ELECTRICITY GENERATION FROM *BACILLUS SUBTILIS* ISOLATED FROM AEROBIC SLUDGE USING MIRCOBIAL FUEL CELL TECHNOLOGY AND ITS OPTIMIZATION

Dr. K. Vanmathiselvi*1 and P. Komathi2

1Asst. Professor, Dept. of Microbiology, Sri Akilandeswari Womens College, Vandavasi.
2Research Scholar, Dept. of Microbiology, Sri Akilandeswari Womens College, Vandavasi.

ABSTRACT

The aim of the present study is to investigate electricity generation from microbial fuel cells which treat sewage waste water treatment and bioelectricity generation. In this process the sewage waste water effluent were treated for DO, BOD, COD, TDS, TSS, TS, Total alkalinity and acidity. The number of bacterial colonies was isolated. Two different chambered such as cathode and anode (negative and positive) is prepared. The maximum current generated with membrane and salt bridge MFCS was 0.73, 0.31 and 0.23 volt respectively. The produced voltage and current intensity were measured using various ph range, Temperature and nutrient supplementation. In this report the sewage sludge waste was utilized for the bioelectricity production by *Bacillus subtilis*.

KEYWORDS: Sewage sample, *Bacillus subtilis*, Microbial fuel cells and electricity generation.

INTRODUCTION

Every year the global energy demand increases. While petroleum products currently supply much of this demand, the increasing difficulty of sustained supply and the associated problems of pollution and global warming are acting as a major impetus for research into alternative renewable energy technologies Microbial fuel cells (MFCs) are bio-electrochemical transducers that convert microbial reducing power (generated by the metabolism of organic substrates), into electrical energy (Bennetto, 1984). They are an
alternative to conventional methods of generating electricity, for small-scale applications (Allen and Bennetto, 1990).

The principle of operation of MFCs lies in the extraction and transfer of electrons from microbial cells onto the anode electrode. The anode is connected to the cathode via an external electrical circuit through which electrons flow to form the current. Electrons travel from the anode (negative) to the cathode (positive) due to the redox potential difference that exists between their dissimilar liquid solutions.

Microbial fuel cells (MFCS) technology represents a promising approach for generating electricity from biomass using bacteria. A MFC is a bioreactor that converts the energy stored in the chemical bonds of organic compounds directly into electric energy through electro catalytic reactions of microorganisms under anaerobic conditions.

MATERIALS AND METHODS

Sample collection
Sewage effluent sample was collected from lactic field in Vandavasi, Tamilnadu, India (Plate– I). The effluent sample was collected in plastic containers and stored in refrigerator.

Analysis the physico chemical parameters
The physico-chemical parameters such as Dissolved oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Alkalinity and Acidity, Total solids, Total Dissolved Solids (TDS) and Total suspended solids (TSS) were analyzed using standard manuals APHA, (1992).

Isolation of Bacteria
Identification of Bacteria
The isolated bacterial strains (SBCI) was identified based on the cultural, morphologic and biochemical characteristics.

Electricity generation
MFC set up construction
A two chambered fuel cell was constructed. Two plastic containers each with diameter 20mm were taken and marked cathode and anode. Two holes of diameter 6mm and 1.5 mm were made on each of the lids for the insertion of the salt bridge and electrodes as shown in plate–IV. In the anode container, 60 ml bacterial culture was inoculated and in the cathode
container 60 ml potassium permanganate solution was used and the container lids were closed and sealed with tape.

**Salt bridge preparation**
Salt bridge was made with 6mm diameter level tube. The salt bridge contained a mixture of 1M potassium chloride with 5% agar. The mixture was sucked into the level tube. This salt bridge was inserted into both the containers through one hole on both containers sealed with tape. Different salt bridges were prepared by replacing potassium chloride with potassium nitrate, sodium chloride and in various combinations.

**Anode chamber preparation**
Isolated bacterial strains were inoculated in nutrient broth of pH 7.2 and incubated at 37°C at 120 rpm in shaker for 48 hrs.

**Cathode chamber preparation**
The cathode chamber, 0.1M Potassium permanganate solution was prepared. Further, various electrolyte solutions of 0.1M Potassium dichromate and 0.1M Potassium ferric cyanide were used.

**Assay of Bioelectricity Generation**
The Bioelectricity generation of isolated microbial fuel cell *Bacillus subtilis* was analyzed using different cathode chamber such as Potassium permanganate, Potassium dichromate and Potassium ferric cyanide. The bioelectricity production was operated at 37oc for 24hours and bioelectricity production level recorded using multimeter.

**Optimization of Bioelectricity generation**
**Effect of pH on the production of Bioelectricity**
The optimized media were prepared using the individual substrate and the pH was set at different level such as, 5.5, 6, 6.5, 7, 7.5 and 8 respectively by adding 1N NaoH and 1N Hcl. Then the media were autoclaved. Later they were inoculated with broth culture separately it was incubated in shaker at 27°C 3 days. After incubation the broth culture was used for bioelectricity production.

**Effect of Temperature on the production of Bioelectricity**
The optimized media were prepared individually by using the substrate and autoclaved. Later it was inoculated with broth cultures and it was incubated at different temperature such as 20,
25, 30, 35, 40 and 45 °C respectively. Then the culture was used for Bioelectricity production.

Effect of different carbon and nitrogen sources on the production of Bioelectricity
The different carbon sources (Glucose and Sucrose) and nitrogen sources (Yeast extract and peptone) was added in the 100 ml of the medium. Then the flaks were sterilized at 27 °C for 72hrs. After sterilization the inoculum was added separately. Then it was used for bioelectricity production.

RESULTS AND DISCUSSION
In the present study bacterial strains were isolated and identified from the sewage sample. The isolated bacterial strains bioelectricity productions were analyzed and also optimized the bioelectricity production using various parameters.

Assay of bioelectricity production of Bacillus subtilis
The bioelectricity generation of Bacillus subtilis was analyzed using different cathode chamber such Potassium permanganate, Potassium dichromate, Potassium ferric cyanide.

Optimization of bioelectricity generation
The bioelectricity generation of Bacillus subtilis was optimized using different physiochemical parameters such pH, temperature and supplement of carbon and nitrogen sources using potassium permanganate as a cathode chamber.

Effect of ph on bioelectricity production
The bioelectricity generation of Bacillus subtilis were analyzed using various pH range and the table-4 and fig.2. The table results revealed the highest (0.81V)level of electricity production was recorded at pH 7 compared to all other range of pH. The bioelectricity production level decreased when the pH range bellow or above 7 conditions.

Effect of temperature on bioelectricity generation
The bioelectricity production was analyzed using different level of incubation temperature by Bacillus subtilis production. The results were presented in table-5 and fig.3.Among this study increased (0.81V) amount of bioelectricity production were recorded at 35°c compared to other range of incubation temperature. Lowest level of electricity recorded at 20°c(0.52V)and45°c(0.43V).
Effect of carbon and nitration source for bioelectricity production

The *Bacillus subtilis* bioelectricity production were analyzed using different carbon and nitrogen sources such as glucose, sucrose and yeast extract peptone respectively. The results were given in table-6 and fig-4. From the table results maximum (0.83V and 0.70V).

In the present study the isolate and identified the bacterial strains from the sewage and these bacterial strains were used for the bioelectricity generation. The bioelectricity production was also optimized.

In this study maximum electricity generated was obtained at 30 to 35°C (0.81 and 0.80 V) compare to other temperature, at the same time low level of electricity Generated was noted in 20 and 45°C temperature. Dramatic increase in the output is possible through various modifications of the MFC (Park and Zeikus, 2003).

In this study investigated the nitrogen sources such as yeast extract and peptone were utilized by *Bacillus subtilis*. Electricity generation was maximum level analyzed in peptone (0.70 V) followed by yeast extract (0.68 V). When the MFCs were operated with different mediators like Methyl Orange (MO), Methyl Viologen (MV), Methyl Red (MR), Methylene Blue (MB), Bromothymol Blue (BB) and Gram’s Safranin (GS) there was an increase in the voltage output compared to the normal output (Ieropoulos et al., 2005).

**SUMMARY AND CONCLUSION**

In the present study the isolated and identified the bacterial strains from the sewage and these bacterial strains used for the bioelectricity generation.

Experimental data demonstrated the feasibility of dual chambered microbial fuel cell (MFC) in bioelectricity generation from chemical wastewater treatment without using mediator in anode chamber. Designed MFC configuration, adopted operating conditions and used selectively enriched mixed inoculums showed feasibility of power generation from chemical waste water treatment along with waste water treatment.

Major advantages of energy produced from wastewater are the absence of environmental emissions, simultaneous recovery of energy and wastewater treatment.
BIBLIOGRAPHY