

# Engineering of a Novel Plant Microbial Fuel Cell to Increase Electric Potential and Power Output Using *Thinopyrum intermedium*

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## Introduction

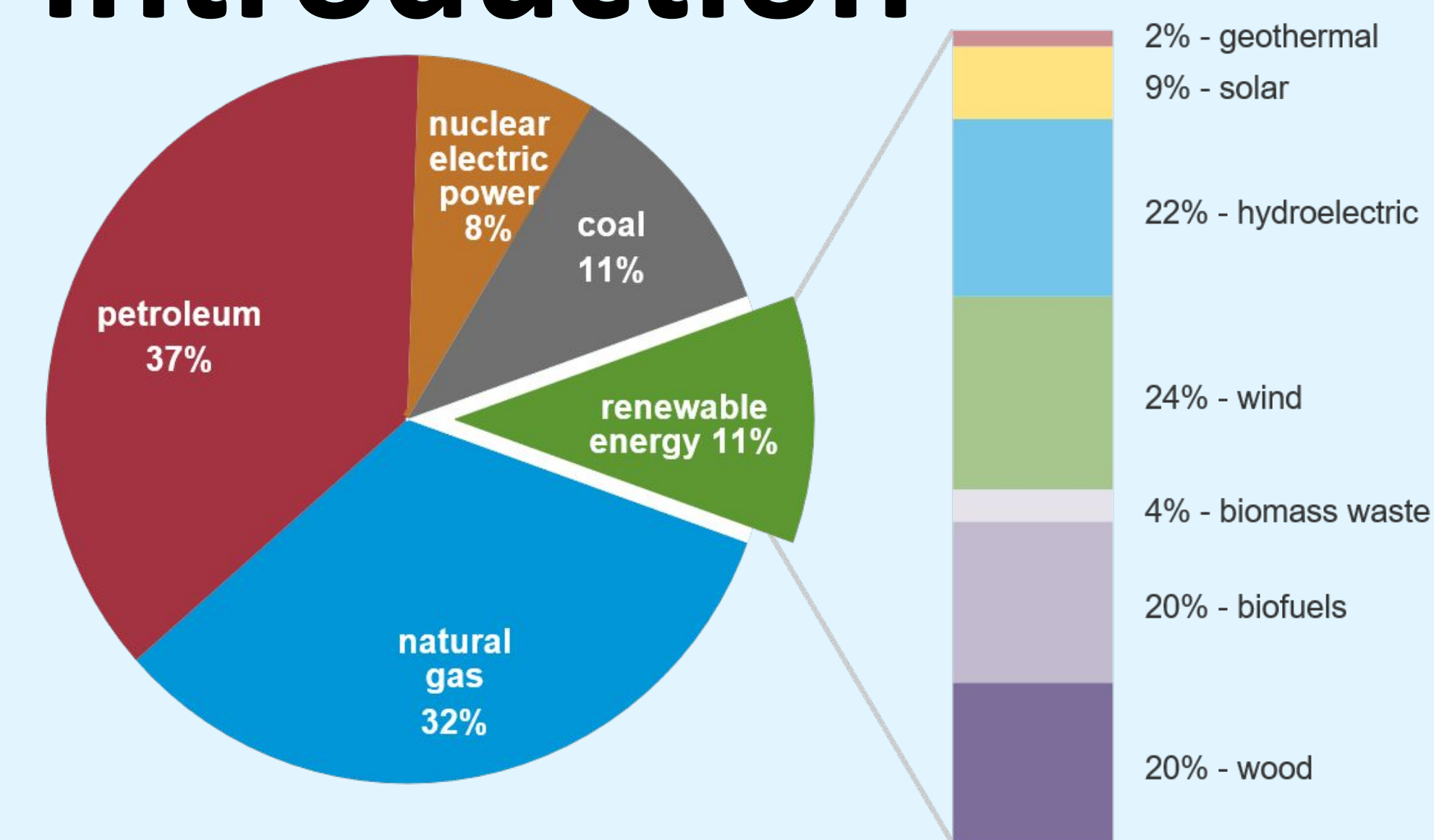


Figure 1: Distribution of energy sources for energy consumption in the United States (EIA, 2019)

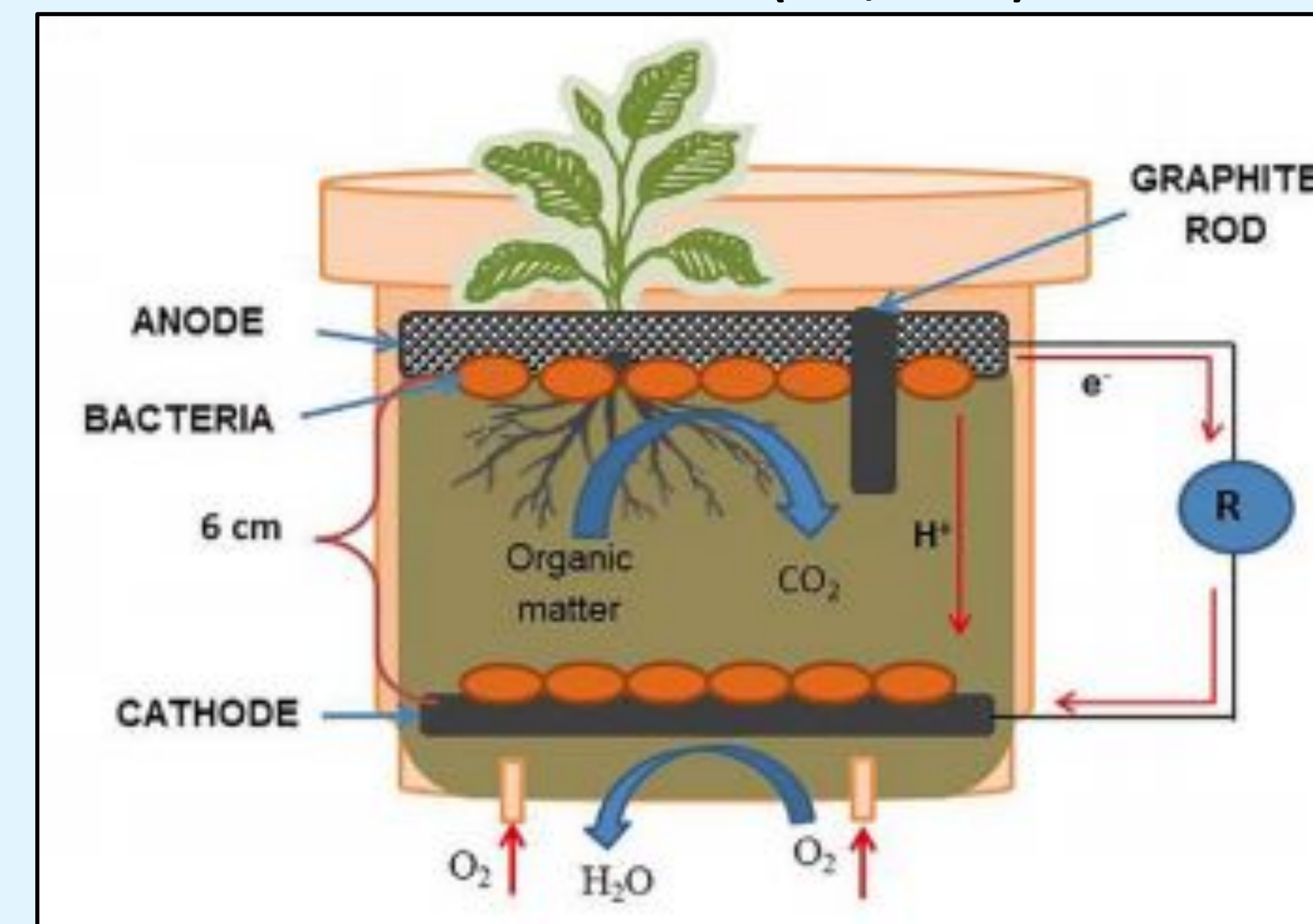


Figure 2: Diagram of a standard plant-microbial fuel cell (Tapia et al., 2011)

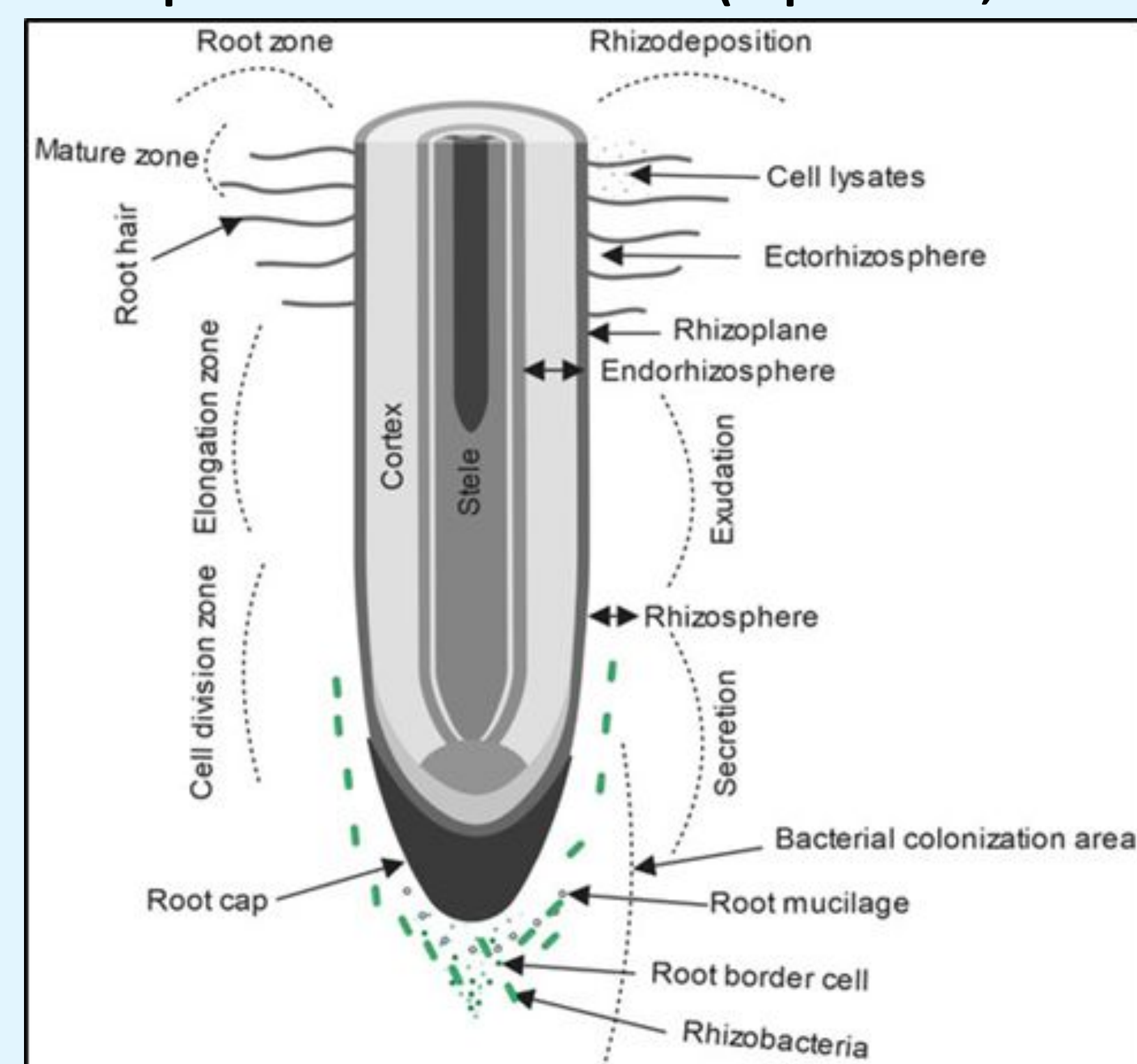


Figure 3: Diagram of rhizodeposition through a root cross-section (Hassan et al., 2019)

## Methodology

### Phase 1: Determination of Optimal Concentrations and Ratios

**Experimental Setup:** Different concentrations of each substance was determined through using purchased MudWatts. *Escherichia coli* K12 was first cultured and transferred into luria broth and was set to grow for two to three days. A spectrophotometer was used to measure the optical density under the  $\lambda 600$ . After, *E. coli* K12 was micro-pipetted onto the anode of the fuel cell. Different concentrations and ratios of coffee grounds, phenylacetic acid, and urea were mixed into soil (pre-sifted to  $<0.2\text{mm}$  pore size). The preminent concentration or ratio was determined through the best power output gained.

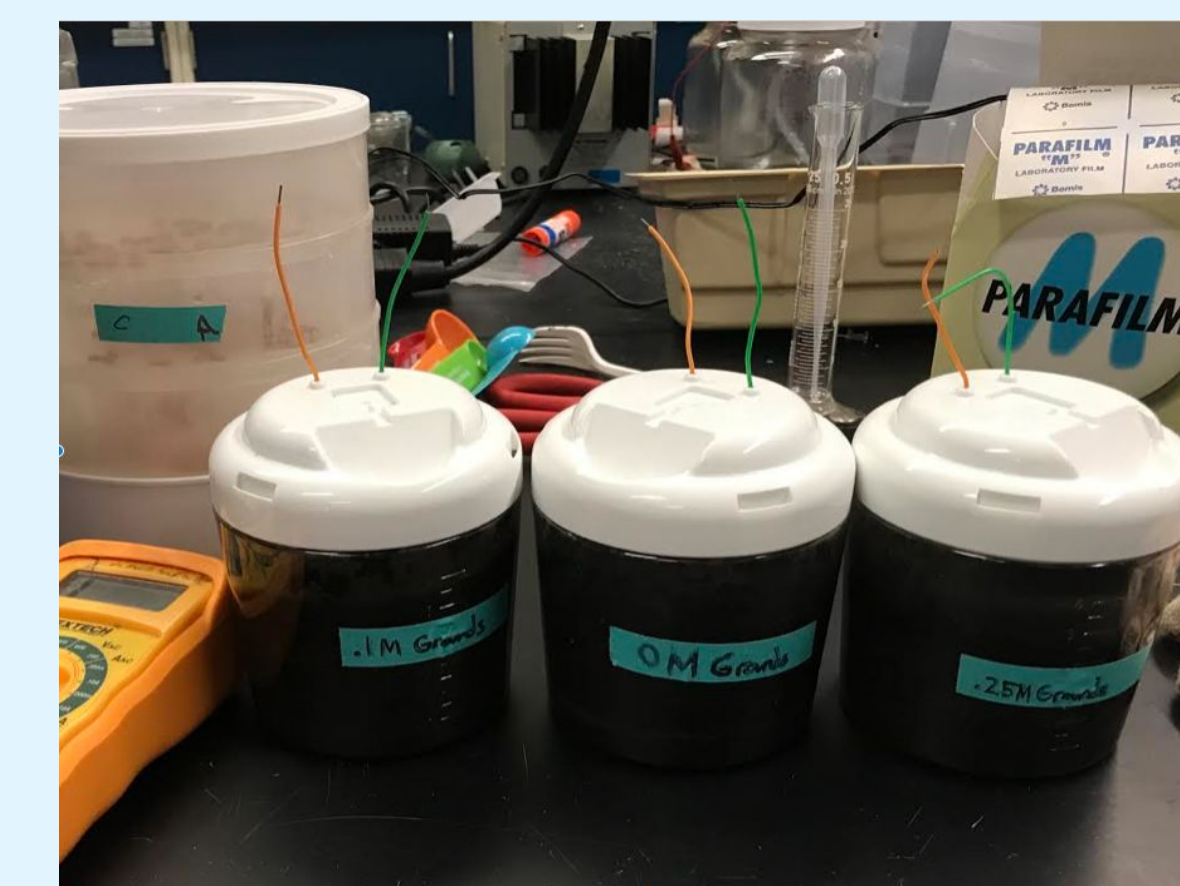
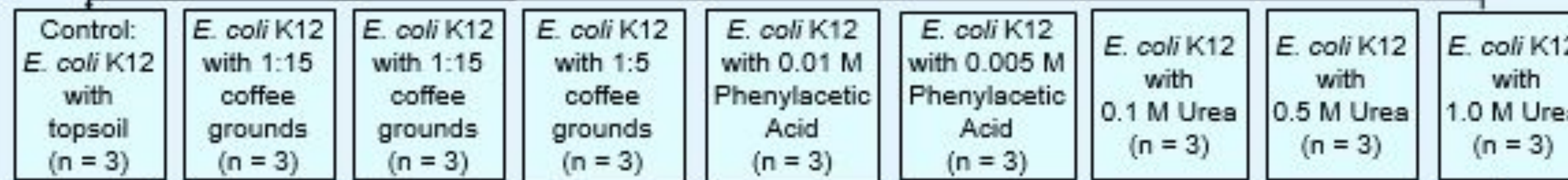


Figure 4: Three MudWatts used (photo by author)



Voltage and amperage were collected using a multimeter for 5 days. Power and current density were calculated.

### Phase 2: Creation of the Novel P-MFC and Experimentation of Concentrations and Soil Porosity Within the System

**Experimental Setup:** The Novel P-MFC was created via Computer Software CAD. Plastic pots (10.16 cm) were altered based on the generated design. Plastic felt was cut to match the radii of the bottom and top of the pots and acted as the anode and cathode. In the Novel P-MFC, the membrane was placed between the cathode and side of dirt and wire (1 ohm resistance) connected the system. A clear top was placed over the system. *Thinopyrum intermedium* was planted after soil was placed above the anode.

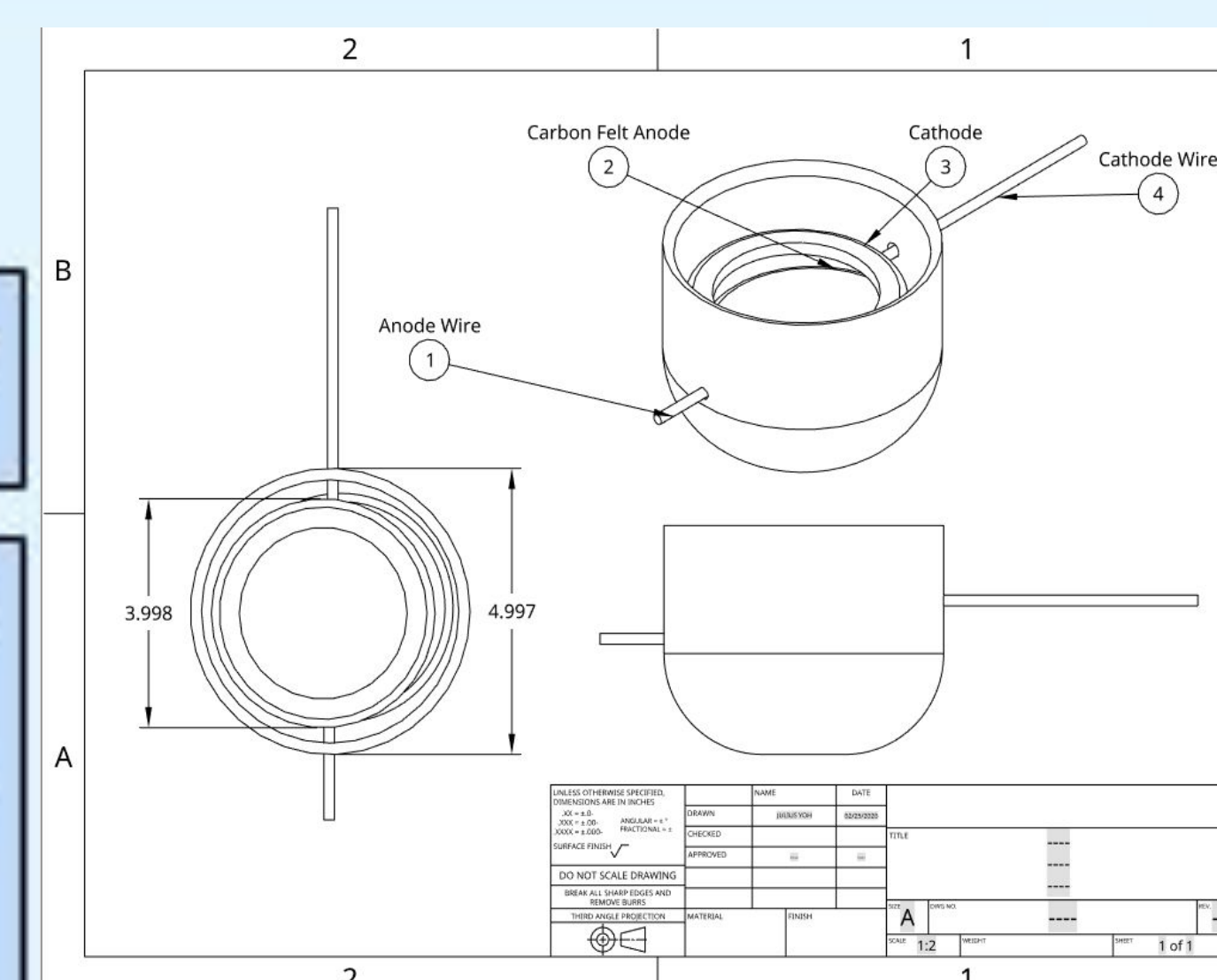
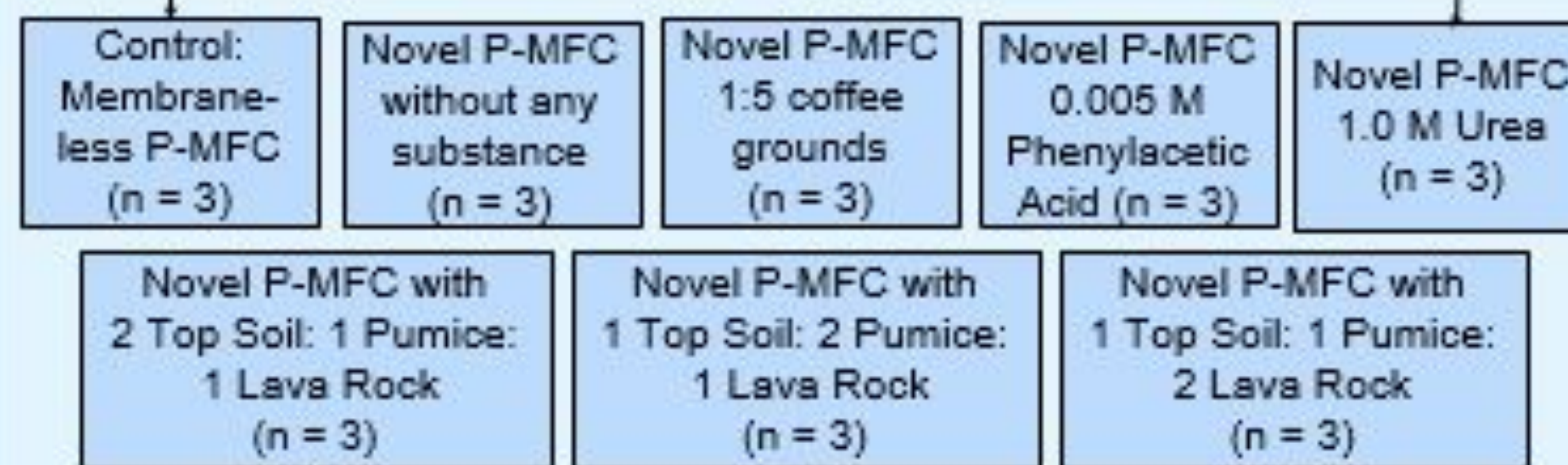


Figure 5: Schematics of control P-MFC design (photo by author)



Voltage and amperage were collected using a multimeter for 14 days. Power and current density were calculated.

Data was analyzed on IBM SPSS v.25. A t-test and one-way ANOVA were performed, followed by a post hoc scheffe ( $p < 0.05$ ) on both. Descriptive Statistics (mean +/- standard deviation) were ran on Microsoft Excel.

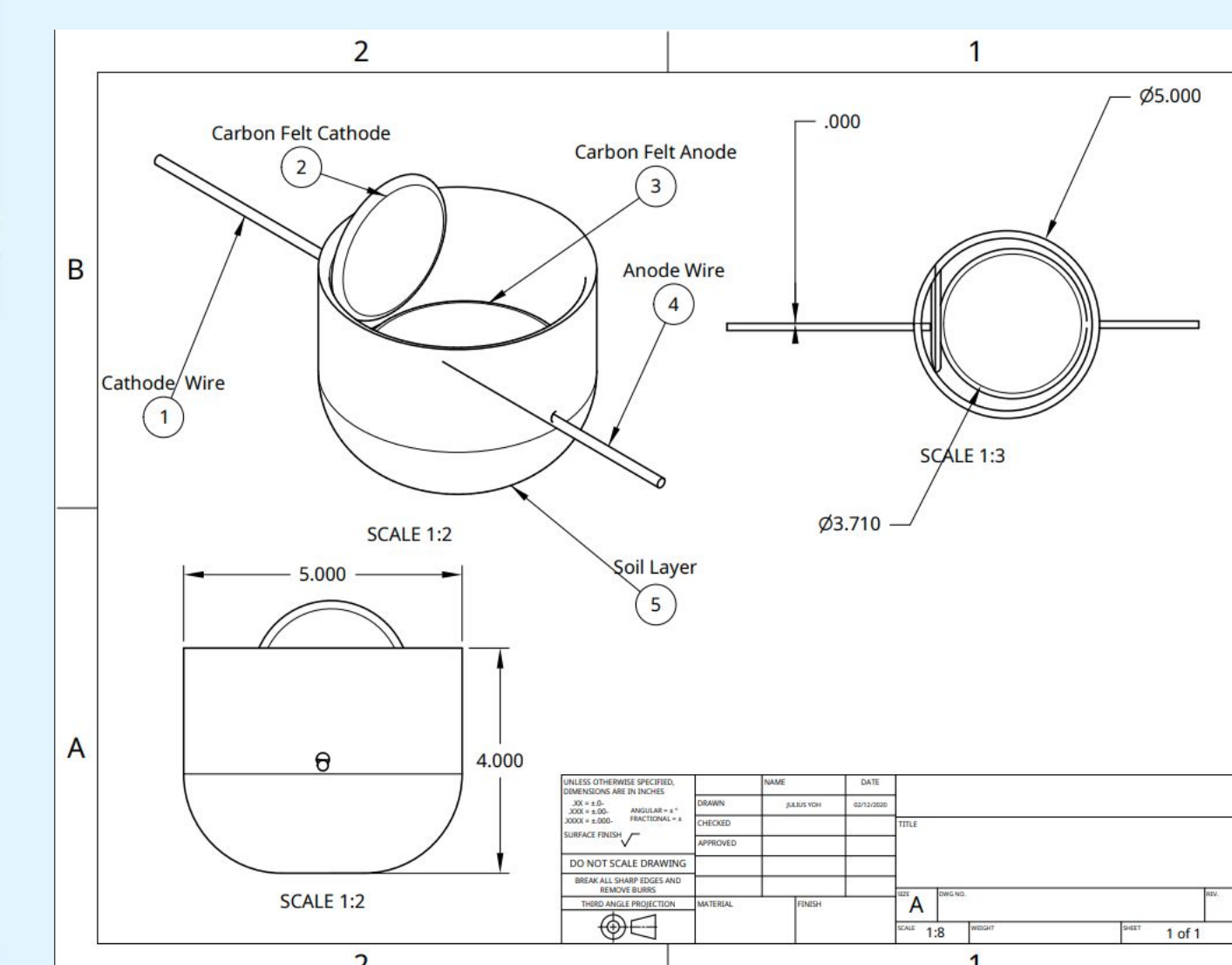


Figure 6: Schematics of novel P-MFC design (photo by author)

## Results

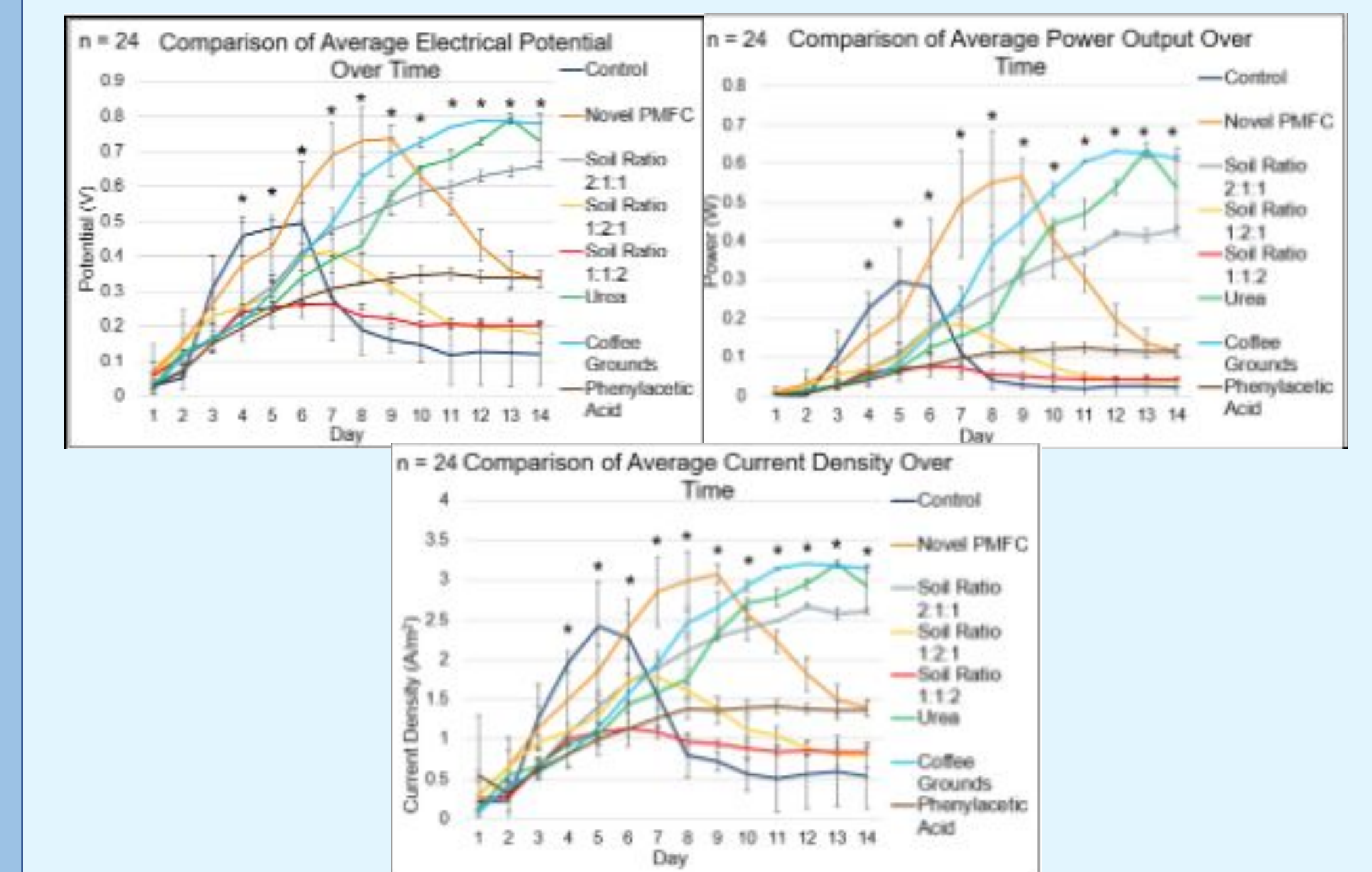


Figure 7: Graphs comparing power production over time between P-MFCs (graph by author)

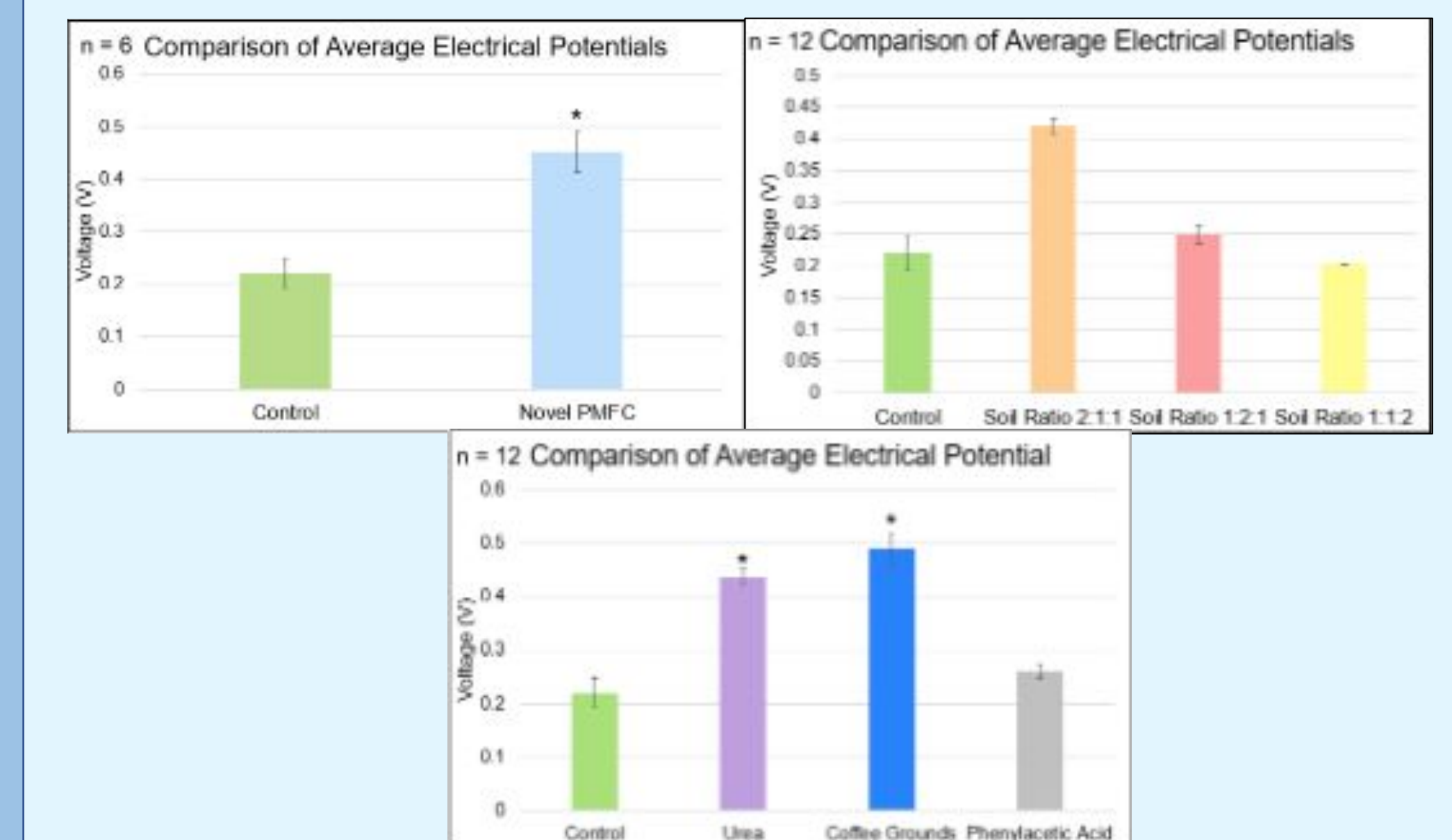


Figure 8: Graphs comparing average electrical potential between grouped P-MFCs (graph by author)

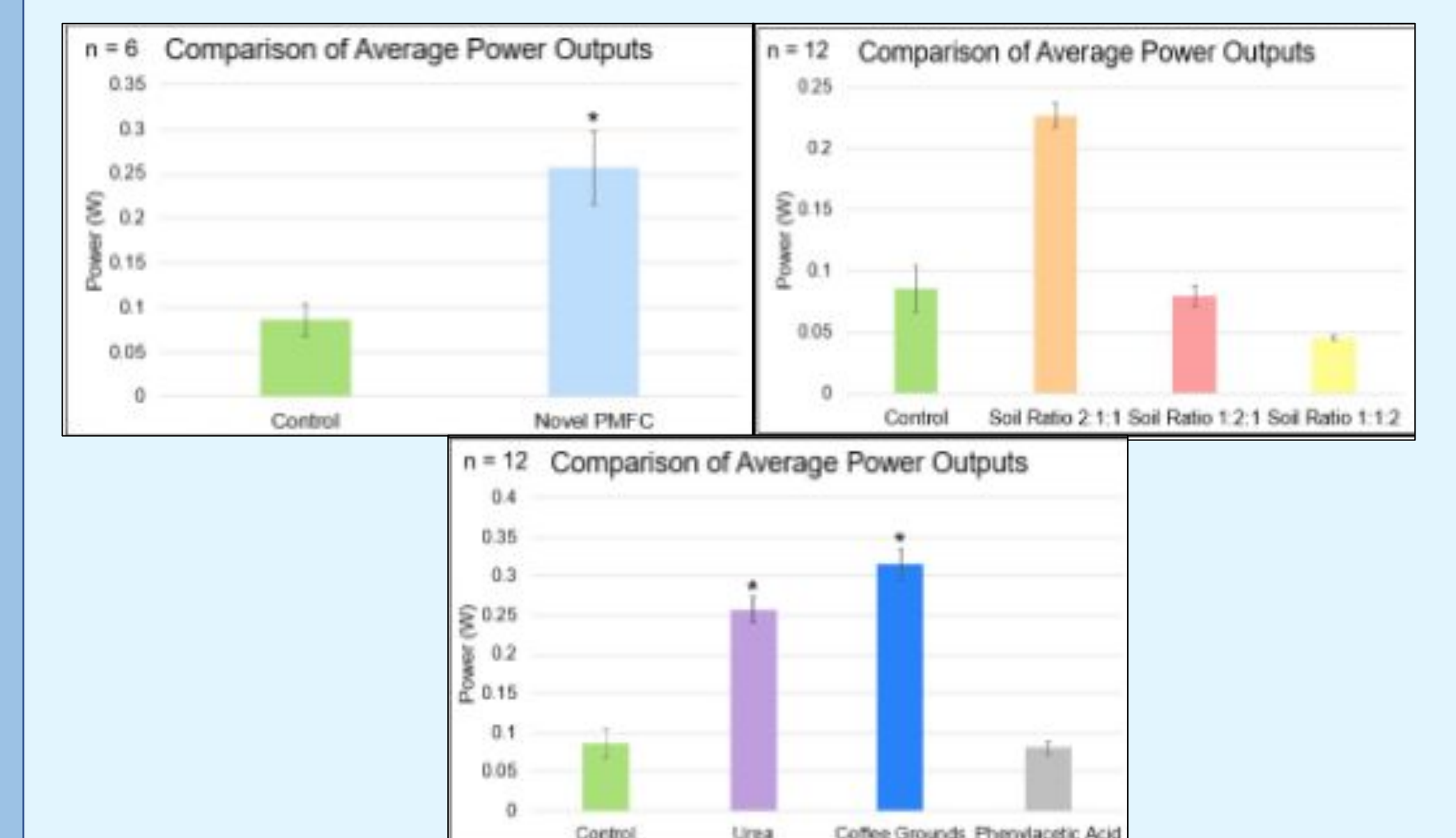


Figure 9: Graphs comparing average power output between grouped P-MFCs (graph by author)