Comprehensive study of the level of electrolyte in selected organic wastes by using double chamber microbial fuel cell

V.Thushyanthini[a] V.Kirusanthy[b] S.Loheeswaran[a,b,*]

[a]p.thushy94@gmail.com
[a]Department of Physical Science, Trincomalee Campus, Eastern University, Sri Lanka
[b]Department of Physical Science, Trincomalee Campus, Eastern University, Sri Lanka

Abstract

Microbial fuel cells technology is most attractive alternative energy source to generate bioelectricity from wide range of substrates by using bio electro genic microorganisms. It has special interests on supply the energy demands for small devices by using waste materials. In this study a prototype double chamber microbial fuel cell was developed with copper as cathode and anode electrodes and salt bridge as the proton exchange membrane. The performance of microbial fuel cell was tested with the substrates extract from waste vegetables and fruits such as Potato, Wood apple and Mango to generate bioelectricity over a testing period of 20days and without renovation of substrates in the batch mode operation. Results reveal that the average value of open circuit voltage for Potato, Wood apple and Mango are 315,307 and 299 mV respectively. The output voltage depends on reaction of microorganisms, electrode and environmental conditions. The micro-organisms growth and multiplication period, the output voltage is high and the output voltage pattern over the tested period shows good agreement with growth pattern of microorganism.

Keywords: Microbial fuel cell, double chamber, microorganism and electricity;

1. Background and Objectives

The microbial fuel cell (MFC) technology is one of the most attractive technologies at present for renewable energy production. MFCs are the bio electrochemical devices that utilize microorganisms as the biocatalysts to convert the chemical energy present in organic or inorganic compounds into electric current [1]. A typical double-chamber MFC is made up of two chambers, i.e., the anode and the cathode. Usually a proton exchange membrane (PEM) is placed between these two chambers that allows the protons produced at the anode to pass through itself to the cathode. The cathode and the anode are connected by an electrical circuit (e.g., with titanium wires or copper wires) to make it a complete system. The organic substrates are oxidized by the microorganisms at the anode chamber and produce electrons, protons and carbon dioxide. The electrons generated from the microbial metabolic activity are firstly transferred to the anode surface by redox-active proteins or cytochromes and then passed to the cathode through electrical circuit[2].

In this study electricity generate from vegetables and fruits waste (Potato Wood apple and Mango) by using double chamber microbial fuel cell and evaluate the relationship between the phases of bacterial growth curve and open circuit voltage for vegetables and fruits waste (Potato Wood apple and Mango).

2. Materials and Methods

MFC technology works with anodic chamber in anaerobic conditions; meanwhile, cathodic chamber operates in aerobic conditions, both compartments (anode and cathode) are usually separated by a proton exchange membrane (PEM)[3]. However, in this study the DMFCs employed a salt bridge as membrane, and the anode and cathode electrodes were made of copper plates (25mm×15mm). Water and organic waste were kept in cathode and anode respectively and without renovation of microbial fuel and over a testing time of 20 days in batch mode of operation. The open circuit voltage measure was carried out daily by using a digital multimeter.

3. Results and Discussion

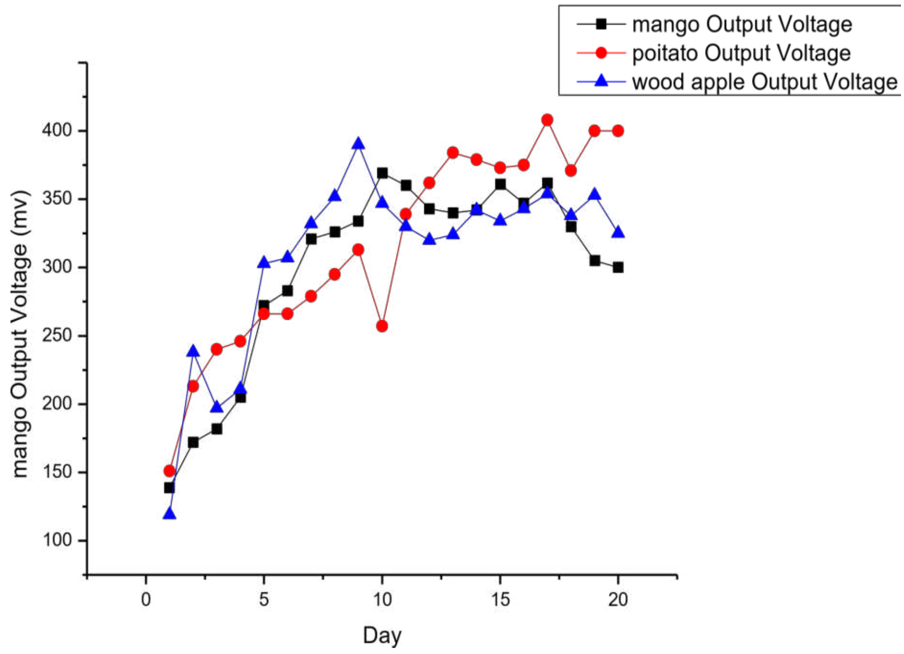

Fig 1: Open circuit voltage changes with days in potato wood apple and mango sample

Fig 1 shows that the open circuit voltage variation with 20 days period for potato wood apple and mango waste. For potato waste during the first 13 days, Microorganisms were grew & multiplied in the potato waste. As result, the open circuit voltage was suddenly increased. After 13 Days, microorganisms were survived. So, open circuit voltage was also not increased. Maximum voltage (408mV) at day 17 and minimum voltage (151mV) at day one was generated by potato waste. For Wood apple waste during the initial 10 days, Microorganisms were grew & multiplied in the Wood apple waste. As result, the open circuit voltage was suddenly increased. After 10 Days, microorganisms were survived. So, open circuit voltage was also not increased. Maximum voltage (390mV) at day 9 and minimum voltage (119mV) at day one was generated by wood apple waste. These graphs represented the lag phase and stationary phase for bacterial growth curve. For mango waste during the first 8 days, Microorganisms were grew & multiplied in the mango waste. As result, the open circuit voltage was suddenly increased. After 8 Days, microorganisms were survived. So, open circuit voltage was also not increased. After 17 days, microorganisms were not survived in mango waste. So open circuit voltage was suddenly decreased. Maximum voltage (369mV) at day 10 and minimum voltage (139mV) at day one was generated by mango waste. This graph represented the lag phase stationary phase and death phase for bacterial growth curve. On average the open circuit voltage for potato, wood apple and mango are 315,307 and 299 mV respectively. The results also concur with the study conducted by Logroño et al, in which they obtained open circuit voltage as 330mV [4].

4. Conclusion

A prototype double chamber microbial fuel cell was successfully developed and tested by using waste fruits and vegetables. The output voltage pattern over the tested period shows good agreement with growth pattern of microorganism. During the micro-organism's growth and multiplication period, open circuit voltage value is high.

References

1. Aelterman et al. 2006; Bermek et al. 2014; Kumar et al. 2016.
2. Borole AP, Reguera G, Ringeisen B, Wang ZW, Feng Y, Kim BH (2011) Electroactive *biofilms:* current status and future research needs. Energy Environ Sci 4:4813–4834. doi:10.1039/ C1EE02511B.
3. Ringeisen BR, Henderson E, Wu PK, Pietron J, Ray R, Little B, et al.High power density from a miniature microbial fuel cell using Shewanella oneidensis DSP10. Environ. Sci. Technol. 2006; 40: 2629–2634