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RESEARCH ARTICLE

Assessment of different types of waste water formulations with cattle dung for generation of electricity.

■ **SHIVARAJKUMAR M. ARIKATTI, M. MAHADEVA MURTHY, MOHAN RAJU, D. RADHAKRISHNA AND T.K. NAGARATHNA**

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SUMMARY : Electricity generation through microbial fuel cells using different types of waste water formulations with cattle dung was studied. This experiment revealed that, in Microbial Fuel Cell (MFC), among different types of waste water formulations made with sterilized cattle dung slurry, it was found that, biogas slurry was producing stable and maximum voltage followed by sewage waste water.

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Author for correspondence **:**
M. MAHADEVA MURTHY
Department of Foresty and Environmental Science, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

See end of the article for **Coopted authors'**

Now-a-days, Microbial Fuel Cells (MFC) are very promising technology in mitigating greenhouse gas effect. MFC is a device that converts chemical energy into electrical energy by catalytic reaction of microorganisms. It is well known that microorganisms can produce fuels such as ethanol, methane and hydrogen from organic matter. MFC offer the possibility of harvesting electricity from organic waste and renewable biomass. Among the 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).

Continuous flow and single component and single-compartment MFCs and membrane-less MFCs were used for wastewater treatment due to concerns in scale-up (Jang *et al.*, 2004; Moon *et al.*, 2006). Using a neutral hydrolysate produced by steam explosion of corn stover in an MFC production of as much as 933 mW/m^2 was done by Zuo *et al*. (2006). MFCs are capable of converting the chemical compounds in a biomass to electrical energy with the aid of microorganisms. The chemical energy from the oxidization of fuel molecules is converted directly into electricity instead of heat (Du *et al.*, 2007).

In their work, Rodirgo *et al.* (2007) studied the oxidation of the pollutants contained in an actual urban wastewater using a two-chamber Microbial Fuel Cell (MFC). The power density generated was found to depend mainly on organic matter content (chemical oxygen demand) but not on wastewater flow-rate.

EXPERIMENTAL METHODOLOGY

A systemic study was conducted to utilize waste water and the cattle dung through a microbial fuel cell. The experiments were carried out in the Department of Forestry and Environmental Science, College of Agriculture, GKVK, UAS, Bangalore. For all experiments, cattle dung from G.K.V.K dairy farm was used.

Waste water is very rich source of organisms and bacterial community. Among them, facultative bacterial are responsible for electrical power generation in MFC.

For this, the best microbial fuel cell for generation of electricity in the form of electrode distance as well as concentration of cattle dung was used for construction of final set up of

microbial fuel cell and later it was used for assessment of different types of formulations with cattle dung. Fresh cattle dung was sterilized by autoclaving at 121^0 C for 15 minutes at 15 psi and was made free of all micro-organisms.

Later, this sterilized cattle dung was mixed with distilled water in proportion at which it was already shown best result for electric power generation. Further, this standard substrate was mixed with different formulations like sewage wastewater, domestic wastewater, dairy wastewater, industrial wastewater and biogas slurry wastewater in the proportion of 9:1. For this, 720 ml of sterilized cattle dung standard substrate was mixed with 80 ml of different sources of waste water. For all treatments, six replications were maintained. The treatment details are given below :

Treatment details :

T_1=90% of standard substrate*+10% sewage waste water.
T_2=90% of standard substrate*+10% dairy effluent waste water.
T_3=90% of standard substrate*+10% soap industrial waste water.
T_4=90% of standard substrate*+10% domestic waste water.
T_5=90% of standard substrate*+10% biogas slurry waste water.
T_6=100% of standard substrate (control).

These treatments were prepared by fixing with electrodes at particular distances where they have shown best results for electric power generation. On the lids of the containers, pin holes were made, later sealed by waxing to make them airtight. By using digital multimeter, power generated was noted down continuously for 30 days and the best formulation was selected for further studies.

EXPERIMENTAL FINDINGS AND DISCUSSION

The effect of different types of formulations with sterilized cattle dung namely, biogas slurry, domestic waste, soap industrial wastes, dairy effluent waste, sewage waste on voltage generation is shown in Table 1.

In this experiment, maximum voltage generation was observed on the initial day in biogas slurry (0.89V) followed by sewage waste water (0.84V). In case of sewage waste water formulation with cattle dung, initial voltage was 0.84 V and decreased with little faster rate than biogas slurry. For other formulations preparation with standard substrate, sterilized cattle dung was used and voltage generation was either low initially or it was decreasing very rapidly with time. Least voltage generated was in completely sterilized cattle dung slurry substrate *i.e.*, control. On initial day it recorded 0.12V and found to be 0 V on the 18th day (Voltage values mentioned here are mean values of six replications). So for further studies, biogas slurry was selected as the best formulation with cattle dung. It was interesting to note, the ability of microbial consortium to produce voltage in combination with different media. Among the different combinations of formulations of waste water with sterilized cattle dung, the formulation with biogas slurry inoculated with sterilized cattle dung resulted in increased voltage generation upon different intervals of time followed by sewage waste water.

Similar findings were also obtained by number of scientists who used soluble organic matters as supporting medium for voltage generation (Rabaey *et al.*, 2004).

Similarly, study conducted by Howell *et al.* (2008) on harvesting electrical energy from cellulose using cow manure microorganisms as biocatalysts in a two-chamber microbial fuel cell had revealed that cow manure can be an efficient biocatalyst in generating electricity from cellulose in a microbial fuel cell and to construct a MFC using inexpensive and local materials.

In their work Rodrigo *et al.* (2007) studied the oxidation of the pollutants contained in an actual urban wastewater using a two-chamber microbial fuel cell (MFC). The power density generated was found to depend mainly on organic matter content (COD) but not on wastewater flow-rate.

Table 1 : Effect of different types of waste water formulations with cattle dung for voltage generation in MFC (Voltage values mentioned here are mean values of six replications)

Sl. No.	Types of formulations	Voltage (V)					
		Initial day	6th day	12th day	18th day	24th day	30th day
1.	Biogas slurry	0.89 [a]	0.86 [a]	0.83 [a]	0.79 [a]	0.75 [a]	0.70 [a]
2.	Domestic waste	0.63 [c]	0.60 [c]	0.57 [d]	0.53 [d]	0.49 [d]	0.43 [d]
3.	Soap industrial waste	0.60 [c]	0.55 [c]	0.54 [d]	0.49 [d]	0.45 [d]	0.41 [d]
4.	Dairy waste	0.81 [b]	0.76 [b]	0.72 [c]	0.67 [c]	0.62 [c]	0.54 [c]
5.	Sewage waste	0.84 [ab]	0.81 [ab]	0.77 [b]	0.73 [b]	0.69 [b]	0.62 [b]
6.	Sterilized cattle dung slurry	0.12 [d]	0.03 [d]	0.01 [e]	0.00 [e]	0.00 [e]	0.00 [e]
	F-test (p<)	S	S	S	S	S	S
	S. Em ±	0.01	0.01	0.008	0.007	0.008	0.014
	CD (P=0.01)	0.05	0.05	0.04	0.04	0.04	0.07

NOTE: S indicates significant

Although pure cultures can be used as inoculum in microbial fuel cells, sewage sludge is a relatively better source for power production in microbial fuel cells because it can be readily obtained from wastewater and it contains various electrochemically active microbes (Logan *et al.*, 2001).

Coopted Authors' :

M. MAHADEVA MURTHY, Department of Foresty and Environmental Science, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

MOHAN RAJU, Department of Crop Physiology, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

D. RADHA KRISHNA, Department of Agriculture Microbiology, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

T.K. NAGARATHNA, AICRP on Sunflower, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

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