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PRODUCTION OF BIOELECTRICITY THROUGH MICROBIAL FUEL CELL

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ABSTRACT

Waste generated by both agro based industries and domestic units have high nutrient contents to support microbial growth, these wastes are indiscriminately dumped and constitutes environmental and health hazards. Some of these wastes can be used to grow some bacterial species in microbial fuel cell to generate bioelectricity. The Microbial fuel cell is a device where the bacteria can grow on one electrode, they breakdown organic matter and release electrons from it. The bacteria can do this by keeping them separate from the oxygen, and when they release those electrons it creates a potential between the electrodes of about half a volt and voltage times current is power, and that is how power is generated from it. The waste materials used in this work are banana peels. Bacterial isolates that are used from the sewage and hay soil all within Gandhigram institute, Gandhigram. Microscopic characterization of the isolates by Gram reaction revealed the Gram negative and Gram positive and Biochemical test showed that the three isolated organisms were Escherichia sp., Pseudomonas sp, Bacillus sp. Microbial fuel cell were fabricated with a two plastic bottles as anode and cathode chamber. The electrode used were Aluminium mesh. A 3.75% sodium chloride, 2.2% agar salt bridge connected the chambers. The organism and banana peel as biocatalyst. Result that was monitored showed the maximum of 86mV at 24 hours reading respectively.

INTRODUCTION

Renewable energy is an increasing need in our society. Microbial fuel cell (MFC) technology represents a new form of renewable energy by generating electricity from what would otherwise be considered waste. This technology can use bacterium already present in wastewater as catalysts to generating electricity while simultaneously treating wastewater (Liu and Logan, 2004; Min et al., 2005). A fuel cell is an electrochemical device that unceasingly exchanges chemical energy to electrical energy as long as fuel and oxidants are supplied to it. A Biological fuel cell defined as "An assembly of an electrochemical device that converts chemical energy derived from a biological substrate such as carbohydrates like sugar and alcohol directly into electrical energy". With the advent of space research, concept of fuel cell was introduced. The need for a minute device required the fabrication of fuel cell to meet the obligation of electricity in a short span of time. The chemical fuel cell construction includes high cost chemicals and extreme operational conditions. Enzymatic fuel cells are much elsewhere the purview of commercialization due to the cost involved in enzyme production and purification.(Min et al.,2005). Production of electrical energy using microorganisms through microbial fuel cells (MFC) is a renewable and sustainable technology that is considered to be one of the most efficient (HaoYu *et al.,* 2007) and carbon neutral energy sources (Lovley, 2006). Microbial fuel cells are devices that use bacteria as the catalysts to oxidize organic and inorganic matter to generate current. Microbial fuel Cells technology has generated considerable interests among academic researchers in the last decades (Venkata *et al.,* 2008). So, recently the increased interest in MFC technology was highlighted by the naming of *Geobacter sulfurreducens* KN400, a bacterial strain capable of high current production, as one of the top 50 most important inventions for 2009 by Time Magazine. Many microorganisms can contribute to electricity production in microbial fuel cell.

MATERIALS AND METHODS

Collection Of Sample

Sample 1:

Sewage sludge sample were collected from the hostel septic tank in Gandhigram rural institute, Ladies Hostel, Gandhigram using well labelled sterile sample bottles and in the microbiology laboratory the serial dilution was carried out using sterile test tube and further analysis.

Sample 2:

The soil is taken from the decomposed hay waste from the Gandhigram rural Institiute backyard, Gandhigram, using sterile bottle and that was kept for sterilization in hot air oven for an hour. The serial dilution was carried out in test tube and further analysis.

Preparation Of Organic Waste.

Banana peel was used as a organic substrate and Glucose was served as positive control.

Preparation Of Substrate.

The substrate was collected using sterile container and sterilized under low pressure in Hot air oven. It was dried and grounded, then 24g of substrate was measured using a digital weighing balance and placed into a well labeled 1000ml conical flasks containing 600ml of distilled water respectively. Isolation of bioelectrogenic organism and identification of organism and MFC Construction and Fabrication were done using the standard methods.

RESULTS

Preparation Of Culture

Sample 1:

The sewage sample was collected from the septic tank and the culture that was isolated from the EMB medium is *Escherichia coli*

Sample 2:

The decomposed hay soil was taken and the bacterial isolates such as *Pseudomonas spp*., and *Bacillus spp*., were isolated using the standard methods.

Identification Of Isolates

The sample that was inoculated in plate was identified by the biochemical test such as motility test, MRVP, indole test, catalase test, citrate test, Gram's staining etc.

Construction Of Microbial Fuel Cell

The H- shaped microbial fuel cell was constructed by the

electrode (Aluminium mesh) and electrolyte (salt bridge) for conductivity the 12 gauge copper wire is used in both the chamber. The organism and substrate is inoculated in distilled water in the anode chamber with required amount, salt and distilled water in the cathode chamber. The multimeter is connected to the copper wire and the readings are noted.

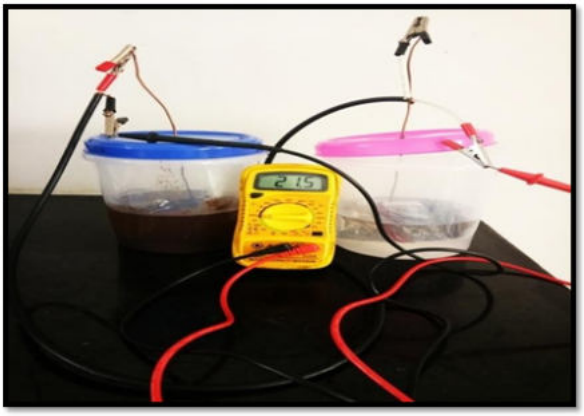

Fig 1: Microbial Fuel Cell Construction

Table 1: Voltage Of Current Produced In By Microbial Isolates Using The Substrate

SOURCES	HOURS(24hr)	VOLTAGE(mV)
ISOLATES *Escherichia* sp, *Pseudomonas* sp., *Bacillus* sp., ***SUBSTRATE*** Banana peel	24	86
	48	74
	72	70
	96	63
	120	58
	144	42
	168	29
	192	16

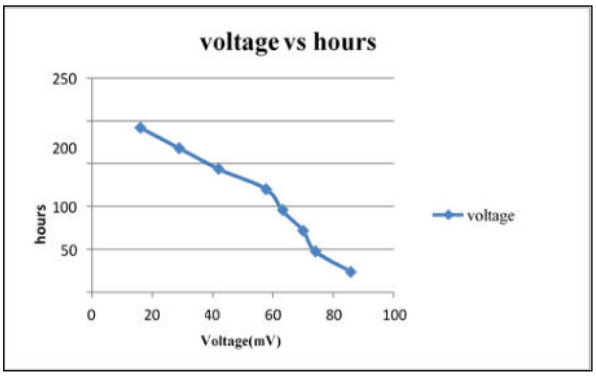

Fig 2: Voltage(mv) Of Current Produced By The Bacterial Isolates

DISCUSSION

Both waste disposal and crisis and fuel combustion problems may no longer continue to be challenging occurrences. Since wastes that are regularly generated comprise about 60% of agricultural wastes, these can be channeled towards bioelectricity production by means of MFCs with suitable biocatalysts as is reveled in this present study, which demonstrated the possible application of different organic wastes for electricity generation using microbial fuel cell technology.

The effect of the MFC with the consortium was monitored is shown in Table 1. The dual chamber that one side was anaerobe and other side is aerobe gave the maximum energy of 86mV at the 1 day of the operation when banana peel was used as electron donor in Figure -1. As earlier stated, time was also a good factor to be considered. As the time increased, there was always a fall in the amount of power produced. This was a result of a reduction in the available nutrients and carbon sources present in the substrate as well as the growth pattern of each organism. This is because the organism tend to reduce the work output as they head toward the stage of decline (Figure-2). Previous study carried out the ability of organism like *Escherichia coli and Bacillus sp.,* that utilize the Banana peel and pineapple peel as a substrate for the organism growth that reduces the energy when monitoring, it was performed as a comparative study by Okeke Ugochukwu Chibueze et.,al 2018.

The sample used for the isolation of *Escherichia coli* from sewage sludge sample, *Pseudomonas sp., and Bacilli sp.,* from the decompost hay soil in Gandhigram that was inoculated and isolated in EMB medium for *Escherichia coli*, Nutrient media for *Pseudomonas sp., and Bacilli sp., were pseudomonas sp.,* showed the green pigmentation. The isolate from here was also proven to be a good electrogenic organism useful in the running of Microbial Fuel Cell. It is also economical as it cut the expenses imposed by the use of artificial mediator which acts as electron shuttle by producing its own as proposed by Derek(2008). The inoculation of organism in the anode chamber in the MFC were done and the chamber yielded different voltage which was a result of the amount of carbon supplied by the substrate and the internal resistances.

In the MFCs, the electricity was produced by the microbial growth in the anaerobic anode compartment, while the organic wastes were consumed by active microorganism or enzymes (Figure-1). The electrode in the MFC were copper wire in both sides and that was wrapped with wire gauge to increase its surface for bacterial attachment and boost increase in voltage. It was tightly fixed with the container containing medium, culture which is in accordances with Wei et.al.,(2011). The organism used for the MFC was recorded for the aid of the spectrometer at 540nm for population growth before inoculation that was proved by Saravanan and Angel (2015).

The bacteria used for the study was identified based on cultural, microscopic examination. Various biochemical isolates were carried out such as Gram staining, Oxidase, Catalase, MRVP.

It showed that the organism isolated was Gram negative and Positive rod, Aerobic and facultative anaerobic, Positive and Negative biochemical results as it is a consortium of *E.coli*, *Pseudomonas species, Bacillus species.,* the mixed culture showed the best activity proved by Sun et.al,(2011a).

The result from this showed that the organisms can be used as electrogenic for the Microbial fuel cell for electricity generation and the organic wastes such as Banana peel is used to support the growth and as such, they not be seen as a mere waste.

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