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Review Article

Review on nanomatricidal toxicity: Its environmental impact.

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Abstract

Microorganisms are of great environmental importance because they are the foundation of aquatic ecosystems and provide key environmental services ranging from primary productivity to nutrient cycling and waste decomposition. Consequently, an understanding of nanomaterial microbial toxicity to microbes is important to evaluate the potential impacts of nano material in the environment. Furthermore, microorganisms are convenient model test organisms because they grow rapidly and are inexpensive to culture; have a high surface-to-volume ratio, making them sensitive to low concentrations of toxic substances; and facilitate studies at many levels ranging from a single biochemical reaction in bacteria to complex ecosystems containing a diversity of microorganisms. Also, it is highly likely that bacteria will influence nonmaterial fate and behavior.
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Keywords: Nanomaterial, particlecidal, toxicity, environment

Introduction

Nonmaterial technology has started gaining recognition related to most science field and technology. Nanomaterial is a material with one dimension under 100 nm SCENIHR, (2007). Nanoparticles (NP) is defined as materials with at least two dimensions between 1 and 100 nm ASTM, (2006) .Nanoparticles have always existed in our environment, from both natural and anthropogenic sources, in air were traditionally referred to as ultrafine particles, while in soil and water they were colloids, with a slightly different size range. In urban atmospheres, diesel- and gasoline-fueled vehicles and stationary combustion sources have for many years contributed particulate material throughout a wide size range, amounting to more than 36% of the total particulate number concentrations Shi et al (2001) .In addition, there is a natural background of NPs in the atmosphere, although the total concentration is low in comparison to potential releases of manufactured nanoparticles. The health effects of such particles are still being investigated with regulatory concerns moving from the traditional PM10 (particles less than 10 μm in aerodynamic diameter) to PM5, PM2.5, and below as increased toxicity.By microbial ecotoxicity tests investigative survival, reproductive capacity, and mutation as well as nonlethal toxicity endpoints could be ascertain Tsai et al (2007) and Tasi et al (2007). Some environmental contaminants can be mutagenic and cause changes in the genetic code of receptor organisms.

Literature describes toxicity of various nanomaterials on microorganisms which are very limited compared to that evaluating the toxicity on eukaryotic organisms; however, the toxic effects of nanomaterials in prokaryotic systems are increasingly being characterized. Silver nano particles and titanium dioxide are among the best-studied nanomaterials with respect to microbial toxicity, such materials are established as antimicrobial agents, and their nanocrys-talline forms may act similarly Matsumura et al (2006).

Toxic effects of nanomaterials on bacteria

Nanomaterial	Toxic effects
C_{60} water suspension (nC_{60})	Antibacterial to a broad range of bacteria
C_{60} encapsulated in polyvinylpyrrolid	Antibacterial to a broad range of bacteria
Hydroxylated fullerene (HTF)	Bactericidal for Gram-positive bacteria
Silver	Bactericidal and viricidal
Gold	Low toxicity to E. coli and *Staphylococ aureus*
Magnetite	Low toxicity to *Shewanella oneidensis*
Tio_2	Accelerates solar disinfection of *E. coli* through photocata-lytic activity and reactive oxygen species (ROS); surface coatings photocatalyt Antibacterial activity against *B. sutbilis* and *S. aureus* oxidize *E. coli,*
Mgo	*Micrococcus, B. subtilis,* and *Aspergillus niger*
CeO_2	Antimicrobial effect on *E. coli*
ZnO	Antibacterial activity against *E. coli* and *B. subtilis*
SiO_2	Mild toxicity due to ROS production

The bactericidal effect of silver compounds and silver ions is well known and has been applied in a wide range of disinfection applications from medical devices to water treatment wolfrum et al (2007). While there is probably a particle effect, release of silver ions has been proposed as one of the toxic mechanisms of silver nanoparticles. Nano-TiO_2 in water treatment membranes inhibits fouling by *E. coli* when the system is placed under ultraviolet illumination kwak et al (2007) Furthermore; antiviral properties of nanomaterials have also been reported. Nonlethal effects, such as inhibition of enzymatic activities, have been described in some cases liu et al (2004) , Tsai (2007) .The objectives of this review are to introduce the key aspects pertaining to nanomaterials in the environment and to discuss what is known concerning their fate, behavior, disposition, and toxicity, with a particular focus on those that make up manufactured nanomaterial.

There have been very few comprehensive studies of nano material impacts on environmental microbial communities. Only a few representative materials have been tested under controlled conditions, and specific dose–response data are not always reported. The synergistic or antagonistic effects of mixtures have not yet been investigated.

Nano microbes on freshwater invertebrates and their primary producers

In aquatic systems, colloid is the generic term applied to particles in the 1-nm to 1-µm size range. The natural nanomaterial fraction has been identified as being of particular concern because of the changes that occur in this size range, although the most important size range in terms of environmental processes is not well defined. Aquatic colloids comprise macro-molecular organic materials, such as humic and fulvic acids, proteins, and peptides, as well as colloidal inorganic species, typically hydrous iron and manganese oxides. Their small size and large surface area per unit mass make them important binding phases for both organic and inorganic contaminants. Additionally, high surface energy, quantum confinement, and conformational behavior are likely to be important, although discussion of these parameters currently remains qualitative because of the complexity of colloids or nanoparticles, Oberdorster et al, (2006). Although dissolved species are operationally defined as those that pass through a 0.45-µm filter, this fraction also includes colloidal species whose bioavailability is quite different from truly soluble organic or ionic metal species oberdorster et al, (2006).

Most of the work assessing the effects of nanomaterials in fresh-waters to date has focused on a narrow range of compounds and test species. Invertebrates have been the most commonly used organisms with little published work carried out as yet on vertebrates, primary producers, and unicellular freshwater organisms. Invertebrates have been used for a number of reasons:
The earlier published studies on freshwater invertebrates focused mainly on crustaceans, with *D. magna* being the most studied test species. Lovern and Klaper (2006) exposed *D. mag-na* to C_{60} or TiO_2 . The particles were treated to break up the aggregates either by sonicating in medium for 30 min or by treatment with the organic solvent THF. Both the TiO_2 and the C_{60} particles were more potent at killing the organisms when prepared in tinehydroxylated fullerene (THF) than when prepared by sonication, and the C_{60} was more potent than the TiO_2.

Nano microbes on freshwater vertebrates (fish)

According to Oberdörster et al. (2006) using juvenile largemouth bass was the first nonhuman, nonrodent vertebrate study on NP toxicity to be published. The fish were exposed to 0.5 and 1 mg/L nC_{60} for 48 h and were found to exhibit signs of lipid peroxidation in the brain., Zhu et al.(2006) demonstrated that Tinehydroxylated fullerene (THF)-pre-pared C_{60} induced 100% mortality within 6 to 18 h of exposure in adult fathead minnow (*P. promelas*). Conversely, nC_{60} generated by water stirring had no impact on lethality over the same time period, although lipid peroxidation was observed in the gill, suggesting oxidative damage as well as a significantly increased expression of cytochrome P2 family isoen-zymes in the liver as compared to control fish. Results of Zhu et al. (2006) again suggest that the method of preparation can increase toxicity.

Similarly to some of the studies with invertebrates, Kash-iwada (2006) studied the uptake and fate of nanomaterials in a vertebrate test species. Eggs and adult fish were exposed to fluorescent polystyrene particles of a wide size range. Results suggest rapid uptake and translocation across the different organs, as suggested by previous work with invertebrates. A thiobarbituric acid-reactive substances test was carried out to assess relative amounts of lipid peroxidation products to detect any effects of the exposure on oxidative stress. Results demonstrated dose-dependent and statistically significant decreases especially in the gill, brain, and liver.

Effects of Nanomaterials on Soil and Soil Ecology Organisms

In soils, natural nanoparticles include clays, organic matter, iron oxides, and other minerals that play an important role in bio-geochemical processes. Soil colloids have been studied for decades in relation to their influence on soil development (pedogenesis) and their effect on soil structural behavior Cameron, (1915). Particular relevance to manufactured nanomaterials, soil colloids and other porous media may facilitate the movement of contaminants in soils and other porous media. Contaminants sorbed to or incorporated into colloids can be transported when conditions for colloidal transport are favorable. For example, natural soil colloids have been found to be vectors for transport of metals through soil profiles.

One of the difficulties of measuring nanoparticle toxicity in soils is ensuring the homogeneous mixing of nanoparticles with soil test media. Where nanoparticles can be made into a stable suspension, dosing can take place by spraying the nanoparticls evenly onto soil and mixing thoroughly. Problems may occur at high dose levels where stability of the nanoparticle suspensions may be compromised (aggregation), and repeated addition of lower doses, coupled with drying of the soil between dosing, may be needed. Where dry nano sized powders are mixed with soil, heterogeneity becomes a major problem if sub sampling of the soil batch is performed later for ecotoxicological analysis. This may be minimized by mixing the nanoparticle with an inert carrier powder having a particle size closer to the nanoparticle size compared to sieved soil, such as talc, although appropriate controls are needed to confirm that the inert carrier has no adverse toxicological effect on the endpoint in consideration. Identification of nanoparticles in soil requires the separation of the particles from the soil solid phase, desorption and their dispersion into an aqueous suspension so that the techniques outlined previously can be used to identify the nanoparticles extracted. Nanoparticles have high surface reactivity, and, depending on surface charge and coatings, their adhesion to reactive soil surfaces may be strong.

Conclusion

Nano matricidal effect cut across all sphere be in aquatic or terrestrial .This colloidal energetic particle in nature coming from man activities brownian the aquatic and terrestrial ecological had been found to have lethal effect on ubiquitous microorganisms found in association .This review is to pose to the food scientist, microbiologist and food processor that this ionic, molecular particulates should be tailored to achieve an ordered entropy of the environment.

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