CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

S1716

Project Title

A Novel Approach to Sustained Hydrogen Production by Cycling Photosynthetic Stages in Chlamydomonas reinhardtii

Abstract

Objectives/Goals

Chlamydomonas reinhardtii algae are a potential means for producing renewable hydrogen gas. However, current methods to produce hydrogen using these algae are inefficient, costly, and unsustainable. Hydrogen production will either occur only in the light or the dark depending on the initial media conditions. The purpose of this project is to determine the effect of sulfur deprivation on light and dark cycles of hydrogen production. The objective is to produce hydrogen for sustained amounts of time in changing dark and light conditions. It is hypothesized that the dark phase will induce anaerobic conditions, but hydrogen production in the light will be low due to adverse effects of sulfur deprivation in dark anaerobic conditions.

Methods/Materials

Algae were cultured in TAP media with varying low concentrations of sulfur and sealed. They were grown in the light for a 48 hour growth phase. Then, they were placed in the dark for 24 hours. Hydrogen and oxygen concentrations were measured at the end of the dark phase. They were then placed in the light for 72 hours and gases were measured once again. Throughout the experiment, chlorophyll density and sulfur deprivation were measured spectrophotometrically.

Results

Hydrogen production in the dark phase was significantly greater in sulfur concentrations of 60.7 and 80.9 uM, with 80.9 uM producing the greatest concentration of hydrogen. There was no dark hydrogen production in the sulfur-free and 20.2 uM groups. Significant amounts of hydrogen were produced in the light for all groups except the sulfur-free group.

Conclusions/Discussion

Under sulfur stress, hydrogen is still produced in both the dark and the light. Extended dark and light phases in only the 40.4-60.7 uM sulfur range enable optimal hydrogen production. Additionally, algae survive for at least 120 hours after the initiation of the light phase, which gives a total of at least 144 hours of potential hydrogen production. This project proposes an efficient means of producing hydrogen gas using sulfur limitation with dark and light phases. Additionally, an application of this project would produce hydrogen in both the night and day, essential for sustained energy production.

Summary Statement

This project developed a novel method for producing significant amounts of hydrogen in both the dark and the light using algae, enabling sustained hydrogen production for large scale energy purposes.

Help Received

Used lab space and equipment of Dr. Arthur Grossman of the Carnegie Plant Biology Department at Stanford under the supervision of Dr. Wenqiang Yang.