CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Sumit Mitra

Project Number
S0899

Project Title
The Environmental Implications of Nanotechnology

Abstract

Objectives/Goals
When Fullerene-based Nanoparticles (FNPs) undergo photoexcitation from the sun they produce toxic reactive oxygen species (ROS). The objective of this study was to investigate the environmental impact of this toxicity.

Methods/Materials
FNPs were placed into the ten different environments and vials were made for each time step. The first time step (t-1) was the starting point, i.e., (t-1 = 0 day). After two weeks, time step two (t-2=14 days) was tested and one month after that, time step three (t-3= 30 days) was tested. Using high performance liquid chromatography, the degradation of an organic compound was tracked. Also, stock solutions of E.coli were prepared and tested with nanoparticles to determine if the particles were toxic to the bacteria. Viruses were then tested in 3 scenarios: First, viruses with no nanoparticles were exposed to UV-A to see if the virus was inactivated. Second, viruses were mixed with nanoparticles but were not exposed to UV-A light. Third, nanoparticles were added to viruses and were exposed to UV-A light.

Results
t-2 and t-3 data revealed that samples which contained humic acid seemed to have a greater inhibitory effect on all nanoparticles than samples without humic acid. It appeared that sample with FNPs + MgCl2 + humic acid had the greatest inhibitory effect on the generation of singlet oxygen compared to the other environments. In creek water samples, the generation of singlet oxygen by both single and multi walled carbon nanotubes was negligible. Fullerol still produced singlet oxygen in the creek water because it was dispersed in the sample better than the other nanoparticles. For viruses, the T7 phage was highly resistant to inactivation by UV-A, indicated by insignificant inactivation rate constant 0.000 min-1.

Conclusions/Discussion
It was observed that in the presence of salts, nanoparticle aggregation increased, and ultimately reduced ROS generation. Furthermore, it was noted that humic acid seemed to inhibit ROS production. In addition, because of its low concentration, it was evident that FNPs had limited inactivation on the virus. From this it was concluded that the toxicity of nanoparticles may not be too damaging if released in low concentrations into the environment. However, further research needs to be conducted on the ecological impact of the aggregation of these nanoparticles to fully assess how safe FNPs are.

Summary Statement
This project investigates the effect of photosensitization of Fullerene-based Nanoparticles on reactive oxygen species generation and toxicity to viruses in various aqueous environments

Help Received
Dr. Mark Wiesner, Prof.- Duke University gave me the opportunity to work in his lab and provided the guidance needed to carry out this project ; Dr. Appala Raju Badireddy helped me with virus testing ; Jeff Bardner guided me on the day to day work in the lab ; Parents helped me with the supplies ; My science