CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S1796

Project Title

The Effect of Ammonium on Silver Nanoparticle and Silver Ion Induced Inhibition of Nitrosomonas europaea

Abstract

Objectives/Goals

Silver nanoparticles (Ag-NP) and silver ions (Ag+) have been shown to inhibit the nitrite production of ammonia oxidizing bacteria, a discovery that can affect the efficacy of wastewater treatment plants. The purpose of this study is to analyze the influence of an ion commonly found in wastewater, ammonium (NH4+), on silver nanoparticle and silver ion induced inhibition of the ammonia-oxidizing bacteria N. europaea, and subsequently determine whether Ag-NP or Ag+ more significantly impacts the bacteria's inhibition when in contact with NH4+.

Methods/Materials

Two separate experiments were run to compare the effect of NH4+ on the toxicity of Ag-NP and Ag+ to N. europaea. The first evaluated the change in nitrite production of N. europaea when exposed to a constant concentration of Ag-NP and varying concentrations of NH4+. The second evaluated the change in nitrite production of N. europaea when exposed to a constant concentration of Ag+ and varying concentrations of NH4+. Triplicates of eleven treatment conditions were tested per experiment, with NH4+ concentrations ranging from 0 to 50 mM. Samples of each triplicate were taken every 45 minutes over a 3 hour testing period. The nitrite production of each condition was measured through a colorimetric nitrite assay at an optical density of 540 nm via UV-Visible spectrophotometer.

Results

As the concentration of NH4+ increased in triplicates containing N. europaea and Ag-NP, nitrite production significantly decreased. Contrastingly, as the concentration of NH4+ increased in triplicates containing N. europaea and Ag+, nitrite production remained fairly constant.

Conclusions/Discussion

These trends suggest that NH4+ attaches to and pulls off the Ag+ that coat the surfaces of Ag-NP to form a silver amine complex, which is just as toxic to N. europaea. Ag+ then quickly regenerate on the surface of the nanoparticle. However, in the second experiment, because there is a limited amount of Ag+ free in solution, even though silver amines form, the overall toxicity remains constant despite varying concentrations of NH4+. This research suggests that Ag-NP would be more toxic in an environment with high concentrations of ammonium rather than in one with low concentrations; it provides a footing for understanding the effects of constituents in wastewater on the toxicity of Ag-NP and Ag+, as well as on the overall efficiency of wastewater treatment plants.

Summary Statement

To analyze the effect of ammonium on silver nanoparticle and silver ion induced inhibition of the ammonia-oxidizing bacteria N. europaea.

Help Received

Mentored by and used lab equipment under the supervision of Dr. Tyler Radniecki, SDSU.