The Effect of Various Bacteria on *Thinopyrum Intermedium* Plant-Microbial Fuel Cell Output

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I. Introduction

In 2006, alternative energy sources provided less than 15% of the total energy supply for the human society [1].

A plant-microbial fuel cell utilizes living plants and bacteria to generate electricity. Most photosynthetic waste ends up as rhizodeposists that release electrons when oxidized by bacteria. These electrons can be harvested [2,3].

Wheatgrass, *Thinopyrum intermedium*, was selected as the root system is similar to rice, it grows hydroponically, and consistently hosts large colonies of microbes [4]. This concept provides the basis for this study.

Three bacteria were utilized in this study: *Pseudomonas fluorescens*, which is a biocontroller (symbiotic with plants); *Enterobacter cloacae,* which is exoelectrogenic (releases more electrons); and *Serratia liquefaciens,* which has both traits. The purpose of this experiment was to find which bacteria would produce the most power when paired with *T.int*. It was hypothesized that *S.liq* would produce more power when paired with *T.int* than the other species of bacteria.

II. Methodology

The bacteria were used as monocultures grown among the roots of *T.int* as the three variables. *T.int* seeds were germinated using a sterilized germination chamber. Once germinated, the seeds were planted on growth pads under three cool white lights; 6 x 12 inch polyester plant pads were autoclaved, then immediately transferred into each tray. Two days after planting, 0.2 mL of the bacteria broth was pipetted onto each seed's roots. The positive control was *T.int* grown on unsterilized soil of equal dimensions to a growth pad, and the negative control was *T.int* grown on a growth pad with no bacteria. A fuel cell was created in each tray by placing carbon sheet (cathode) and a graphite rod (anode) at opposite ends of the pad/soil.

III. Measurement

The tray assay consisted of measuring the voltage and resistance of each tray using two separate multimeters simultaneously. Each was connected to the anode and cathode. Data was collected daily for 10 days, starting 24 hours after the addition of bacteria to the system.

After these 10 days, the plants were considered mature and ready for the single plant assay. This assay consisted of measuring the voltage and resistance of single, isolated plants on a sterile, non-conductive surface with multimeters connected to two roots at opposite ends. Each plant constituted a single trial.

In the height assay, the average plant height in each tray was measured every other day in centimeters.

Data from the tray and single plant assays was calculated to power (1) and current (2). V=Voltage (Volts), R=Resistance (Ohms), P=Power (Watts), and I= Current (Amperes)

$$V^2 / R = P \quad (1)$$

$$V / R = I \quad (2)$$

Statistical analysis was run in SPSS 20 and included the means of all trials ± SDs, with a One-way Anova test using a post hoc Scheffe with a P-Value of <0.05 to determine significant differences between groups.

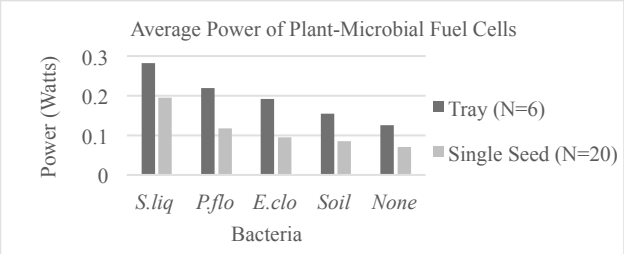

Figure 1. Graph comparing the power averages of all trials of both the tray and single plant assays. Significant differences were found between all monocultures with both controls, and between the *S.liq* and all test groups in both assays.

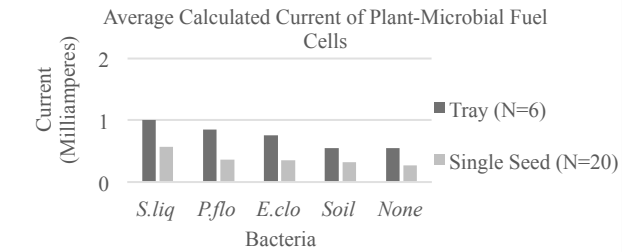

Figure 2. Graph comparing the current averages of all trials of both the tray and single plant assays. Significant differences were found between all monocultures with both controls, and between the *S.liq* and all test groups in both assays.

IV. Results

It was found that *S.liq* had significantly greater power and current production than other groups. Voltage among all groups was similar; no significant differences were found.

Results showed that the *S.liq* and *P.flo* units had significantly taller plants than all other groups.

V. Discussion

This study showed that *S.liq* yielded the most power and current when paired with *T.int*. The results show that resistance and current are the main modifiers of the power output; there were no significant differences among voltage, but the calculated current had very similar trends and significant differences to the power results for both the single plant and tray assays. Plant height was used to show that biocontroller properties of *P.flo* and *S.liq* were interacting with the *T.int*.

VI. Conclusion

The hypothesis was supported; *Serratia liquefaciens* was most effective in producing power in *Thinopyrum intermedium* plant microbial fuel cell. Although the *Pseudomonas fluorescens* and *Enterobacter cloacae* were able to increase the power output in comparison to the controls, the *S.liq* addition was more effective in doing so; it can thus be concluded that *S.liq* can be added to plant microbial fuel cells to increase power and current output as well as plant growth.

Acknowledgments

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References

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