CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

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Project Number

S1406

Project Title

Modeling the Toxic Effects of Silver Nanoparticles under Varying Environmental Conditions

Abstract

Objectives/Goals

With an increased surface area to volume ratio, silver nanoparticles exhibit a more efficient antimicrobial potential than its metallic counterpart, silver ions. The abundance of silver nanoparticles in the consumer market, however, increases the risk of environmental exposure. This investigation attempts to model and quantify the toxicity of silver nanoparticles under varying environmental conditions and to measure the toxicity of nanosilver in a model consumer product.

Methods/Materials

Preliminary experiments conducted under varying interaction times and particle concentrations determined the optimum time and condition for the assay. From this, a novel, high-throughput bacterial toxicity assay was developed. Toxicity, redefined as the percentage of dead cells that died in excess to that of the natural death of cells, was subsequently quantified using the live to dead cell fluorescence intensity ratio. A water filtration system was developed to provide a practical application of the bacterial toxicity assay to a model consumer product containing silver nanoparticles.

Results

From the preliminary experiments, the optimum interaction time between the surrogate bacteria and the silver nanoparticles/silver ions was determined to be approximately 3 hours. The bacterial toxicity assay showed that silver nanoparticles and silver ions induce equal toxic effects on the environmental bacteria; yet, they induce a greater toxicity in gram-negative bacteria than in gram-positive. Finally, the practical application of the water filtration system revealed the potential risks of using nanosilver consumer products.

Conclusions/Discussion

The conclusions of this investigation demonstrated three essential concepts. First, this novel bacterial toxicity assay technique is a reliable, reproducible approximation of the potential toxicities of silver nanoparticles. Secondly, the toxicity assay revealed that the silver nanoparticles induce high toxic effects, including overwhelming cell death and cell inactivity, in a relatively short period of time. Finally, the practical application of the toxicity assay substantiates the known efficacy of silver nanoparticles, but questions the reliability of using nanosilver consumer products. This investigation took fundamental steps toward understanding and quantifying the potential environmental consequences and risks of using nanoparticles.

Summary Statement

This investigation attempts to model and quantify the toxicity of silver nanoparticles on various surrogate environmental bacteria and to measure the potential toxicity of nanosilver in a model consumer product.

Help Received

Mentored by Dr. Eric Hoek; Used lab at UCLA under supervision of Jin Xue and Xiaofei Huang; Advised by Peter Starodub