Studies on Bioelectricity Generation From Yeast by Using Mediator microbial Fuel Cell

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Abstract- *Yeast microbial fuel cells have received little attention to date. Yeast should be ideal MFC catalyst because they are robust, easily handled, mostly non-pathogenic organisms with high catabolic rates and in some cases a broad substrate spectrum. In the present research, bioelectricity was generated by using yeast cell within pH 6 to 8 and at RT by using MFC technique. Here we showed that bakers yeast transfers electrons to an electrode through the secretion of a reduced molecule that is not detectable when washed cells are first resuspended but which accumulates rapidly in the extracellular environment. It is a single molecule that accumulates to a significant concentration. Single dual chamber and multi chamber method of MFC were used for bioelectricity generation under anaerobic condition for 24 hours. On 12 hrs in multi chamber method 2.26V were generated.The bulb (LED) glowed prominently at this voltage. From this study it is concluded that bekers yeast is a good candidate for bioelectricity generationin a MFC technique.*

Keywords- yeast, Mediator, MFC technique, bioelectricity.

I. INTRODUCTION

Energy is the most important factor in today's world. To find out novel sources of energy is the need of time. Increasing human activities are consuming the natural energy sources leading to depletion of fossil fuels. Nearly all the conventional energy production processes practiced today which requires combustion of polluting fossil fuels are expensive and are not considered to be environmental friendly [1,2].The US Department of Agriculture and Energy claims that nearly 30% of the United States' energy needs could be met using energy from biomass instead of fossil fuels [3]. Electricity can be generated by many ways. Multidirectional research regarding electricity generation is in progress all over the world. Lignin and cellulose, the largest sources of carbon in plants, are mostly unavailable for exploitation because they are difficult to efficiently break down into useful products [4].A microbial fuel cell (MFC) is a bioreactor that converts chemical energy in the chemical bonds in organic compounds to electrical energy through catalytic reactions of microorganisms under anaerobic conditions. It has been known for many years that it is possible to generate electricity directly by using bacteria to break down organic substrates. . MFCs can also be used in wastewater treatment facilities to break down organic matters and lower down BOD values.

MFC consists of anodic and cathodic chambers partitioned by a proton exchange membrane (PEM). These released electrons pass through the semi permeable membrane or agar salt-bridge that connects the two chambers of the Microbial Fuel Cell (MFC). The transferred electrons generate a current and can be used to power devices [6].In a MFC, bacteria that oxidize a substrate are kept physically separated from the electron acceptor by a proton exchange membrane. Electrons pass from the bacteria to the electrode (anode) in the same chamber and then via a circuit to the cathode where they combine with protons and oxygen to form water. The difference in the potential coupled to electron flow produces electricity in this fuel cell. Electrons generated by bacteria through the anaerobic oxidation of organic matter (by non fermentative reactions) are passed to respiratory enzymes normally bound to the inner cell membrane [7]

The performance of a MFCs is mainly influenced by several factors such as: (1) supply and consumption of oxygen in cathode chamber, (2) oxidation of substrates in anode chamber, (3) electron shuttle from anode compartment to anode surface, and (4) permeability of proton exchange membrane [8]. Protons produced in the anode chamber migrate into the cathode through the proton exchange membrane or salt bridge which complete the electrical circuit.

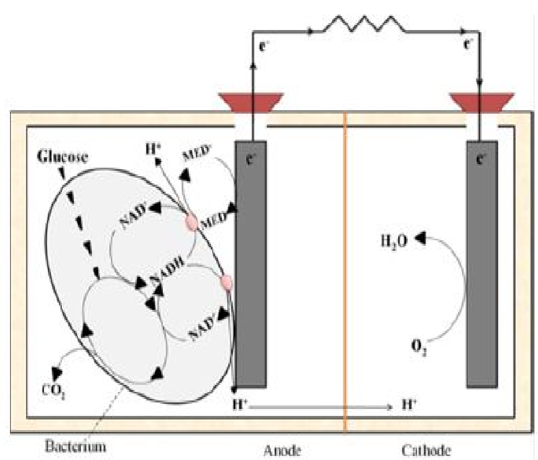

Fig.1 Working principle of a microbial fuel cell

For the complete oxidation of glucose, the anodic reaction is given by :-

$C_6H_{12}O_6 + 6H_2O \rightarrow 6CO_2 + 24H^+ + 24e^-$

The electrons are transferred to the cathode compartment through the circuit, because of the potential difference developed between the reducing anode and cathode supplied with air. The protons are transferred to the cathode through the membrane. The electron and proton are consumed, reducing oxygen in the cathode compartment (cathode reaction) :-

$24H^+ + 24e^- + 6O_2 \rightarrow 12H_20$

In an ideal condition, 24 electrons should be produced form one molecule of glucose to give twelve molecules of water in the cathode [9,13].

In the present research work bioelectricity generation was carried out from Bekers yeast by using Mediator MFC.

II. MATERIALS AND METHODS

(A) Sample collection and storage

The sample for bioelectricity generation yeast sample were used which was collected from Atharv Bekary industry sangli(M.H) and stored at refrigerator for further use.

(B) Construction of MFC

In the present study a two-chamberedmicrobial fuel cell was constructed from two glass bottles were purchased from market. They marked as a cathode and anode chamber.One hole were made on each of the lids for the insertion ofelectrodes while same holes were made at bottom half of glass bottles for the preparation of salt bridge.

(i) Anode chamber preparation

For the preparation of anode chamber, first carbon electrode were sealed to hole of anode glass bottle lid. then sample was used for bioelectricity production.

(ii) Cathode chamber preparation

For the preparation of cathode chamber, second **c**arbon electrode were sealed to hole of Cathode glass bottle lid.

(iii) Salt Bridge preparation:

Salt bridge was prepared with a 10mm diameter level of PVC pipe. In that pipe 1% agarose were poured as a proton exchanger and This salt bridge was inserted into both the anode and cathode into bottom holes.

(iv) Electrodes:

Carbon rods were used as electrodes in both anode and cathode chambers with copper wire connections.

(C) Anode solution for bioelectricity generation

24hrs. old culture of yeast cells was inoculated in 500ml nutrient broth. 2% glucose solution was added to the mixture with 10ml 0.04% w/v methylene blue.

(D) Cathode solution: 500ml of $K_2Cr_2O_7$ solution.

III. RESULTS AND DISCUSSION

The experiment of bioelectricity was carried out for 24 hours i.e. 1 days in single dual and multi chamber method under anaerobic conditions [13]. The experiment showed bioelectricity production fromyeast which is single cell microorganism converts sugars into carbon dioxide and ethanol. Growth enhancers like glucose when added to enhance the growth of and mediators such as methyl orange which was added to enhance the transport of electrons from cell to electrodes in MFC [8]. In the sample of different sets there was production of electricity due to fermentation of organic materials in the anaerobic condition when incubated at room temperature. The bioelectricity generation was observed in the bekers yeast cell sample, the pH of sample was adjusted to pH 6 to pH 7 [16]. The highest electricity generation was observed with pH 6.2 with 2.26V. The experiment was performed at room temperature. The MFC was continuously monitored during experiments and readings were take after each 4 hours of inoculation, inoculation time was considered as time '0' and after 24 hours first reading was taken. Fuel cell was operated for 24 hours i.e. 1days for samples. The experimental data showed the feasibility of electricity generation from yeast cells was effective as campared to Bacterial pure or Mixed culture.

In this study, single dual-chambered MFCs did not generate high voltages. It has been shown that using MFCs in series connection gives a higher voltage[22]. Connecting three MFCs (Bakers yeast) in series connection gave a higher voltage of 2.26 V.

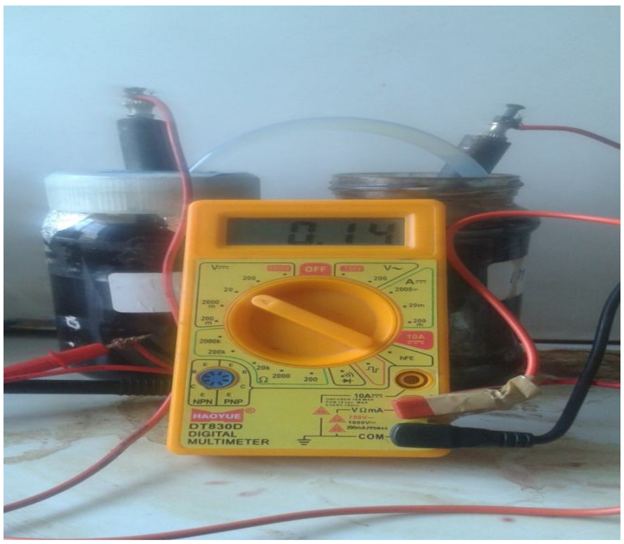

Figure:I Bioelectricity generation from yeast cells on 4hours of first day of incubation by single dual chamber method.

Figure:IIBioelectricitygenerationfromyeastcellson8th hours of first day of incubationby single dual chamber method.

Figure:III Bioelectricity generation from yeast cellson 16 hours of first day of incubation by single dual chamber method

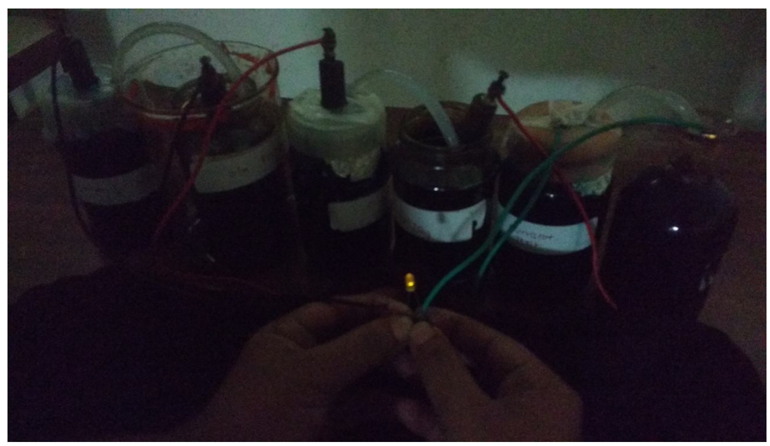

Figure:IV Bioelectricitygenerationfromyeastcellson24 hours of first day of incubation by multi chamber method.

IV. CONCLUSIONS

From the present study, it can be concluded that the yeast is efficient to generate bioelectricity as compared to pure bacterial culture and polluted water samples.

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