CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
31941

Project Title
Evaluation of Hydrogenase on Hydrogen Production by Cyanobacteria

Abstract

Objectives/Goals
The declined fossil fuel availability and carbon dioxide induced global warming prompt the research of alternative energy sources. Hydrogen gas is an environmentally clean source that is both efficient and renewable.Commercially viable hydrogen production can be produced by cyanobacteria, and is controlled by both nitrogenase and uptake hydrogenase. Hypothetically, the species with the lowest content of hydrogenase will have the highest hydrogen production.

Methods/Materials
There are three spheres of hydrogen production analyzed in this project, including the growth curve over eight days, the amount of hydrogen produced (in microliters), and the relative amount of uptake hydrogenase enzyme in each of the three species of cyanobacteria: Synechococcus PCC 6830, Anabaena PCC 7120, and Nostoc PCC 73120. Procedurally, the cyanobacteria were grown in BG-11 liquid media in lighted conditions, hydrogen gas was collected using a water displacement mechanism, and uptake hydrogenase was purified from the total protein of cyanobacteria through elution. The relative amount of enzyme was quantified by reducing methylene blue with the uptake hydrogenase from each species, and calculus was used to determine the average rate of reduction.

Results
The results of these experiments prove the inhibitory activity of the uptake hydrogenase enzyme in hydrogen production by cyanobacteria, and confirm the hypothesis.Anabaena grew the fastest, followed by Nostoc and then Synechococcus. Anabaena produced the most hydrogen, compared to Synechococcus and Nostoc, over 48 hours. Moreover, the uptake hydrogenase enzyme in Anabaena reduced the least amount of methylene blue, indicating the lowest amount of uptake hydrogenase in Anabaena's cells.Thus, Anabeana produced the highest volume of hydrogen and had the lowest amount of hydrogenase in its cells.

Conclusions/Discussion
All three cyanobacteria species produced hydrogen gas, yet uptake hydrogenase was found to be inhibitory to net production. In the future, the activity of the uptake hydrogenase enzyme can be repressed, either by competitive inhibition or decreasing the enzyme production in the cell, thus causing increased hydrogen production that is commercially feasible. Such a system producing efficient, green hydrogen production can potentially be tapped as the next biofuel.

Summary Statement
In this project, hydrogen gas is collected from 3 cyanobacteria species, uptake hydrogenase is purified from protein content, & the effect of hydrogenase on H2 production is analyzed, leading to the potential of using H2 as the next biofuel

Help Received
Mr. Chan fed my curiosity and mentored me; Dr. Jung-Gun Kim, postdoctoral scholar, taught me critical lab techniques, and I used lab equipment at Mudgett Lab, Department of Plant Biology, Stanford University under the supervision of Dr.Mary Beth Mudgett.