic organisms, the bioavailability, and bioaccumulation of NMs in water environment. Since the amount and diversity of nanomaterial applications increases, concerns about their release into the environment and their impact on natural ecosystems are growing. Evaluating the potential biological impact of nanomaterials has become increasingly important in recent years. This is particularly relevant because the rapid of nanotechnology development has not been accompanied by an investigation of its safety in the environment. The aim of this chapter is focused on studies of nanotoxicity in different models of aquatic organisms and their impact on aquatic ecosystems. The NMs are applied for their specific characteristics resulting from an altered surface area to volume ratio compared to their bulk counterparts.

Preliminary studies report that the NMs can play a role in damaging numerous important biological processes on living organisms. According to a recent report, (Henry et al., 2007) carbon nanomaterials have the highest relative frequency of occurrence in consumer products already on the market and these materials may contaminate the environment in the future. The effects of NMs in the environment