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Abstract

Bioaccumulation Potential of Selenium Nanoparticles †

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Selenium is an essential poison with a very narrow physiological window [1]. In amino acids, selenium replaces sulfur. Proteins including selenium amino acids are more resistant to oxidation than proteins incorporating related sulfur amino acids [2]. Ionic selenium is more than 50 times more toxic than zerovalent selenium [3]. Zerovalent selenium's tendency is to form hydrophobic nanoparticles in aqueous environments. Such hydrophobic nanoparticles are stabilized by amphiphilic biopolymers (e.g., chitosan, various proteins), generating products that are considered effective agents for plant biofortification [3] or aquaculture metabolic regulation [4]. Such applications are related to a high release into the environment of manufactured selenium nanoparticles. The hydrophobic nature of zerovalent selenium can enhance the bioaccumulation potential of the selenium nanoparticles released into the environment. This study aims to evaluate the present knowledge related to the bioaccumulation of selenium nanoparticles. An extensive bibliographic study was done to find and analyze peer-reviewed papers referring to selenium nanoparticles bioaccumulation and biomagnification in sentinel organisms from the aquatic and soil food webs. The study was done using the main databases, Clarivate Web of Science, Scopus, CABI, and PubMed. The comparison was made with the studies done related to the bioaccumulation of ionic selenium. Although several review papers discuss the bioaccumulation potential of selenium nanoparticles, only one experimental research article analyzed the accumulation of selenium nanoparticles in red sea bream (*Pagrus major*) [5]. There is a lack of studies related to the effects of selenium nanoparticles on sentinel organisms from the soil food web—e.g., detritivores such as earthworms and functional guild of nematodes, such as fungal-feeding nematodes, bacterial-feeding nematode, plant-feeding nematodes, and predators and omnivores. There is also a gap in knowledge related to bioaccumulation and biomagnification of selenium nanoparticles in organisms from the aquatic food web and related to the toxicity of selenium nanoparticles. There are plenty of data regarding the toxicity and bioaccumulation of selenium ionic species. It is necessary to determine selenium nanoparticles' toxicity for the aquatic environment primary producers (microalgae), planktonic herbivores, and other herbivores (Crustacea, Mollusca). A dose–response curve needs to be generated for each species bioassay and toxicity endpoints, including no observable effect concentration (NOEC), lowest observable effect concentration (LOEC), EC/LC10, and EC/LC50. Where possible, these data should be used to formulate a species sensitivity distribution (SSD) for the nanoparticles and help provide a holistic assessment of environmental risk for bioaccumulation and biomagnification. There is a deep knowledge gap related to selenium nanoparticle toxicity, bioaccumulation, and biomagnification. This gap needs to be filled. Otherwise, the lack of knowledge related to selenium nanoparticle environmental behavior will hinder the potential application of selenium nanoparticles in agriculture and aquaculture.

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