CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34865

Project Title

Performance of a Plant Microbial Fuel Cell with Oryza sativa

Abstract

Objectives/Goals

To construct a fuel cell that utilizes microbes and plants to produce energy. To analyze and compare the energy production of fuel cells consisting of Enterobacter cloacae (bacteria) only, Oryza sativa (rice) only, and both bacteria and rice. We predicted that the one with E. cloacae and O. sativa (a plant-microbial fuel cell) would generate the most electricity.

Methods/Materials

We constructed three fuel cells in aquarium tanks: one consisted of only E. cloacae and soil (tank 1), a second consisted of only Oryza sativa and soil (tank 2), and a third consisted of all three (tank 3). Carbon cloths were placed in the anode to pick up the electrons, agar salt bridges were used to transfer electrons from the anode to the cathode, and graphite rods were placed in a potassium chloride solution to build the cathode. All three fuel cells were subjected to the same conditions. We allowed each tank to run for 60 seconds while measuring the voltage with a digital multimeter and various resistors. To analyze the collected data, we used the voltage and resistance to calculate the wattage produced.

Results

We tested resistors with 9000, 24000, and 61000 ohms. Respectively, tanks 1, 2, 3 produced a maximum of 2714.4 nW, 3054.4 nW, and 4220.7 nW at 9000 ohms resistance. Trials with the 24000 ohm resistor and the 61000 ohm resistor produced similar results, where tank 3 had a significantly higher energy output than the others. The voltage decayed as time progressed. Tank 3 produced both a higher initial and final voltage. Plants provide a constant supply of nutrition for the bacteria and would therefore explain why the bacteria would produce more electrons in this communalist relationship.

Conclusions/Discussion

Tank 3 (both bacteria and rice) produced the most watts, followed by tank 2 and tank 1. We predicted that a fuel cell in which plants and microbes cooperate would be more efficient and effective, and our data proves that the hypothesis was correct. Potentially, this technology could be implemented in rice paddies, as the plants are not harmed in any way. If modified further to be more efficient, plant microbial fuel cells show promise for real world applications.

Summary Statement

Our project determines and analyzes the electrical output of a fuel cell with electrochemically-active bacteria and rice plants.

Help Received

Mrs. Messenger (teacher) helped with materials and procedure as well as monitoring our progress; Mr. Messenger helped with electrical calculations; Mr. Jan Arends provided research articles and references