Soil Microbial Fuel Cell (SMFC) offer the possibility of extracting electric current from a wide range of organic wastes and renewable biomass but existing methods can require expensive electrochemical equipment and specialized reactors. In the present research a simple system for conducting high throughput bio electrochemical research was developed using multiple inexpensive microbial fuel cells built with commercially available materials and operated in room temperature without using agar salt bridge and proton exchange membrane. In our present investigation, two different types of soil samples were collected: Brinjal cultivated soil ($S_1$) and Sugarcane cultivated soil ($S_2$). The production of electricity was measured by using power measurement for these two cultivated soil sample. The maximum generated open circuit voltage, power density and current density achieved in Brinjal cultivated soil ($S_1$) were found to be 543 mV, 12.8 mW/m² and 23.6 mA/m² respectively. The constructed SMFC provide enough voltage (2.3 V continuously for about 456 hours) to power the LED bulbs successfully for about 456 hours continuously in Brinjal cultivated soil ($S_1$). No electricity was produced in Sugarcane cultivated soil ($S_2$), it mainly confirms the role of EC for electricity production in the soil.

**Key words:** Microbial Fuel Cells (MFCs), Brinjal Soil, Sugarcane Soil, Gingelly Soil, Agathi Soil, power measurement, electricity.

**INTRODUCTION**

Nowadays, Energy plays an important role in our life. Fossil fuels are depleted and the demand for alternative energy generation has an increasing trend. Renewable energy may be a suitable alternative for existing energy sources. Microbial fuel cells (MFCs) are an emergent technology that offers a novel approach to small scale electrical power generation that could be useful for powering LED, recharging batteries for use in cameras, medical devices, or other battery-operated devices in areas without access to the capital needed for more traditional means of electrical generation. Power generated from microbial fuel cell (MFC) is considered as renewable energy. MFCs provide new possibility for production of bio-energy from organic and inorganic sources (Logan et al., 2006). The organic matters are converted to hydrogen in the presence of active biocatalysts in anode chamber under anaerobic condition. Generally, MFC consists of two compartments: an anaerobic anode and aerated cathode compartments in single chamber MFC. Microorganisms are used in MFCs to convert organic and inorganic compounds into bioelectricity. Pure or mixed culture of microorganisms can be used as biocatalyst in anaerobic anode chamber. The concept of electricity production was introduced in past few decades. Recently soil MFCs are effectively used in waste treatment and degradation of pollutions but application of MFC technology required more research in MFC construction and operation. In this work, applicability of soil MFC operation was checked in different soil sample to confirm the influence of soil in MFC technology.

**MATERIALS AND METHODS**

In the present research a simple system for conducting high throughput bio electrochemical research was developed using multiple inexpensive microbial fuel cells built with commercially available materials and operated in room temperature without using agar salt bridge and proton exchange membrane. In our present investigation, two different types of soil samples were collected: Brinjal cultivated soil ($S_1$) and Sugarcane cultivated soil ($S_2$). The production of electricity was measured by using power measurement for these two cultivated soil sample.

**Experimental procedure:** Soil testing is conducted to calculate the availability of nutrients to the plants, and to know the physical and chemical properties of the soil. The two cultivated soil ($S_1$, and $S_2$) were sent to agricultural laboratory. The various parameters were interpreted in the soil testing that includes pH, EC, N etc. Electrical conductivity (EC) plays a main role in identifying whether the electricity was produced from the particular soil or not. It is the ability of a material to transmit an electrical current. It is an important indicator of soil health. It affects crop suitability, plant nutrient availability, crop yields, and activity of soil microorganisms which persuade key soil processes including the emission of greenhouse gases such as methane, nitrogen oxides, and carbon dioxide.
In this work, Mudwatt Microbial fuel cell was used for the electricity production for these two samples (Keego Technologies LLC, Stanford, USA). Soil was patted down in MFC up to 1 cm to make a smooth surface and anode was placed on the top of the soil, finally soil ample was added up to 4 cm line. The cathode was placed on the top of the soil and the setup was closed using a lid. Electricity production was measured using digital multimeter.

**Power Calculation:** The voltage across the external resistor in an MFC can be measured using a multi meter. Voltage measurements are converted to current values using Ohm’s law:

\[ V = I \times R \]

Where \( V \) = voltage, \( V \)

\( I \) = current, \( A \)

\( R \) = resistance, \( \Omega \)

The power output from an MFC is calculated as

\[ P = I \times V \]

Where \( P \) = power, \( W \).

**Isolation of microorganism from anode surface:** After the experiment was over, anode graphite fiber was removed from the Soil MFC and was kept for incubation in phosphate buffer solution for 1 hour in shaker and serial dilution was done by adding 1ml of phosphate buffer in 99ml of sterile water. 0.5ml aliquots of each serial dilution were transferred to agar plates by spread plating technique and were incubated at 37°C for 24 hours. After incubation, 20 different colonies were selected based upon colony morphology.

**RESULT AND DISCUSSION**

**SOIL TESTING:**

Soil testing reports for different soil were collected from Soil Plant Analytical advisory centre, Department of Soil and Environment in Agricultural College and Research Institute at Tamil Nadu Agricultural University, Madurai. It includes pH, EC, N, P, K etc.

**Graphical Representation of SMFC:** Voltage reading in the digital multimeter was recorded for all the experiments with an interval of every three hours using 10-1000 \( \Omega \) resistance. The potential difference and power was calculated with different resistance using Ohm’s law. The voltage across the external resistor is load in an MFC can be measured using a multimeter.

Initially, when started running soil microbial fuel cells, it was realized that most of the literature only included studies on peak current (Kim et al., 2003, Lee et al., 2008, Park and Zeikus 2003, Gil et al., 2003). Peak current was defined as the maximum current obtained when a load is applied between the anode and cathode of the fuel cell. The maximum current occurred at the moment the load was applied between the anode and cathode (12 hours experimental time) was noted. Within minutes, the current drifted towards zero as time progressed. Additionally, once the load was applied, there was a decrease in the anode potential was observed. Therefore, as current was drawn, the fuel cell’s total potential decreased.
CONCLUSIONS

In this experimental investigation, carbon-based materials such as graphite fiber was equipped with MFCs can efficiently improve the bioelectricity production. Novel Soil Microbial fuel cell has been constructed for soil electricity production with low cost and effectively without Salt Agar Bridge and costly PEM. Soil sample collected from Brinjal cultivated soil and Gingelly cultivated soil shows less moderate electricity production rather than Sugarcane cultivated soil and Agathi cultivated soil. The maximum generated open circuit voltage, power density and current density achieved in Brinjal cultivated soil ($S_1$) were found to be 543 mV, 12.8 mW/m$^2$ and 23.6 mA/m$^2$ respectively. The constructed SMFC provide enough voltage (2.3 V continuously for about 456 hours) to power the LED bulbs successfully for about 456 hours continuously in Brinjal cultivated soil ($S_1$). No electricity was produced in Sugarcane cultivated soil ($S_2$), it mainly confirms the role of EC for electricity production in the soil.

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