CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S1705

Project Title

Characterizing the Toxicity of Copper Nanoparticles on Environmental Microorganisms

Abstract

Objectives/Goals

To accurately assess the impacts of ever-increasing inputs of copper nanoparticles on the environment, it is important to explore their interactions with microbes, which are at the foundation of all ecosystems, serving as primary producers and drivers of global nutrient cycles. Chlamydomonas reinhardtii is a photosynthetic unicellular freshwater microalgae. It serves as the primary producer of many freshwater ecosystems. The objective of this project is to evaluate the interaction of metallic copper nanoparticles with Chlamydomonas reinhardtii in order to understand fate and toxicity of nanoparticles in the environment.

Methods/Materials

Chlamydomonas reinhardtii cultures were grown in Tris Acetate Phosphate medium at 25 degress Celsius under 16h:8h light:dark cycle. Culture samples were transferred twice each, then taken from the mid-logarithmic growth phase and exposed to copper nanoparticle concentrations ranging from 0.098 to 100 mg/L or equivalent concentrations of copper ions derived from CuCl(2). CellTiter-Glo was added to the cell solution after incubation, and the cells were placed in a 384 well plate. Bio-luminescence was taken through high-throughput screening, and the logarithmic graph of ATP concentration was plotted. Chlorophyll concentration measurements were derived from optical density readings of cultures exposed to 20mg/L copper nanoparticles and copper ions.

Results

Chlorophyll, ATP concentration, and photosynthetic yields of algal viability declined with increasing dose, confirming that copper nanoparticles were toxic to algae. The average IC50 value for copper nanoparticles were 20mg/L, while those for copper ions were 15 mg/L, which are comparable. Thus, the results indicate that copper nanoparticles are primarily toxic due to the release of copper ions.

Conclusions/Discussion

Copper is critical for photosynthesis because deficiency causes chlorosis of chloroplasts, while excess copper is toxic to photosystem II. This project proposes a rapid and efficient method for assaying growth and viability counts of algae by utilizing novel high-throughput screening process. In summary, this research provided a foundation for understanding copper nanoparticles impact on environmental microbial communities as well as management of the global aquatic carbon cycle.

Summary Statement

This project investigated the toxic effects of copper nanoparticles on the carbon cycling microorganism Chlamydomonas reinhardtii

Help Received

Mentored by Dr. Shaily Mahendra of UCLA, Environmental Engineering; Used lab at UCLA under supervision of Melissa Spitzmiller; Advised by Mr. Peter Starodub