RESEARCH PAPER
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Standardization of microbial fuel cell for generation of electricity through, standardization of electrodes distance and by assessing different concentration of cattle dung slurry

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Microbial fuel cells (MFC) are special types of bio fuel cells, producing electrical power by utilizing metabolic activities of microorganisms. An attempt was made to construct a MFC for generation of electricity through, standardization of electrodes distance, assessing different concentration of cattle dung slurry. The results of the experiment revealed that, in MFC the distance between electrodes do not have any role in voltage generation. The concentration in the ratio 1:1 of cattle dung slurry was found to be the best in terms of voltage generation as well as stability of power generated.

Key words : Cattle dung slurry, Electricity, Electrodes distance, Microbial fuel cell, Multimeter, Voltmeter

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INTRODUCTION

Electrical power can be generated by burning any combustible materials. Some electrical power is generated by burning crops which are grown specifically for the purpose. Usually, this is done by fermenting the plant materials to produce ethanol which is then burned. This may also be done by allowing organic matter to decay in order to produce biogas, which is then converted into electricity. Burning of organic matter or biomass produces many similar emissions as burning of fossil fuels does. So, the greenhouse gas generation is increasing very rapidly. Currently, there are about 2.7 million households and community biogas plants installed around India (Chand *et al.*, 2007). So, there is an increase in greenhouse gas emission by biogas plants also. There is little or no control on the rate of gas production although the gas can be stored to some extent and used as and when required. Though, the processes of digestion of cattle dung in biogas plant and in electric fuel cell unit, takes place in a similar way and both produce fertilizer, there is a volume loss of the organic waste in biogas plant as compared to electric fuel cell unit of cattle dung. Biogas contains contaminant gases which can be corrosive to gas engines and boilers.

It is well known that microorganisms can produce fuels such as ethanol, methane and hydrogen from organic matter. Microbial fuel cells offer the possibility of harvesting electricity from organic waste and renewable biomass. Among electrochemical cells, microbial fuel cells are special types of bio fuel cells, producing electric power by utilizing metabolic activities of microorganisms, instead of isolated enzymes, to assist redox reactions (Katz *et al.*, 2003).

Microbial fuel cell is a device that converts chemical energy to electrical energy by the catalytic reaction of microorganisms. A typical microbial fuel cell consists of anode and cathode compartments separated by a cation (positively charged ion) specific membrane. In the anode compartment, fuel is oxidized by microorganisms, generating electrons and protons. Electrons are transferred to the cathode compartment through an external electric circuit, while protons are transferred to the cathode compartment through the membrane. Electrons and protons are consumed in the cathode compartment, combining with oxygen to form water (Allen and Bennetto, 1993).

Studies have shown that microbial fuel cells typically use expensive solid graphite electrodes (Bond and Lovely, 2003) but a group of other scientists suggested that, less expensive graphite felt and carbon cloth can also be used (Chaudhuri and Lovely, 2003 and Liu and logan, 2004).

RESEARCH METHODOLOGY

A systemic study was conducted to utilize the cattle dung for generation of electricity, standardizing the fuel cell. The experiments were carried out in the Department of Forestry and Environmental Science and in the Department of Agricultural Microbiology, College of Agriculture, GKVK, UAS Bangalore. For all experiments, cattle dung from G.K.V.K dairy farm was used.

For the experiments, 1cm thick carbon rod of size 10 cm long was used and 2 mm thick rectangular shaped zinc plate of the dimensions of 10 cm long and 4 cm breadth were used.

From microbial fuel cells varying in their electrodes distances, voltage generated was noted down for 30 days continuously by using multimeter. Since the circumference of the container was 39 cm, it was divided into eight equal distances by using a marker. Out of eight distances made, only half portion of container which contained four different distances was used as a treatment, because it represented another half portion of the round shaped container. In all the treatments, the carbon rod (positive electrode) was fixed at one end and zinc plate was moved to four different distances to get four different types of treatments as follows :

Treatment details (distance of zinc plate away from carbon rod).

T_1 = 4.8 cm
T_2 = 9.7 cm
T_3 = 14.6 cm
T_4 = 19.5 cm

For all these types of microbial fuel cell six replications were maintained. In every microbial fuel cell, small pin holes were made on the lid of the container at the distances exactly where the electrodes were fixed. Later through these holes, copper wires were passed and connected to electrodes and these holes were sealed by using sealing wax. For this experiment, copper wire was used for conduction. The one end of the copper wire was connected to electrode and other end was connected to multimeter to measure the voltage output. Like this, twenty four microbial fuel cells were constructed.

In each of these microbial fuel cells, the slurry consisted of 400 g of cattle dung and 400 g of distilled water. Electricity generated everyday was determined with reference to concentration of dung slurry, for maximum electricity for which best electrode distance was used. Different concentrations of cattle dung slurry were made for generation of electricity. For this, cattle dung was mixed with distilled water to get different concentration of cattle dung slurry. The treatment details of the different

Table 1 : Effect of electrode distance on voltage generation of MFC in 1:1 proportion of cattle dung and distilled water (Voltage values mentioned here are mean values of six replications)

Sr. No.	Distance between electrodes	Voltage (V)					
		Initial day	6^{th} day	12^{th} day	18^{th} day	24^{th} day	30^{th} day
1.	4.8 cm	0.88	0.86	0.84	0.82	0.80	0.74
2.	9.75 cm	0.87	0.85	0.81	0.76	0.74	0.71
3.	14.6 cm	0.89	0.86	0.83	0.79	0.74	0.72
4.	19.5 cm	0.89	0.87	0.85	0.80	0.75	0.72
F- test (@5%)		NS	NS	NS	NS	NS	NS
C.V. %		2.44	1.92	3.25	4.48	5.04	4.86

NS= Non-significant

Table 2: Effect of different concentration of cattle dung with distilled water on voltage generation of MFC (Voltage values mentioned here are mean values of five replications)

Sr. No.	Concentration of cattle dung with distilled water	Voltage (V)					
		Initial day	6^{th} day	12^{th}day	18^{th} day	24^{th} day	30^{th} day
1.	1:0	0.71^{b}	0.54^{c}	0.33^{d}	0.25^{d}	0.19^{d}	0.12^{d}
2.	1:1	0.90^{a}	0.87^{a}	0.84^{a}	0.80^{a}	0.74^{a}	0.70^{a}
3.	1:2	0.70^{b}	0.67^{b}	0.59^{b}	0.52^{b}	0.44^{b}	0.36^{b}
4.	1:3	0.66^{b}	0.59^{c}	0.50^{c}	0.40^{c}	0.33^{c}	0.26^{c}
5.	1:4	0.49^{c}	0.46^{d}	0.43^{c}	0.36^{c}	0.23^{d}	0.15^{d}
6.	0:1	0.08^{d}	0.02^{e}	0.0^{e}	0.0^{e}	0.0^{e}	0.0^{e}
F-test (p<)		0.001	0.001	0.001	0.001	0.001	0.001
S.E.±		0.013	0.013	0.018	0.018	0.015	0.016
C.D. @ 1 %		0.05	0.05	0.07	0.07	0.06	0.06

concentration of slurry are given below.

Treatment details :

T_1 = 1:0 (cattle dung: distilled water) (800g+0g)

T_2 = 1:1 (cattle dung: distilled water) (400g+400g)

T_3 = 1: 2 (cattle dung: distilled water) (266g+534g)

T_4 = 1:3 (cattle dung: distilled water) (200g+600g)

T_5 = 1:4 (cattle dung: distilled water) (160g+640g)

T_6 = 0:1 (cattle dung: distilled water) (0g+800g)

For all the treatments a fixed volume of 800ml was used. Accordingly, the ratio of the slurry was adjusted to get a total of 800ml. For which, slurry types of 800g + 0 g of distilled water (control), 400 g cattle dung + 400 g of distilled water, 266.67 g of cattle dung and 533.33 g of distilled water, 200g of cattle dung + 600 g of distilled water, 160 g of cattle dung + 640 g of distilled water and 0 g of cattle dung + 800 g of distilled water was prepared to get 1:0, 1:1, 1:2, 1:3, 1:4 and 0:1, respectively. For each concentration, five replications were maintained.

The electricity generated was tested from each of the treatments and power generated was recorded by using multimeter for 30 continuous days. In all these microbial fuel cells, the electrodes were fixed at the distance where they produced best result for generating maximum electricity. By this, the best cattle dung slurry concentration was selected for further studies.

RESEARCH FINDINGS AND ANALYSIS

Effect of different electrode distances on voltage generation is depicted in the Table 1. The electrodes were arranged at a distance 4.8 cm, 9.75 cm, 14.6 cm and 19.5 cm apart in the MFC. It was observed that all treatments were having same voltage generation capacity *i.e.* on the first day, voltage generated by respective microbial fuel cell types were 0.88V, 0.87V, 0.89V and 0.89V and on 30^{th} day voltage were 0.74V, 0.71V, 0.72V and 0.72V, respectively (Voltage values mentioned here are mean values of six replications). In other words, electrode distance is having no role in voltage generation because more or less same voltage was generated irrespective of distance. Therefore, for further experiments no electrode distance was maintained.

For testing the effect of different concentrations of cattle dung slurry on voltage generation, different concentrations of cattle dung slurry were prepared. This was done by adding distilled water to cattle dung at the ratio 1:0, 1:1, 1:2, 1:3, 1:4 and 0:1 and finally microbial fuel cells (MFC) were constructed. Here cattle dung without distilled water was kept as control. It was found that, cattle dung slurry at ratio of 1:1, the voltage generation was maximum and stable (0.9 V on the first day, 0.87 V on 6^{th} day, 0.84 V on 12^{th} day, 0.80 V on 18^{th} day, 0.74 V on 24^{th} day and 0.70 V on 30^{th} day). It was further observed that, except 1:1 ratio of cattle dung slurry, in all other concentration types including control, the decreasing trend of voltage generation was observed. The least voltage generation (0.08V) was observed at 0:1 concentration type of cattle dung and distilled water slurry type on initial day and was 0.00 V on 6^{th} day (Voltage values mentioned here are mean values of five replications). So, for further studies, 1:1 ratio of cattle dung and distilled water slurry was used.

All different types of MFC varying their distances were tested for power generation and it was found that, voltage generation was not or least affected by electrode distance.

After testing the effect of different concentration of cattle dung with distilled water on voltage generation, it was found that 1: 1 ratio of cattle dung and distilled water mixture was found to be best in terms of both power generation capacity as well as its stability in different intervals of time. It was because of efficient utilization of substrate by microorganisms in optimum level of moisture by different groups of microbes. This is in conformity with the findings of Howell *et al.* (2008) who had reported that, greatest yield in voltage generation by the MFC was obtained using 50% cow manure concentration with water.

LITERATURE CITED

Allen, R.M. and Rennetto, R.P. (1993). Microbial fuel-electricity production from carbohydrates. *Appl. Biochem. & Biotechnol.,* **39**: 27- 40.

Chand, A.D., Datta, B.K. and Murthy, N. (2007). District level management system for biogas programme. *Econo.& Pol.Weekly,* **23**(22): M80- M84.

Chaudhuri, S.K. and Lovley, D.R. (2003). Electricity generation by direct oxidation of glucose in mediator less microbial fuel cells. *Natu. & Biotechnol.,* **21**(10): 1229-1232.

Howell Henrian, G., Bayonaian, K.B. and Tabios (2008). Harvesting electrical energy from cellulose using cow manure microorganisms as biocatalysts in a two-chamber microbial fuel cell. Applied Science Category (Paper presented in International Environmental Project Olympiad).

Katz, E., Ehilpway, E.N. and Eillner, E. (2003). *Handbook of fuel cells- fundamentals, technology and application* (Eds: W. Vielstich, H. A. Gasteiger, A. Lamma), WILEY.

Liu, H. and Logan, B. (2004). Electricity generation using an air-cathode single chamber microbial fuel cell in the presence and absence of a proton exchange membrane. *Environ. Sci. & Technol.*, **38**: 4040-4046.