GE07
Bio-Electricity Generation by Using Organic Waste in Bangladesh

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Abstract— **Resource recovery and recycle of organic waste is a major concern now-a-days all over the world. This present study deals with the Microbial Fuel Cells (MFC) using kitchen garbage to produce electricity as well as recycle of organic waste and its potential use in Bangladesh. A rectangular acrylic container (10 x 10 cm) was used as the cell. The container was filled with well mixed kitchen garbage (120 g), leaf mold (120 g), effective micro-organisms (15g) and distilled water (80 g). The data logger stored the data of voltage in every 20 minutes in the constant room temperature at 25^{0}C for 45 days. It was observed that voltage increased rapidly during initial time (first 2 days), then gradually increased and reached to peak after 2 weeks and after reaching the peak gradually decreased. The maximum power was 682 mW/m^2 during the laboratory test of the MFC by using the kitchen garbage.**

INTRODUCTION

Microbial fuel cells (MFCs) are bio-electrochemical transducers that convert microbial reducing power (generated by the metabolism of organic substrates), into electrical energy [1], [2], [3], [13]. They are an alternative to conventional methods of generating electricity for small scale applications. Energy, in any form, plays the most important role in the modern world. We need energy, especially electrical energy in our daily needs of life, such as operating toaster to steel plant. Energy output has become pone of the country's progress indication factor. We have been completely dependent on conventional energy sources such as coal and oil for quite a long time. These two non-replenishable sources of energy contribute to the major part of our energy consumption and we are slowly approaching a stage where these fuels are fast becoming scarce due to the huge increase in the world demand. Biological fuel cells offer a potential solution to all these problems, by taking nature's solutions to energy generation. They use the available substrates from renewable sources and convert them into harmless by-products with simultaneous production of electricity [8]. Resource recovery and recycling from waste is a burning question both in the developing countries as well as industrialized countries. For example, the annual organic waste generated from the food industry and kitchen garbage in Japan is about 20 million tons per year [6]. Most of this waste is directly incinerated with other combustible waste, and the residual ash is disposed of in landfills. However, incineration of this water-containing waste is energy-consuming and results in the production of dioxins. Instead of considering the garbage as waste, garbage should be considered as valuable biomass for resource recovery. From the characteristics analysis of the solid waste of Bangladesh, it is found that the major portion (more than 80%) of the total solid waste is comprising of organic waste which is not usually get much attention for recycling or resource recovery [9]. This unmanaged organic waste causes environmental pollution and consequently affects the public health. The MFC by reusing the large quantity of organic waste has not been got attention so far to the researchers both in the developing countries as well as industralized countries. The scarce of electricity is one of the major hinders for development of Bangladesh. So the objective of this study is to evaluate of bio-electricity generation by reusing the kitchen garbage so that the organic waste can be recycled as well as give some sorts of solution to the electricity scarced population .

MATERIALS AND METHODS

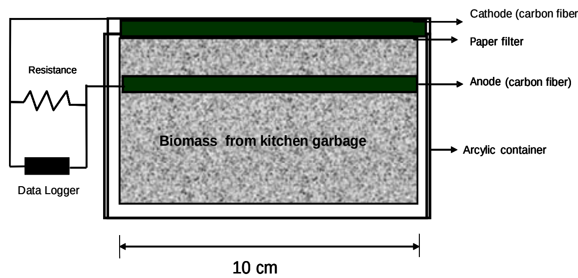

Fig. 1: Schematic diagram of MFC in Laboratory

A rectangular (10 x 10 cm) acrylic container was used in the laboratory as a cell. Then kitchen garbage and leaf mold each of 120 gm mixed with water 80g and 15g effective micro-organisms were blended properly. The mixed sample then placed in the container. Carbon fibre was used for both anode and cathode (Omine et al. 2009). The anode was placed inside the sample and cathode was placed on the top. Both the anode and cathode was connected with a data logger and a fix resistance (51 Ω). A filter paper was used to separate the anode and cathode. The data logger was set to measure the voltage and temperature data in every 20 minutes interval. The stored data were collected and analysis after 45 days. The laboratory test was conducted in a constant room temperature of 25^{0}C. Figure 1 illustrates the schematic diagram of the laboratory test for MFC.

Electrode output was measured in volts (V) against time. The current I in Amperes (A) was calculated using Ohm's law, $I= V/R$, where V is the measured voltage in volts (V) and R is the known value of the external load resistor in Ohms. From this it is possible to calculate the power output P in watts (W) of the MFCs by taking the product of the voltage and current i.e. $P= I \times V$. Current density was calculated using $I = V/aR$, where a is the electrode surface area.

RESULTS AND DISCUSSION

Figure 2 illustrates that the variation of voltage with duration. The voltage (V) increased sharply during the initial time (2 days) after that it increased gradually and reached the peak after 18 days. In the initial stage the bacteria got ample of food and their activities increased very rapidly. For that reason the voltage increased sharply during that stage. The voltage decreased gradually after that with time as the supply of food for the bacteria was using up. The peak voltage reached around 590 mV by using the kitchen garbage comprising of fruit waste and vegetables leftover. The peak voltage showed considerable higher value by comparing others value stated in other literature by using cutting grass and mixed with leaf mold (Omine et al. 2009).

Figure 3 illustrates the variation of power density with duration. It is found that power density increased sharply during initial (2 day) time. After that current density increased gradually and reached to the peak within 2 weeks.

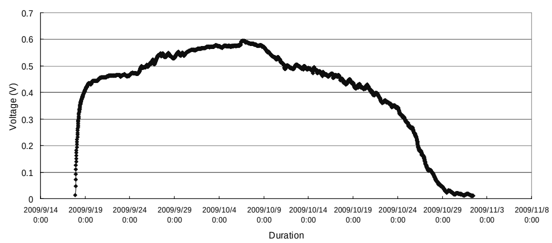

Fig. 2: Variation of voltage with duration

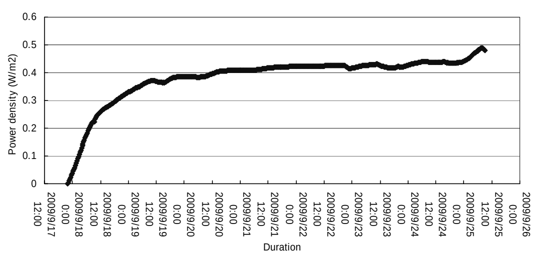

Fig. 3: Variation of power density with duration

The power output data over the first 7 days is shown in Fig. 3. It is seen that power output followed the same pattern of voltage variation i.e. increased sharply during initial days and then gradually increased and reached the value of around 0.5 W/m^2. The microbial activities influenced the generation of higher quantity of electricity in the initial stage. After the depletion of foods for the micro-organisms their activities also reduced and the generation of electricity reduced significantly. Energy, in any form, plays the most important role in the modern life and we need energy, especially electrical energy in our daily needs. Depletion of energy reserves, global warming and the concern of environmental pollution are inspiring the search for new environment-friendly and sustainable energy production methods. In MFCs utilize bio-electrochemical processes of bacteria so that electrical energy is directly recovered from biodegradable compounds. In a MFC system, internal energy loss accounts for a significant element that inherently determines the scale of magnitude in power generation [9].

Table 1 summarizes the maximum level of power density and current density as well as the maximum power generated in the laboratory test of MFC by using the kitchen garbage by hybrid composting method. The values showed in the Table 1 were quite satisfactory with comparing the various parameters in other MFC in different methods. Renewable bio-energy is viewed as one of the ways to alleviate fuel needs of the future and to overcome the crisis of global warming. In this direction bioelectricity production employing microbial fuel cell (MFC) has generated considerable interest in both basic and applied research in recent years. However, by using the kitchen garbage to generate electricity in MFC has not attracted the researchers before.

Table 1: Various parameters showing the performance of MFC

	Parameters	Value
1	V_{max} (mV)	590
2	Current at V_{max} (mA)	11.56
3	P_{max} (mW)	6.82
4	Power Density (mW/m^2)	682
5	Current Density (mA/m^2)	1156

CONCLUSIONS

The organic waste of Bangladesh can be recycled as Bio-electricity generation . The small amount of electricity is also necessary for the electricity scarced developing countries. The MFCs by using the kitchen garbage is proved to be a good way to green electricity generation as well as the recycle of organic waste to maintain the healthy and pollution free environment. The by-product of the electricity generation in MFC by composting method can be used as soil conditioner after further treatment which is another way to serve the agricultural based country. The maximum power was 682mW/m^2 during the laboratory test which was much higher than reported in other literature. The maximum current density was 1156 mA/m^2 in the experiment. The performance of the MFC depends on the type of mediator, mediator concentration, ionic strength and surface area of the cation exchanger in contact with the anode and cathode chamber. All these factors need to be optimized for maximizing the power generation in the MFC by using the kitchen garbage. Parameters such as distance between the electrodes, surface area of the electrodes, catholytic composition, etc. need to be studied further to check the efficiency of the same.

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