Indonesian Journal of Science and Education
Volume 06, Nomor 02, 2022, pp: 18-24
p-ISSN:2598 –5205, e-ISSN: 2598-520, DOI: 10.31002/ijose.v6i2.81
e-mail: ijose@untidar.ac.id, website: https://journal.untidar.ac.id/index.php/ijose/index

ENERGY STORAGE SYSTEM BASED ON CEREMAI FRUIT PASTE AS ALTERNATIVE ENERGY SOURCE

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Received: March, 11th 2022 *Revised: September, 20th 2022* *Accepted: October, 10th 2022*

ABSTRACT

This study aims to analyze the paste of ceremai fruit (Phyllanthus acidus) as a battery electrolyte replacing Manganese dioxide as an alternative energy source. The material used is battery that has carbon (C) and zinc (Zn) electrodes. Battery electrolyte derived from MnO2 was replaced with electrolyte from ceremai fruit paste. The variables measured were electric voltage, electric current and electric power. Based on the results of research and data analysis, the electrolytes from ceremai fruit paste can be used to replace the MnO2 electrolyte which is usually used as a battery electrolyte as an alternative energy source. Although the output voltage is lower. This can be overcome by assembling the bio-battery through a series circuit. The series of 11 bio-batteries circuit can light 6 volt lamp brightly because it can produce a voltage of 6.79 volts. The existence of a load on the lamp can be decreasing in source voltage. The decrease in source voltage followed by an increase in the value of the electric current.

Key Words: electric properties, ceremai fruit paste, bio-battery

INTRODUCTION

Electrical energy is an important factor that influences the development of life in modern era. There is a very rapid technological development in line with the growing demand for electrical energy. This is marked by the large number of electronic equipment uses, but it is not followed by public awareness to use electrical energy efficiently because there is no public awareness that the availability of energy is very limited (Antonov & Rahman, 2015).

Currently, most of the sources of electrical energy used are fossil energy sources such as oil, natural gas, and coal which are not that can be immediately renewed energy source. In addition, fossil energy sources are not environmentally friendly because they can caused air pollution and it takes very long time to be able to renewed (Vassel et al., 2021). This problem solved by alternative energy sources that are environmentally friendly and can be renewed in a short time are needed.

Alternative energy is energy source produced from materials that have never been widely used such as plants (Spets et al., 2010). The energy content used as alternative energy is carbohydrates, glucose, amino acids and enzymes (Fadilah & Rahmawati, 2015). The energy content is considered environmentally friendly because it does not contain chemicals and is made from renewable organic materials.

There are two methods used in the utilization of renewable materials such as fruits as an alternative energy source generally, like galvanic cells (Mertin et al., 2021; Shevtsof et al., 2021; Suciyati et al., 2019; Vassel et al., 2021; Vassel & Vassel, 2020) and Bio-battery (Khairiah, 2017; Pulungan et al., 2017; Sumanzaya et al., 2019). A galvanic cell is an electrochemical cell that its electrical energy occured from a spontaneous redox reaction. Spontaneous redox reactions can result in the generation of electrical energy. A galvanic cell consists of several parts such as two different metals used as anode and cathode and acidic electrolyte solution as a source of ions that produce an electric current (Lacina et al., 2018; Mertin et al., 2021; Shevtsof et al., 2021; Sulaiman et al., 2020). Bio-Battery is a battery with electrolyte derived from natural paste that are environmentally friendly and do not contain harmful chemicals. The principle of bio-battery is involves the electrons transport between two electrodes separated by a conductive medium (electrolyte) and provides electromotive force in the form of electric potential and current (Pulungan et al., 2017; Sumanzaya et al., 2019).

Bio-battery development has been carried out by using fruit paste. Sumanzaya et al., (2019) used cassava as a bio-battery electrolyte paste and produced a voltage of 0.81 volts. Pulungan et al., (2017) used bio-batteries with electrolyte paste from several types of banana peels and produced a maximum voltage of 1.12 volts.

However, previous studies have used more waste from fruit skins, which tend to rot quickly. Therefore, we need other alternative fruits with high acidity so that they can produce high electrical potential as an alternative paste in bio-batteries.

One of the fruits that can be used as bio-battery paste is ceremai fruit. Ceremai fruit contains quite high acid properties (Zulfalina et al., 2018). The acid content in fruit usually comes from citric acid ($C_6H_8O_7$) (Suciyati et al., 2019). Therefore, in this study, we tried to analyze the electrical properties of ceremai fruit as an electrolyte paste in biobatteries.

RESEARCH METHODS

This research is an experimental research conducted at the Advanced Physics Laboratory, Mataram State Islamic University. This research was conducted to determine the electrical characteristics of ceremai fruit (Phyllantus Acidus) as bio-battery electrolite.

The ceremai fruit is washed with clean water and then drained. The ceremai fruit separated from the seeds so that the pulp remains. The pulp of the ceremai fruit mashed by using blender. The bio-battery made by used dry cell type ABC battery. The manganese dioxide in the battery is then removed and cleaned using distilled water. The negative electrode on the battery uses zinc (Zn) while the positive electrode is made of carbon (C).

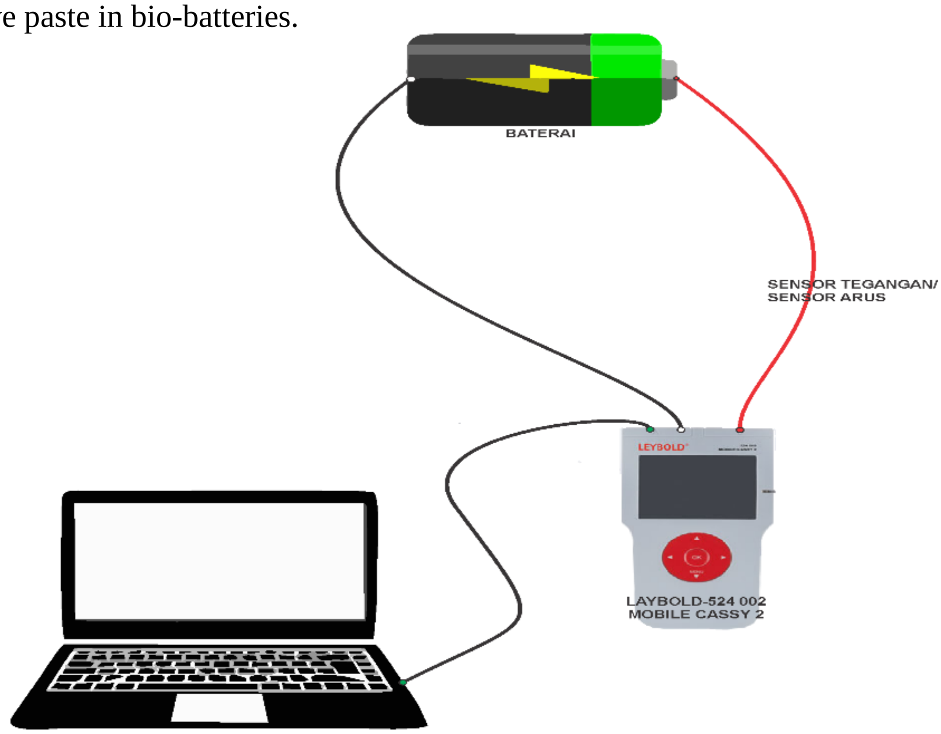


Figure 1. Bio-batteries voltage and current measuring schematic

Each cleaned and dried battery was filled with 40 grams of electrolyte paste from ceremai fruit. The bio-battery electrical characteristics measured by using Casey 2 Logger Pro type Laybold-524 002. Casey 2 Logger Pro equipped by voltage sensor with 1 nV accuracy to measure the voltage value and electric current sensor with 1 nA accuracy to determine the value of the electric current generated by the bio-battery as shown in the figure 1.

Electric power defined as the voltage generated by the bio-battery multiplied by the output current of the bio-battery. The value of electric power obtained by using equation 1 (Didik & Wahyudi, 2020; Ningsih; et al., 2019; Sulaiman et al., 2020).

$$P = V \; x \; I \quad (1)$$

Where P is the electric power (watts), V is the voltage (volts) and I is the current generated by the galvanic cell (amperes). The series of bio-batteries measured is series circuit consisting of 1 bio-battery, 3 bio-batteries, 7 bio-batteries and 11 bio-batteries.

RESULTS AND DISCUSSION

In the first experiment, the maximum output voltage and maximum current output were measured on bio-battery that filled with ceremai fruit electrolyte consisting of 1 bio-battery, 3 bio-batteries, 7 bio-batteries and 11 bio-batteries. Measurement of maximum current and voltage by using the Casey 2 Logger Pro type Laybold-524 002. The measurement results are shown at table 1.

Table 1. The results of measuring the electrical characteristics of galvanic cells with several number of biobaterys

Number of Biobateries	Voltage (volt)	Current (mA)	Electric Power (mW)
1	0,52	58,6	30,47
3	1,68	58,8	98,78
7	3,57	58,5	208,85
11	6,79	59,9	406,72

Table 1 shown the electrical voltage generated by 1 bio-battery cell is 0.52 volts. This value is much lower than the voltage generated by the MnO_2 electrolyte of 1.5 volts. This indicates that the electrolytic power produced by the electrolyte of ceremai fruit paste is lower than that of the MnO_2 electrolyte. However, the electrolyte of ceremai fruit paste has the advantage of being renewable and environmentally friendly (Fadilah & Rahmawati, 2015; Pulungan et al., 2017).

The voltage of the bio-battery increase with increasing the number of bio-battery in the series circuit. The greatest voltage is generated by 11 bio-batteries series which connected by series circuit. However, the current measurement tends to be constant. The current was constant caused by characteristic of series circuit. Voltage source where the resulting voltage is the total amount of electromotive force generated by bio-battery (Didik et al., 2020). The current value tends to be constant because the electric current does not pass through a branch in the case of a series connected circuit (Didik & Aulia, 2019; Didik & Wahyudi, 2020).

Bio-batteries use electrodes made by carbon as the positive electrode and zinc as the negative electrode (Lacina et al., 2019). Voltage and electric current in bio-batteries arise because of the positive electrode of carbon and negative electrode made of zinc. Carbon and zinc made spontaneous oxidation and reduction reactions due to acidic electrolytes (Austin & Seminario, 2018). The reduction reaction occurs in carbon which higher potential while the oxidation reaction occurs in zinc which lower potential. Carbon has cell potential of E^0_{cell} = 0.74 volts and zinc has cell potential of E^0_{cell} = -0.76 volts (Mondal et al., 2019). The result is the potential difference for the bio-battery produced by the zinc and carbon electrodes is theoretically 1.50 volts (Cek, 2018; Lacina et al., 2018).

The effect of the total voltage generated by the bio-battery series circuit will affect the power of the lamp produced. Power of lamp produced shown in Figure 2.

The lamp used has activation voltage of 6 volts, which means that the lamp will light normally when it is installed on a voltage source with minimum voltage of 6 volts (Didik et al., 2020).

(a)

(b)

Figure 2. Loading the bio-battery consisting of (a) 11 bio-batteries and (b) 7 bio-batteries

Suppose the activation voltage of the lamp is written as V_1 so that the power is P_1. So, if the lamp is installed at voltage V_2 which is not same as V_1, then the current lamp power (P_2) will described by equation 2 (Didik et al., 2020).

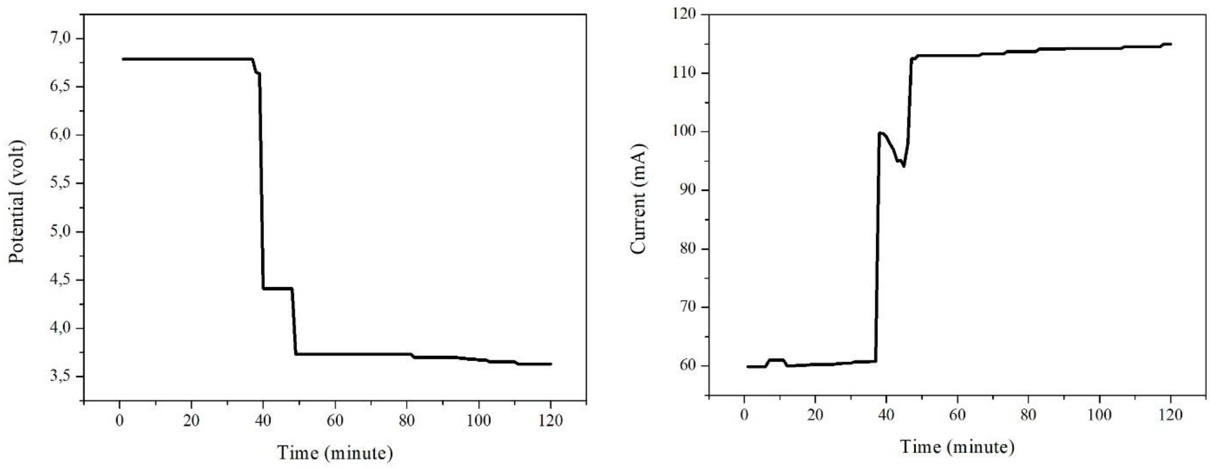
$$P_2 = \frac{V_2}{V_1} P_1 \quad (2)$$

Based on equation 2, it appears that the power produced by the lamp is proportional to the source voltage. This causes the flame produced by the 11 bio-batteries series circuit (figure 2a) to be brighter than the flame produced by the 7 bio-batteries series circuit (figure 2b). The voltage generated in the 11 bio-batteries series circuit of 6.79 volts has a greater voltage than the lamp activation voltage, as a result the lamp flame will be brighter. While the voltage generated in the 7 bio-batteries is 3.57 volts. This value is far from the activation voltage of the lamp so that the lamp flame becomes dimmer.

Table 2. Comparison of the maximum voltage value of bio-battery cells with ceremai fruit electrolyte compared to other studies

No	Electrolyte Paste Source	Voltage (volt)	References
1	Ceremai	0,52	This Research
2	Cassava	0,81	(Sumanzaya et al., 2019)
3	King fruit skin (1 M)	0,60	(Khairiah, 2017)
4	Banana Peel + Salt	0,82	(Pulungan et al., 2017)

The maximum voltage generated by the electrolyte of the ceremai fruit paste is relatively small when compared to other electrolyte sources as shown in table 2. The highest maximum bio-battery voltage is generated by the electrolyte from banana peel paste added with salt (NaCl) which produces a voltage of 0.82 volts (Pulungan et al., 2017). However, the electrolyte from ceremai fruit paste has advantages in the stability of the resulting voltage when it is given load as shown in Figure 3.



(a) (b)

Figure 3. The effect of loading on series of eleven biobattery cells (a) voltage against time and (b) current against time

Figure 3 shows a graph of the voltage and current in 11 bio-batteries series circuit. Based on Figure 3 after being given a load, the voltage and current generated by the bio-battery tend to be stable. Due to the load by the lamp, the source voltage will be burdened, resulting in a voltage drop as shown in Figure 3a. Because the power generated is constant, a decrease in voltage will result in an increase in current as shown in Figure 3b. decrease in the value of the stress due to a large load will result in the stress being difficult to return to its original position. This will be different if the load voltage used is much smaller (Gunawan et al., 2019).

CONCLUSION

Based on the results of research and analysis that has been carried out, it can be concluded that electrolytes from ceremai fruit paste can be used to replace the MnO2 electrolyte which is usually used as a battery electrolyte as an alternative energy source. although the output voltage is lower. This can be overcome by assembling the bio-battery through a series circuit. The series 11 bio-battery circuit can light a 6 volt lamp brightly because it can produce a voltage of 6.79 volts. The existence of a load on the lamp will result in the source voltage being burdened so that it experiences a decrease in voltage but will result in a larger current generated.

ACKNOWLEDGEMENT

Thank you to the Ministry of Religion of the Republic of Indonesia for funding this research through the BOPTN-DIPA fund of the Institute for Research and Community Service (LP2M) Mataram State Islamic University (UIN Mataram) for the 2021 fiscal year.

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