Type of Contribution:
Research Paper
Review Paper
Case Study

ENERGY: JURNAL ILMIAH ILMU-ILMU TEKNIK
Vol. 15, No. 1 (2025) pp 77-88
DOI: 10.51747/energy.v15i1.1517
E-ISSN: 2962-2565

This article contributes to: SUSTAINABLE DEVELOPMENT GOALS 7 AFFORDABLE AND CLEAN ENERGY

Application of Averrhoa Blimbi, L and Activated Carbon to Measure the Characteristics of No-Load Output Voltage, Output Voltage with LED Load and LED Voltage Drop

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Abstract

This paper discusses the use of Averrhoa bilimbi L. (blimbing wuluh) liquid and powdered activated carbon to examine the output voltage characteristics and voltage drop in LEDs. Previous studies using various fruits and fermentation methods showed inconsistent output voltages, prompting the use of Averrhoa bilimbi due to its natural citric acid content, which can produce a small but measurable voltage (0–499 mV). To improve this voltage, activated carbon (MES size 70329-06950) was added to the mixture. The experimental setup included Zn and Cu electrodes, a 30V 5A power supply, and liquid volumes of 75 ml, 100 ml, and 125 ml tested over durations of 1, 5, and 10 minutes. Results showed that without activated carbon, the output voltage ranged from 350–499 mV, while LED voltage dropped slightly (8–0 mV). With activated carbon, output voltage significantly increased to 434–660 mV, while the LED voltage remained stable and the drop minimal. These findings indicate that the addition of activated carbon enhances the electrical output of Averrhoa bilimbi and reduces voltage loss, suggesting its potential use as a simple, renewable bioenergy source for low-power applications.

Keywords: Averrhoa Blimbi. L, Activated Carbon, Renewable Bioenergy, Voltage Drop, LED

Article Info
Submitted: 2025-03-02
Revised: 2025-05-19
Accepted: 2025-05-25

Publisher
Universitas Panca Marga

1. Introduction

Averrhoa Blimbi. L is a traditional medicinal plant that is used to treat inflammatory diseases and coughs [1]. Averrhoa Blimbi. L is used because it has active compounds flavonoids and triterpenoids as anti-bacterial [2], steroids and alkaloids as hyperglycemia reducers in Diabetes Mellitus [3], and vitamin C is used as a health and endophytic bacteria as growth inhibitors of streptococcus pneumonia bacteria [4]. In addition, Averrhoa Blimbi. L has a galvanic cell to produce electric voltage [5]. Galvani cells are electrochemical cells obtained by chemical reactions or electrolysis [6]. The voltage of the galvanic cell is produced with variations of Averrhoa Blimbi. L liquid 25ml, 50ml, 75ml, 100ml is 0.2 volts, and 125ml is 0.3 volts. While the current with the same variation obtained 0.9 A, 1.2 A, 2.3 A, 3.8 A, and 7 A [7]. The difference in galvanic cell voltage between liquid and solid is 0.72 volts and 1.44 volts [8]. The voltage produced by Averrhoa Blimbi. L is influenced by the concentration of citric acid with a percentage of 92.6 ± 133.8 mEq acid/100 grams [9]. Averrhoa Blimbi. L citric acid is an alternative electrolyte liquid as a new renewable energy (EBT).

Galvani cells were not only found in Averrhoa Blimbi. L, but also the other plants and fruits have an effect on increasing voltage, current and output power. Previous research has been showed that the fruits of kedondong, aloe vera, banana produce a voltage of 1.1 volts [10], ceremai fruit of 0.85-1 volt [11], lemon 2 volts, potato 2 volts, apple 3.2 volts, orange 4 volts [12], pineapple and tomato of 4.4 volts [13], star apple juice has a voltage of 1.2-4.0 volts with 10%-100% juice concentration [14], citrus orange 0.69 volts [15], leaf extract 20 grams of moringa paste of 0.49 volts, current 0. 60 A, power 29.4 watts, and solid extract 2 grams is 1.73 volts, current 0.843 A, power 1.45 watts [16], soursop fermentation has a voltage of 4.52 volts, current 0.93 A, power 4.20 watts, while mango is 4.62 volts, 0. 96 A, power 4.46 watts [17], banana paste reached a voltage of 1.01-3.71667 volts, current ± 0.05304 A, power 5736.112 ± 12.62 mW/cm^2 [18], mango peel has a voltage variation of 1.53 volts and a current of 1.9 mA [19]. The voltage, current, and power produced from plants and fruits are influenced by citric acid, pH value, extraction and fermentation treatment.

From the voltage, current, and output power produced with variations of fruits, plants, extraction and fermentation treatments have been carried out. However, the variation of Averrhoa Blimbi. L electrolyte liquid mixing with activated carbon has not been done. The purpose of this research is to examine the characteristics of the output voltage without load, output voltage with LED load, and LED voltage drop based on time variations in Averrhoa Blimbi. L electrolyte mixing. Mixing the electrolyte with activated carbon is used to accelerate the rate of electrochemical recreation with different concentration variations and Averrhoa Blimbi. L was chosen because it has oxalic acid H2C2O4, formic acid, acetic acid C2H4O2 and lactic acid [20]. So that the voltage, current and power can be increased. The activated carbon used is powder-shaped charcoal with MES size 70329-06950.

Then the experiment is classified into 4 treatments with each time 1, 5, 10 minutes, the amount of electrolyte liquid 75ml, 100ml, 125 ml, output voltage without load, output voltage with LED load, and LED voltage drop. This research provides knowledge of the potential of renewable energy by utilizing Averrhoa Blimbi. L liquid in mixing activated carbon variations. In addition, testing is used as an application of alternative energy in electric vehicles.

2. Methods

The Averrhoa Blimbi. L was chosen because it is easily found in Indonesia, especially the Banyuwangi area, East Java. Furthermore, several processes of research stages, calibration and research data collection are described as follows. The first stage of Averrhoa Blimbi. L is squeezed to obtain electrolyte liquid. The second stage of the electrolyte liquid is measured with a measuring cup that has been provided 125 ml each. The third stage chose the type of activated carbon charcoal in powder form with MES 70329-06950. The fourth stage of the research design is described in Figure 1. The research design uses a measuring cup, Averrhoa Blimbi. L liquid, activated carbon charcoal (powder), Zn and Cu electrodes, 30V and 5A power supply. The last stage is the calibration of measuring instruments in each variation of data collection. Data collection was carried out with three time variations of 1 minute, 5 minutes and 10 minutes. This is due to changes in acid levels and pH levels affecting the output voltage in the Averrhoa Blimbi. L liquid. While mixing activated carbon using variations of 5 gr, 7 gr, and 10 gr. Variations were chosen to measure the intensity of changes in output voltage and compare with without mixing activated carbon.

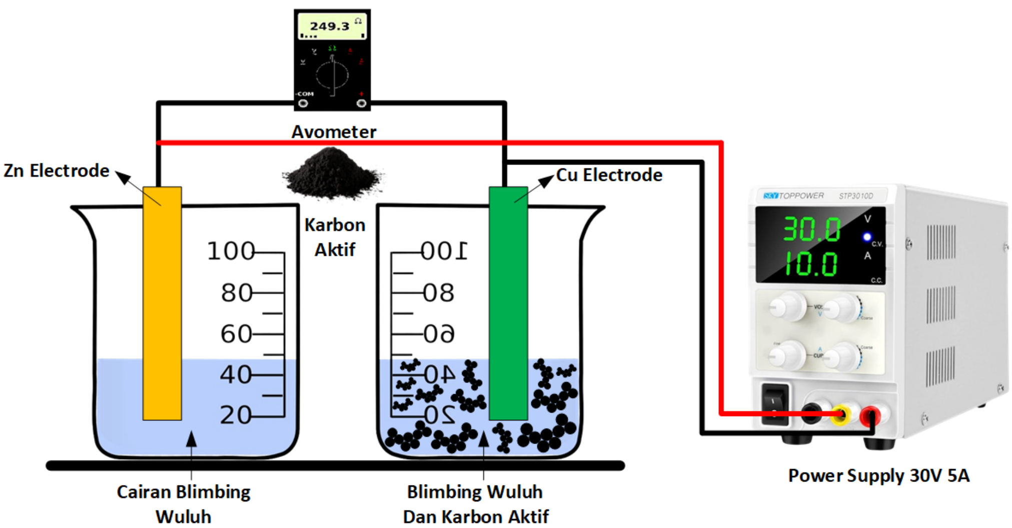

Figure 1. Research Method

3.Results and Discussion

3.1 Results

The results of the output voltage measurement on Averrhoa Blimbi. L with activated carbon variations and without activated carbon are described in Figure 2 below. **Figure 2 (a)** 125 ml Averrhoa Blimbi. L liquid, **Figure 2 (b)** mixing activated carbon variations on Averrhoa Blimbi. L, **Figure 2 (c)** voltage measurement without Averrhoa Blimbi. L mixing, and **Figure 2 (d)** voltage measurement of Averrhoa Blimbi. L with activated carbon charcoal mixing variations.

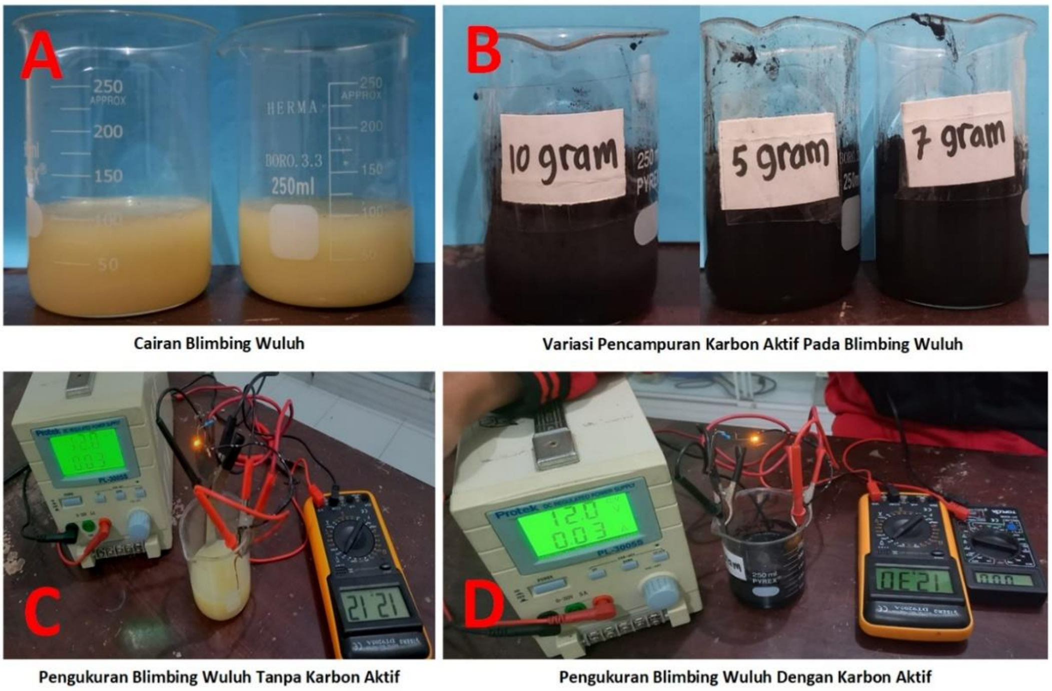

Figure 2. Averrhoa Blimbi. L Voltage Measurement

The measurement of each output voltage produced by Averrhoa Blimbi. L with activated carbon mixture and without mixing is described in **table 1**.

Table 1. Output Voltage Measurement on Averrhoa Blimbi. L

No	Experiments	Time (Menit)	Electrolit (ml)	Carbon Actif (gr)	Vout (mV)	Vout LED (mV)	Drop Vout (mV)
1	I	1	75	0	350	338	12
		5	100	0	420	410	10
		10	125	0	499	490	9
2	II	1	75	5	434	426	8
		5	100	5	520	513	7
		10	125	5	569	563	6
3	III	1	75	7	535	530	5
		5	100	7	650	646	4
		10	125	7	700	697	3
4	IV	1	75	10	600	598	2
		5	100	10	630	629	1
		10	125	10	660	660	0

The experimental I produced output voltages with electrolyte variations of 75 ml, 100 ml, 125 ml, without activated carbon, times of 1, 5, and 10 minutes of 350 mV, 420 mV, and 499 mV in **Figure 3**. LED voltage decreased by 338 mV, 410 mV, and 490 mV shown in the voltage drop value. Experiment II showed an increase in output voltage of 434 mV, 520 mV, and 569 mV in **Figure 4**. This was influenced by mixing 5 grams of activated carbon. However, the LED output voltage decreased by 426 mV, 513 mV, and 563 mV. The decrease in output voltage is caused by the LED load being connected continuously.

The experimental III was varied with time 1, 5, 10 minutes, electrolyte 75, 100, 125 grams, and activated carbon 7 grams each. The variation results give the effect of increasing output voltage 535 mV, 650 mV, and 700 mV, while the LED output voltage and voltage drop are decreasing small 5-3 mV in **Figure 5**. Experiment IV with time variations of 1-10 minutes, electrolyte 75, 100, 125 ml, and 10 grams of activated carbon experienced an increase in output voltage of 600 mV, 630 mV, 660 mV in **Figure 6**. LED output voltage decreased 598 mV, 629 mV, and 660 mV which was influenced by variations in mixing activated carbon of 10 grams, then accompanied by a smaller voltage drop of 2-0 mV. The greater the variation of electrolyte, activated carbon affects the output voltage produced by Averrhoa Blimbi. L and the smaller the voltage drop on the LED.

3.2 Discussion

The results of measuring the output voltage against time in experiment I without activated carbon are described in graph 3. Voltage measurements with 75 ml, 100, and 125 ml electrolyte variations have an increased output voltage of 350 mV, 420 mV, and 499 mV, with a time of 1, 5 and 10 minutes respectively. Then the LED output voltage increased by 338 mV, 410 mV, and 490 mV with a voltage drop of 12, 10, and 9 mV respectively.

Figure 3 shows that the greater the test time and electrolyte variation, the resulting output voltage also increases. The increase in output voltage is influenced by electrons flowing on the cathode side which is greater than the anode side. The electrolyte functions as a negative electrode to flow ions on the positive electrode. While the electrons attached to the cell wall gather on the surface of the copper plate. Then the electrons react with copper ions. In this system causes the movement of negative ions towards positive ions [5]. The nature of negative ions (anions) and positive ions (cations) moves through a dissociated polar solution. So that the negative anode charge attracts the cation charge or the positive charge of the cathode [21]. In addition, the cause of high output voltage is the pH of Averrhoa Blimbi. L. Where the smaller the pH value, the voltage produced increases [22]. This is shown in measurement table 1 at 1-10 minutes. The increase in output voltage measurement results is directly proportional to the voltage on the LED. However, a large voltage causes LED overvoltage (burning). The minimum voltage allowed to flow current is 1.6-3.5 V and the current is 10-20 mA. So, to overcome this LED requires components that can limit the flow of current and voltage [23]. The way to limit the current flow is using LM137 [24] or fault current limiter (FLC) components. FLC components are cheaper than replacing other components [25].

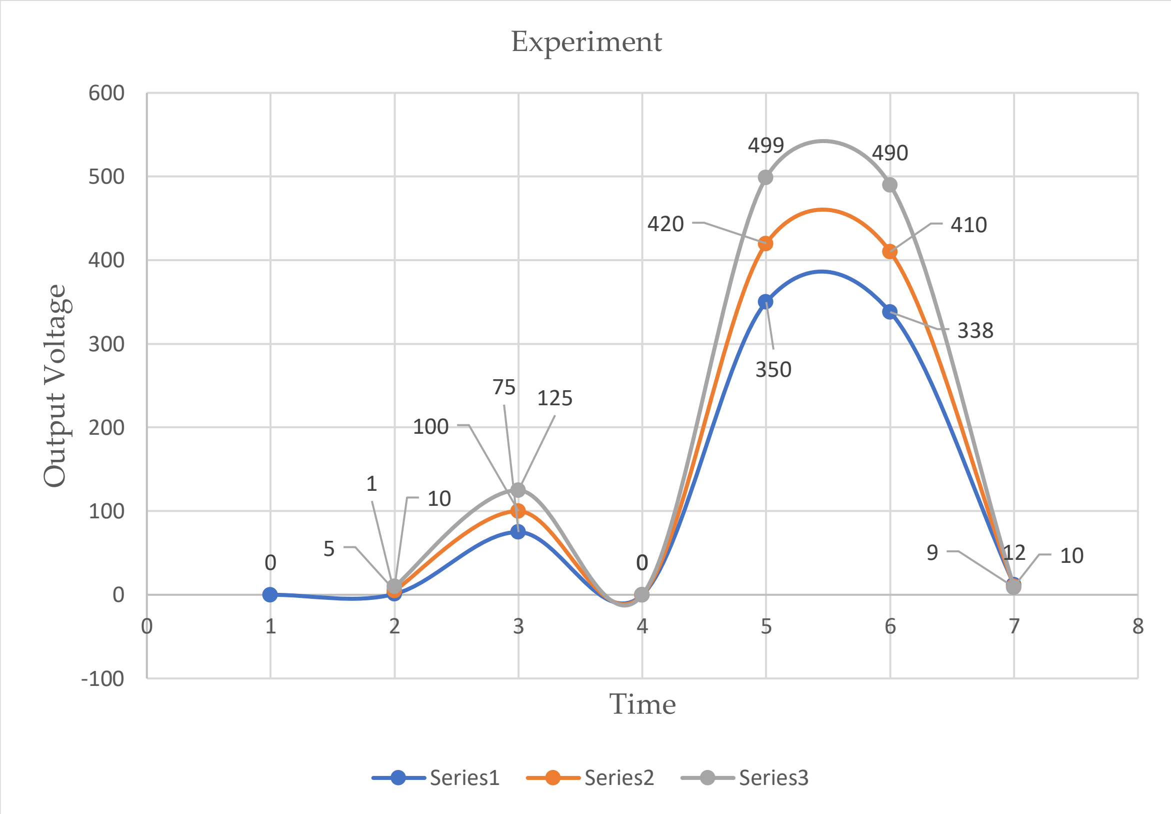

Figure 3. Experiment Results I

The results of measuring the output voltage against time in experiment II using a variation of 5 g activated carbon are described in **Figure 4**. Voltage measurements with electrolyte variations of 75 ml, 100, and 125 ml have an increased output voltage of 434 mV, 520 mV, and 569 mV with a time of 1, 5 and 10 minutes respectively. Then the LED output voltage increased by 426 mV, 513 mV, and 563 mV with a voltage drop of 8, 7, and 6 mV respectively.

Experiment result II presents that the greater the test time, electrolyte variation, and activated carbon, the resulting output voltage also increases. The increase in output voltage is caused by citric acid content in Averrhoa Blimbi. L [26], pH value, and electrolysis process. The electrolysis process decomposes the compounds H2O (water), O2 (oxygen), and H2 (hydrogen) with the supply of electric current. The electricity supply reacts two molecules by capturing two electrons and reducing them to H2 gas and OH- (hydrocide ions) on the cathode (+) side. Then on the anode side (-) two water molecules decompose into O2 and release four H + bonds so that they flow the electron charge on the (+) side. While the voltage is obtained by supplying a current between (cathode) and (anode) which releases H2O molecules into ions (-) and ions (+). The cathode side has (+) ions that absorb electrons to get H2. In addition, (-) ions move towards the anode so that electrons are released and get O2 [27].

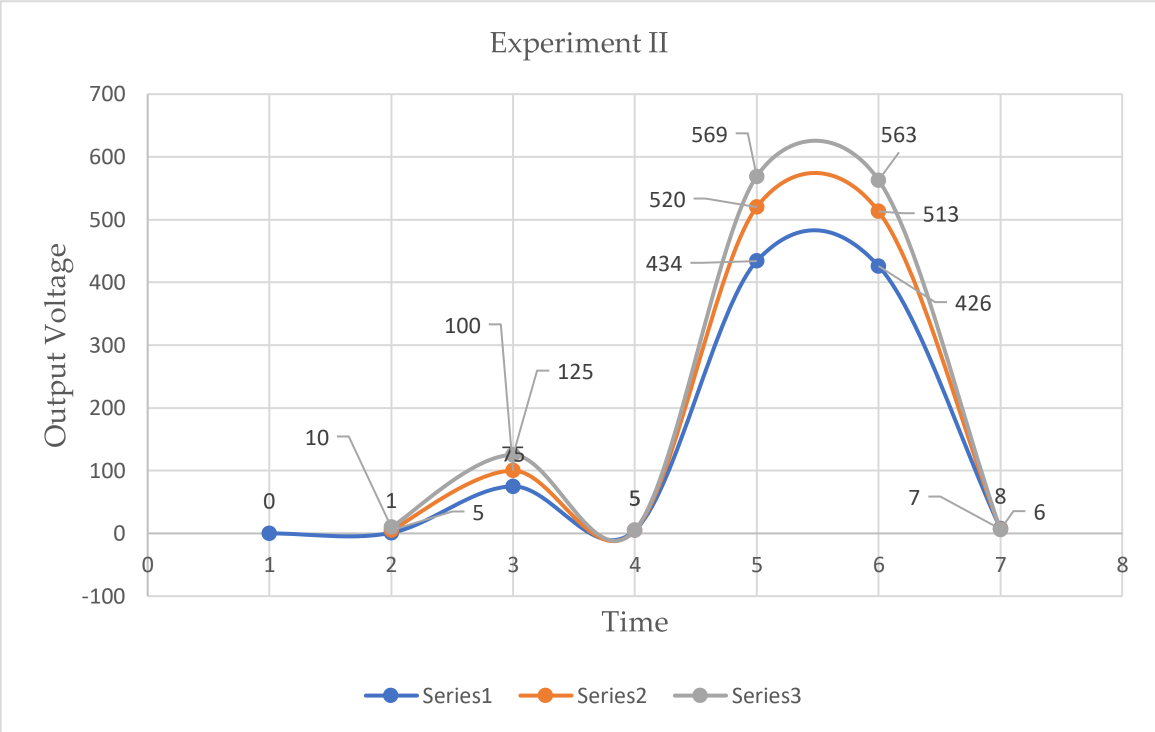

Figure 4. Experiment Results II

The increase in voltage is also influenced by mixing activated carbon by 5 g. Activated carbon is made with 2 stages. The 1st stage is carbonization and the 2nd stage is activation with a temperature of 300-5000C, the higher the carbonization temperature, the conductivity also increases [28]. It is shown that increasing the voltage with a mixture of 75, 100, 125 ml electrolyte and 5 gr activated carbon produces an output voltage of 434, 520, 569 mV and LED voltages of 426, 513, 563 mV with voltage drops of 8, 7, and 6 mV. Physically activated carbon with a temperature of 7000C has a micro and meso porous material structure. Micro pores store electrical energy and meso pores transport ions faster. The combination of pores can increase capacitance and power which is called electrode in energy storage [29]. Electrode materials have the ability to increase the duty cycle in energy storage. This is because the pore space and pore connections on a long scale can accommodate not only volume variations, but heat absorption and dispersion [30].

The results of measuring the output voltage against time in experiment III using 5 g activated carbon variation are described in graph 5. Voltage measurements with 75 ml, 100-125 ml electrolyte variations have an increased output voltage of 535 mV, 650 mV, and 700 mV with a time of 1, 5 and 10 minutes respectively. Then the

LED output voltage increased by 530 mV, 646 mV, and 697 mV with a voltage drop of 5, 4, and 3 mV respectively.

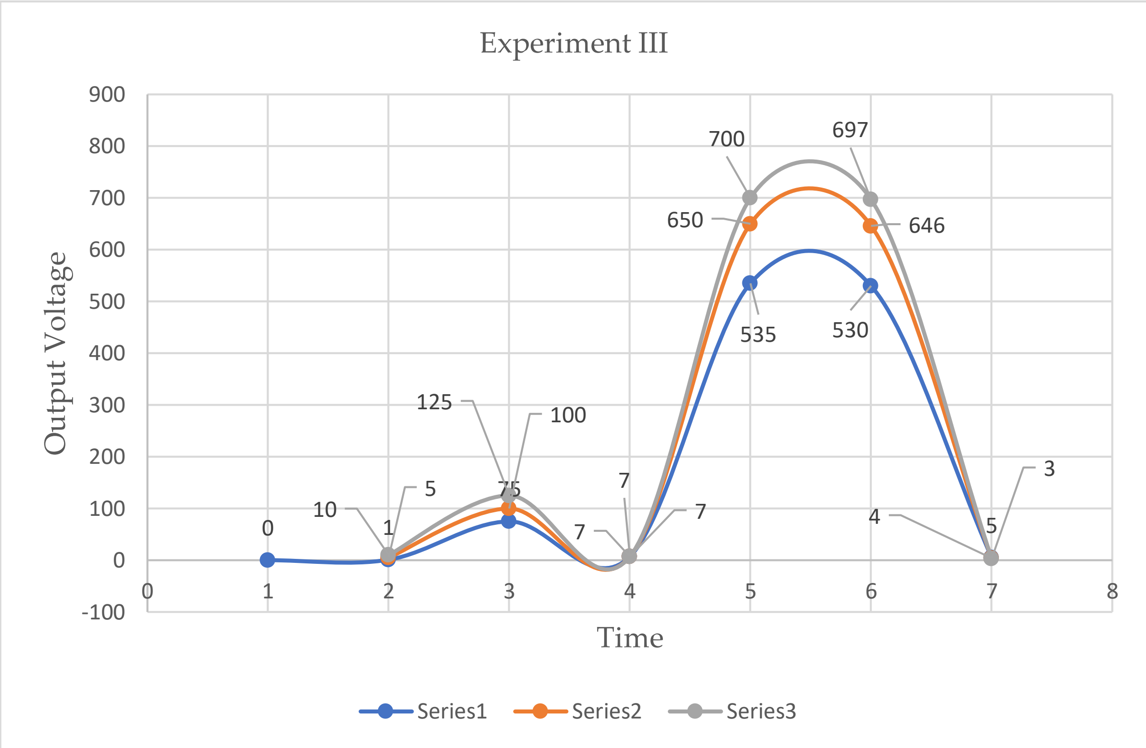

Figure 5. Experiment Results III

The increase in output voltage in experiment graph 5 shows that the greater the variation in time, electrolyte mixture and activated carbon applied, the output voltage, and the LED output voltage also increases. This is due to the variation of electrolyte mixing of 75-125 ml each and activated carbon of 7gr. Activated carbon has electrical conducting properties on porous surfaces exposed to oxygen. In the size of 1 gram, activated carbon has a wide field so that it can produce electrical energy of 1 v and a current of 100 mA. The pore structure of activated carbon can absorb liquid and gas materials with a pore surface area of less than 2 nm [31]. In addition, the broad pore structure has electrical trapping power on the electrode surface. Electrodes have conductive properties and electric charges are connected to the material, the resulting electric field forms a molecular layer. The broad surface layer absorbs ions and energy charging occurs in the ion layer in the form of an activated carbon electrode [32].

Activated carbon electrodes have an important role in the carbonization process, the formation and area of the pore structure [33]. In addition, activated carbon has properties of size shape, nanopore variation and pH. So the characteristics of activated carbon electrodes depend on the material, surface area, pore distribution, and activator compounds [34]. Chemical activators used in the activation process of activated charcoal are usually acids, bases, or salts. In the manufacture of activated carbon usually use chemicals such as KOH, NaOH, H3PO4, H2SO4, HCl, Na2CO3, and others as activators [35]. The use of these chemicals is at risk of causing environmental pollution problems. One of the natural materials that can be used as an activator is belimbing wuluh. Belimbing wuluh fruit is one of the fruits that contains aliphatic acid compounds, hexadecanoic acid, ferric acid, and sulfuric acid. These compounds are needed for charcoal activation because they are reactive to oxygen [36]. The result of this process is charcoal which still has low absorption due to the presence of impurity compounds including hydrocarbons, water, and oxides [37].

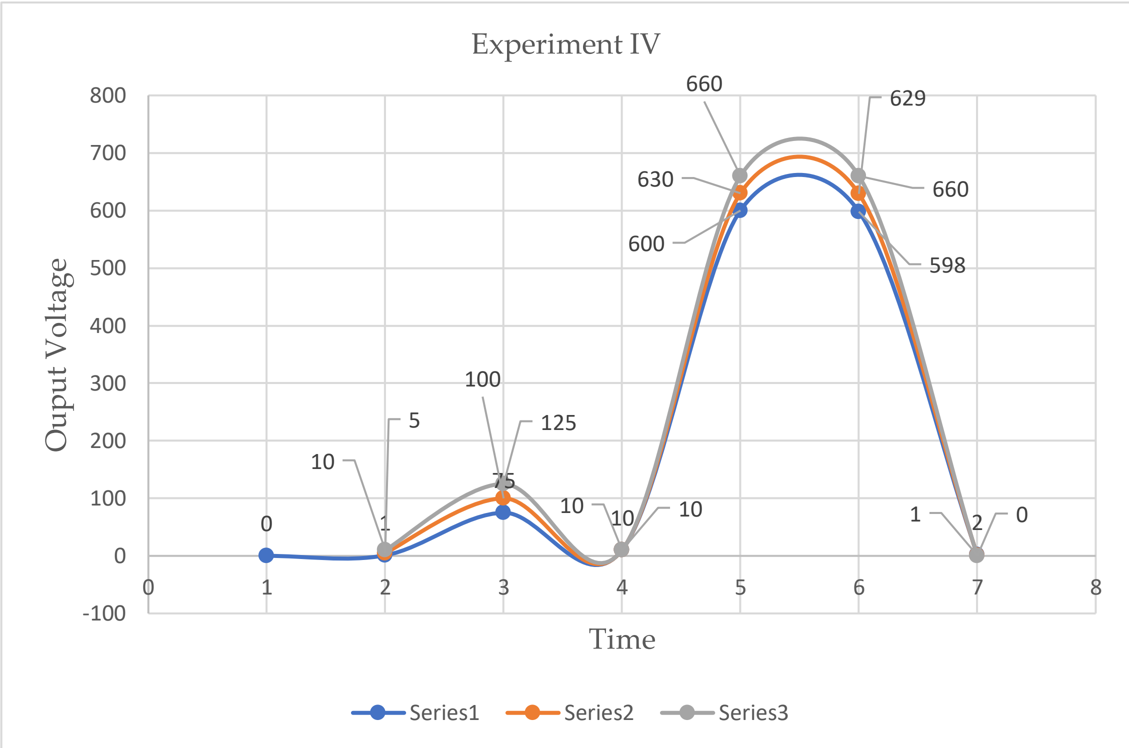

Figure 6. Experiment Results IV

4. Conclusion

The utilization of Averrhoa Blimbi. L and activated carbon are used to characterize the output voltage without load, output voltage with load, and LED voltage drop. The output voltage of various fruits, plants, extraction, and fermentation treatments have been carried out with several activated carbons. However, the resulting output voltage has a different value. Averrhoa Blimbi. L has citric acid content which produces a small output voltage between 0-499 mV. So a variation of activated carbon mixing is proposed to increase the output voltage and decrease the voltage drop on the LED. The activated carbon variation uses charcoal in powder form with MES size 70329-06950. The research method uses a measuring cup, Averrhoa Blimbi. L liquid, activated carbon charcoal (powder), Zn and Cu electrodes, 30V and 5A power supply. Then the experiment was carried out in 4 treatments with each time 1, 5, and 10 minutes, the amount of liquid Averrhoa Blimbi. L 75 ml, 100 ml, 125 ml. The results of output voltage and voltage drop on LED without mixing activated carbon Vout 350 mV, 420 mV, 499 mV, LED Vout 338 mV, 410 mV, 490 mV, voltage drop 8-0 mV. While the application of activated carbon on Averrhoa Blimbi. L 75 ml, 100 ml, 125 ml with testing II-IV produces vout 434-660 mV, LED vout 426-660 mV, voltage drop 8-0 mV. The results of the output voltage comparison in each treatment have a significant increase with a small voltage drop variation. This research provides knowledge of the potential of renewable energy with the use of solar energy

Authors' Declaration

Authors' contributions and responsibilities - The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation, and discussion of results. The authors read and approved the final manuscript.

Funding - No funding information from the authors.

Availability of data and materials - All data is available from the authors.

Competing interests - The authors declare no competing interest.

Additional information - No additional information from the authors.

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