The Effect Of Plant Types On Dual Chamber Biological Fuel Cells To The Generated Electricity

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Abstract: Excessive use of fossil fuels causes a change in the climate cycle due to the accumulation of CO_2 and CO emissions. The use of alternative energy from renewable energy sources becomes the main objective to reduce the positions of fossil fuel consumption. Biological fuel cells or microbial fuel cells are power plants that take advantage of the breakdown activity of organic substrates by microbes. Biological fuel cells are still little used as conventional power plants because it takes a long time to meet the needs of everyday energy. The density of the power can be increased by continuously substrate the anodic region, one of which can be done by utilizing the secretory system of some of the photosynthetic products in living plants. The use of ornamental plants sansevieria golden hahnii as a biomass-producing medium of organic exudate can produce power reaches 145.02 W / m2 in one day.

Keywords: Biological fuel cells**,** microbes, plants.

1. Introduction

In Indonesia, energy sources still depend on fossil fuels. As the exhaust gases of monoxide and carbon dioxide by fossil fuels lead to climate change as well as annual cycles so that flora and fauna that are unable to adapt are extinct. Reduction of global warming is by developing and applying renewable energy sources to meet energy needs without destroying the ecosystem. Biological fuel cells are the least used source of energy because of their small time efficiency. Plants that produce additional substrates and are easily reduced by Saccharomyces Cerevisiae can improve the time efficiency of Biological fuel cells. Biological fuel cell (BFC) is known as a technology that can generate electrical energy through the process of degradation of organic materials by microorganisms through catalytic reactions or through the mechanism of bio-electrochemical systems of microorganisms. Various microorganisms play a role in BFC, ranging from aerobic, facultative anaerobes or obligate anaerobes. BFC has many advantages over technology that generates energy from other biomass sources, including high efficiency, soft operating conditions, no input energy required, and can be applied to various places with poor electrical infrastructure. Living plants photosynthesise on the leaves by using solar energy. Photosynthesis integrates carbon dioxide in the form of carbohydrates. Up to 60% of the carbon can be transferred from the leaves to the roots Depending on the plant species, age, and environmental conditions. Plant roots produce and release various types of organic compounds into the soil, which include (1) exudates: sugars and organic acids; (2) secretion: polymer and enzyme carbohydrates; (3) lysates: dead cell material; and (4) gas: ethylene and CO2. The total of this release process is called the rhizodeposition of the plant and its product, rhizodeposit, which is used in Plant Biological Fuel Cells (P-BFC) as renewable bioenergy substrate. The resulting rhizodeposit accounts for 40% of the productivity of plant photosynthesis. Rhizodeposit plays many roles in the rhizosphere. Carbonic acid has been contained in the mobilization of cation nutrients bound to the soil to be taken by plants. Rhizodeposit contains carbon and part of this carbon can be exploited by microorganisms in rhizosphere, which can cause mutual interaction between plants and microorganisms. Microbes can interact positively with plant roots by forming protective biofilms or by producing antibiotics as biocontrol against potential pathogens.

2. Materials and Methods

The building structure of biological fuel cells uses dual chamber, which consists of anodic chamber, cathodic and salt bridges. The anodic chamber is an anaerobic space, which holds the substrate and biocatalyst - Microorganisms. The cathodic space is maintained under aerobic conditions. The salt bridge that forms the bridge connecting the cathodic and anodic spaces facilitates the transfer of ions (protons). The anodic chamber is a potted pyramidal trapezoidal pot with a dimension of a 10cm square bottom, an upper rectangle of 14cm, and a height of 15cm. In the anodic chamber is placed soil as much as 100 ml and then placed the anode above it. S. cerevisiae between the anode surface and the soil. Then on the ground given the plant. In the cathodic space it has the same dimensions as the anodic chamber. In the cathodic room was given 600 ml of water and above the water surface in a cathode that is conditioned to float. On one side of the two chamber walls were given a hole of 2.55 cm and the two holes were connected to a 5 cm long PVC pipe containing 0.1 M NaCl salt. The electrodes used in this study were a 64 cm2 aluminum plate with 0.3 mm thick as anode, and copper plate copper plate measuring 100 cm2 with a thickness of 0.3 mm as a cathode. Two electrode cables connected with 1KΩ ± 5% resistor in parallel can be seen in Figure 1.

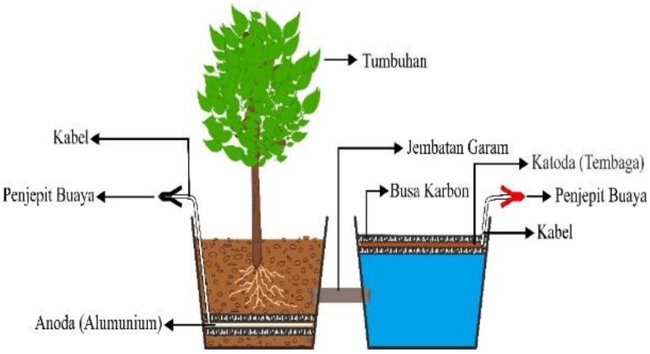

Figure 1. *Structure design of P-BFC*

The study used an experimental method using nine microbial fuel cells, nine microbial fuel cells consisting of three different treatments and each treatment was repeated three times. The nine cells are placed in Greenhouse UPT Agrotechnopark, University of Jember. Plants used in this study are white Jasmine (Jasminum sambac ait), Sirih Gading (Epipremnum Aureum), Lidah Mertua (sansevieria golden hahnii). The study was conducted for 14 days. Before the measurement is done incubation for 7 days. This study focuses on measuring voltages and currents.

3. Result and Discussion

Total use of dual chamber on biological fuel cells or microbial fuel cells is decreasing. This is due to dual chamber is considered less ergonomic. But the use of dual chamber itself has a positive value of ion transfer in the redox reaction that occurs in BFC faster. So it can increase the coloumbic efficiency. Power density can be calculated using the equation:

$$Pd = V.\frac{I}{A}$$

Where :
Pd = Power Density (W/m^2)
V = Voltage (V)
I = Current (A)
A = Anode Area (m^2)

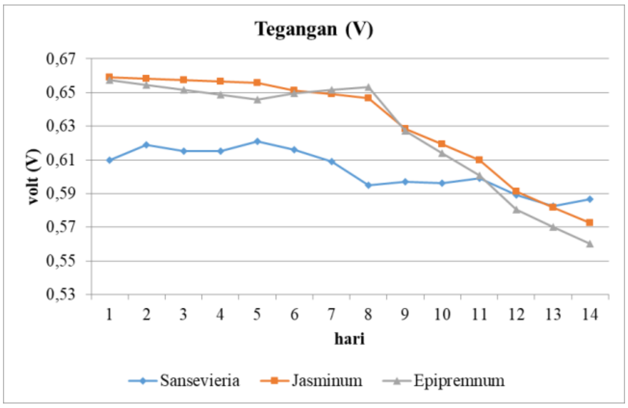

Figure 2. *The Voltage Chart of P-BFC*

On the first day until the eighth day jasminum and epipremnum have almost the same voltage, while different with sansevieria which has a smaller voltage than both. However, after the eighth day of the jasminum and epipremnum decreased to a value of 0.57 V for the jasminum and 0.56 V for epipremnum, whereas sansevieria did not have a significant reduction, the voltage difference on the first day by the fourteenth day was 0.02 V as shown in Figure 2. Current measurement results in this system has an inverse value with voltage. The P-BFC flow using sansivieria has a higher current rating than the jasminum or epipremnum. The current P-BFC sansevieria decreased on the ninth day with a value of 1.35 mA. However, the P-BFC sansevieria current rises again and reaches its peak on the eleventh day with a value of 1.54 mA as shown in Figure 3. The magnitude of the current value indicates the speed of the electron diffusion process through the anode to the external resistor and then reacts with the ions in the cathode chamber across the salt bridge because potential difference.

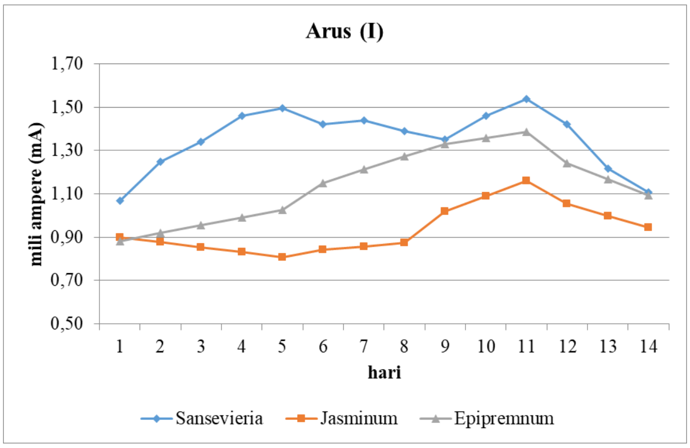

Figure 3. *The Current chart of P-BFC*

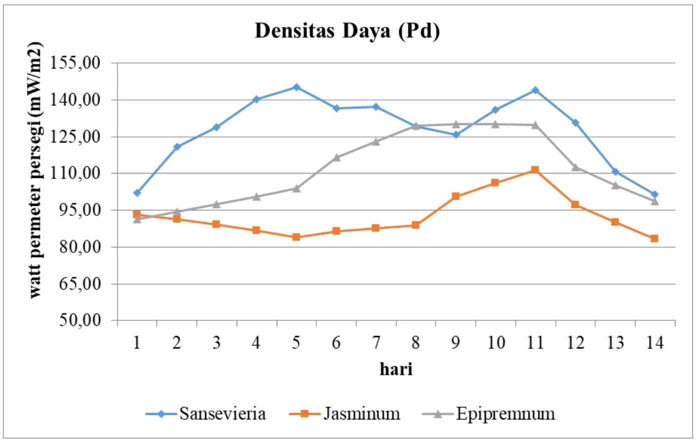

Figure 4. *The Power Density Chart of P-BFC*

The power density or the unitary power of unity is measured by the product of voltage and current per day then divided by the area of the anode. As shown in Figure 4 the power density (Pd) value of P-BFC sansevieria has a higher value than that of the jasminum or epipremnum. The trend shown by the Pd graph has a direction similar to the current. This suggests that S. Cerevisiae has a more ideal living environment under the roots of sansevieria plants than with jasminum and epipremnun. From the Pd chart shown from the twelfth day to the fourteenth day P-BFC from the three plants showed a continuous decline, indicating that the P-BFC system with S.cerevisiae is saturated due to the acid build-up produced by microbes.

4. Conclusions and Recommendations

Biological fuel cells using plants (P-BFC) have a more stable system and potentially contribute to bioenergy substrates continuously. Substrates of bioenergy released through the root-to-soil secretion system have an effect on microbial survival. The type and amount of bioenergy substrates released by plant roots depends on the type, age, and environmental conditions occupied by plants. From the results of this study, Sansevieria showed higher Pd value, maximum value of Pd for P-BFC sansevieria that is equal to 145.02 mW / m2.

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