Available online at www.derpharmachemica.com

Scholars Research Library

Der Pharma Chemica, 2015, 7(11):8-10
(http://derpharmachemica.com/archive.html)

ISSN 0975-413X
CODEN (USA): PCHHAX

Bioelectricity production using algae in microbial fuel cell

Merina Paul Das

Department of Industrial Biotechnology, Bharath University, Chennai, India

---

ABSTRACT

Biomass is a good choice of electricity and algae are the most easily available source of biomass. It is a bioenergy technology with maximum efficiency with minimum cost. This process is combining the biomass production with efficient conversion to electrical energy. In this study, pond water biomass was used in microbial fuel cell (MFC) to produce electricity. Different sets of electrodes were used to get highest amount of current. Among them, zinc mesh (anode) with graphite sheet (cathode) showed significant results. Mixed and pure algae cultures were used in single chamber MFC, but mixed culture gave lower power output than the pure one. Chlorella sp. as a pure culture showed maximum voltage output when compared to Spirulina sp. in single chamber MFC.

Keywords: Microbial fuel cell, Electricity generation, Algae.

INTRODUCTION

The increased use of fossil fuels leads various serious issues like global energy crisis, environment pollution as well as global warming. Microbial fuel cell is not only an attractive alternative energy sources, it can be also used as a tool for hydrogen production, bioremediation and biosensors. Power can be generated from biodegradable biomass. Solar energy conversion by plants and algae into biomass, also called bioenergy, may encompass considerable shares in future sustainable renewable energy production as heat, hydrogen, methane, electricity, and other biofuels [1]. The cultivation of algae has several advantages over other terrestrial plants; they require less space (1/7th less surface area), have higher growth rates, and do not compete with food production [2]. Algae can be classified into macroalgae and microalgae and energy generation using these was examined by various research workers. Microalgae have been tested as raw material for the production of bio-oil [3], methane [4, 5], methanol [6] and hydrogen [7,8]. Macroalgae have primarily been used to produce methane [9-11].

Microbial fuel cells (MFCs) are the promising technology that converts the energy stored in chemical bonds in organic compounds to electrical energy achieved through the catalytic reactions by the electrochemically active living organisms. MFCs have been demonstrated by several groups both with and without the use of mediators to facilitate electron transfer to the anode. The mediatorless fuel cell has an advantage over those with mediators in terms of cost and the absence of undesirable toxic mediators. Successful systems have been constructed without expensive selective membranes, mixed communities have been successfully exploited in a number of MFCs and, more recently, electricity has been generated using complex energy sources, including wastewater [12].

Microbial fuel cells (MFCs) offer an alternative way to obtain electricity from the hydrolysis and fermentation of algae in only one process unit. MFCs consist of an anode and cathode connected by a copper wire. The anode contains mixed or pure cultures of microorganisms that are used to catalyze the decomposition of the organic matter

into electrons and protons. Power is produced through the reduction of oxygen or another chemical at the cathode [13]. In the present study, attempt has been made to produce bioelectricity from different algae sample and to evaluate the optimization of electricity generation by using different electrodes.

MATERIALS AND METHODS

Isolation of algae

To generate the electricity by algae, pond water was taken as it is rich source of algae. Pond water was collected near Tambaram, Chennai. For isolation of algae, Bold's Basal medium was prepared and pond water sample inoculated for 4-5 d in controlled light and temperature conditions. 1 ml of pond water taken and algae was observed through light microscope and identified. Finally pure culture of individual algae was maintained in medium for further studies.

MFC set up

The design of the microbial fuel cell was consisted of single chamber where the pond water was directly used as fuel. Different types of electrodes were used. The length and breadth of electrode was 7 cm and 1 cm respectively. The electrodes were sterilized by soaking in 100 % ethanol for 30 min followed by 1M HCl for 24 h. The salt bridge is made out of KCl with agar. To study the effect of electrode on power generation, three sets of electrodes were used (Table 1). In addition to this, individual identified algae sample was used in single chamber and compared.

Table 1 Microbial fuel cell with different electrode set up

MFC	Cathode	Anode
MFC-1	Carbon rod	Lead
MFC-2	Stainless steel mesh	Lead
MFC-3	Graphite sheet	Zinc mesh

RESULTS AND DISCUSSION

Screening of algal sample for MFC

Pond water contains various types of algae. Here *Chlamydomonas, Chlorella, Spirulina, Micrococcus, Phormidium* sp. were found in the pond water but especially *Spirulina* sp.,*Chlorella* sp. were screened for this study because concentration of these two were high.

Performance of MFC

The power generation by algae is having more advantages because rate of growth is very high and thus it converting the solar energy to chemical by photosynthesis, chemical to electrical energy by microbial fuel cells in large amounts. It is the one of the cheapest source of fuel. Here initially mixed algae culture was used in single chamber MFC with three different types of electrodes for 10 d. Among these, MFC-3 consists of zinc mesh as anode and graphite sheet as cathode, showed better result (Figure 1). It produced maximum voltage of 0.48 v where the rest two produced the same (0.42 v).

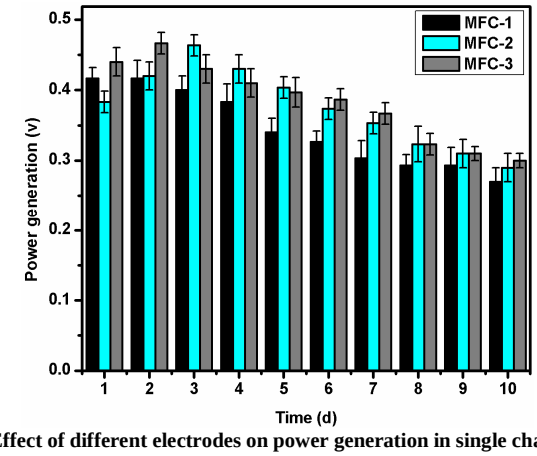

Figure 1 Effect of different electrodes on power generation in single chamber MFC

From the pond water, maximum growth was found for *Chlorella* sp. and *Spirulina* sp. Thus pure culture of each algae sample was used to produce electricity in single chamber MFC for 10 d. The results indicated that pure culture produced stable and more power than the mixed one. Among these potent pure cultures, *Chlorella* sp. can generate more electricity than *Spirulina* sp. (Figure 2). *Chlorella* sp. can produce 0.99 v whereas *Spirulina* sp. 0.96 v. It might be due to *Chlorella* sp. is participating in photosynthesis in higher rate and thus fast growing and converting maximum amounts of energy.

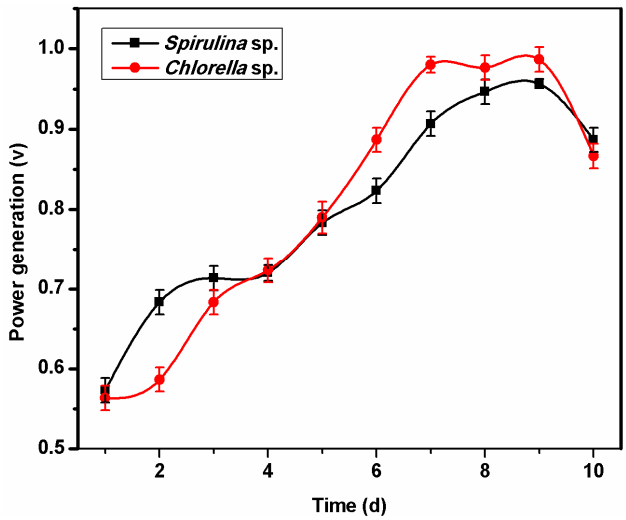

Figure 2 Comparison of power generation by *Chlorella* sp. and *Spirulina* sp

CONCLUSION

MFCs represent a promising, novel, cost effective, environ-benign technology for sustainable energy production. This study suggests that not only microorganisms, algae can produce the electricity in same efficiently with the microbial fuel cells. The results also implies that the diversity of algae that have been produce electricity in MFCs with concomitant transfer of electrons to an MFC electrode. The power density output from MFCs might be improved by altering the design of MFC configuration or changing the physical/chemical environment.

REFERENCES

[1]A.J. Ragauskas, C.K. Williams, B.H. Davison, G. Britovsek, J. Cairney, C.A. Eckert, W.J. Frederick, J.P. Hallett, D.J. Leak, C.L. Liotta, J.R. Mielenz, R. Murphy, R. Templer, T. Tschaplinski, *Science*, **2006**, 311, 484.
[2] E. Hartman; A promising oil alternative: Algae energy. The Washington Post, **2008,** 6.
[3] X. Li, H. Xu, Q. Wu, *Biotechnol. Bioeng*., **2007,** 98(4), 764.
[4]C.G. Golueke, W.J. Oswald, *Appl. Microbiol*., **1959**, 7(4), 219.
[5]T. Minowa, S. Sawayama, *Fuel*, **1999**, 78(10), 1213.
[6]A. Hirano, K. Hon-Nami, S. Kunito, M. Hada, Y. Ogushi, *Catal. Today*, **1998**, 45(1–4), 399.
[7]M.S. Kim, J.S. Baek, Y.S. Yun, S. Jun Sim, S. Park, S.C. Kim, *Int. J. Hydrogen Energy*, **2006**, 31(6), 812.
[8]J. Turner, G. Sverdrup, M.K. Mann, P.C. Maness, B. Kroposki, M. Ghirardi, R.J. Evans, D. Blake, *Int. J. Energy Res*., **2008**, 32(5), 379.
[9] G. Hansson, *Resour. Conserv*., **1983**, 8(3), 185.
[10]P. Morand, X. Briand, *J. Appl. Phycol*., **1999**, 11(2), 164.
[11]R.A. Troiano, D.L. Wise, D.C. Augenstein, R.G. Kispert, C.L. Cooney, *Resour. Recov. Conserv*., **1976**, 2(2), 171.
[12]Keith Scott, Cassandro Murano, *J. Chem. Technol. Biotechnol*., **2007**, 82, 809.
[13]G. Ramanathan, R. Sanath Birthous, D. Abirami, Highcourt Durai, *World J. Fish & Marine Sci*., **2011**, 3(1), 79.