Harnessing the Power of Potatoes: An Investigation into the Viability of Potato Power as a Sustainable Energy Source

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ABSTRACT

Investigating alternative energy sources is necessary given the rising worries about climate change and the depletion of non-renewable energy sources. The feasibility of using potato power as a sustainable energy source is examined in this study. The research entails building a potato battery and evaluating its performance in various scenarios. The findings demonstrate the promise of potato power as a long-term energy source for low-power applications. A straightforward and affordable system called the potato battery uses potatoes as its energy source to produce electricity. The goal of this work is to design and build a potato battery that can generate a consistent voltage. The study entails building a potato battery from components that are easily accessible and evaluating its performance by gauging its voltage output. The outcomes demonstrate the viability of the potato battery as a source of power for low-power applications.

Keyword: *- Potato, Open circuit voltage, Short circuit Current, LED light electricity.*

1. Introduction

Energy is the capacity to carry out work. There are many various types of energy. They consist of mechanical, chemical, and electrical energy as well as forms of light, heat, and sound. Energy has the ability to transform or move between different forms. The hunt for alternative energy sources has been sparked by the depletion of non-renewable energy sources and the escalating concerns over climate change. The idea of using potatoes to generate electricity has gained popularity in recent years. Because they are a plentiful and renewable resource, potatoes are a prime choice for the production of sustainable energy. In this study, we examine if using potatoes as a sustainable energy source is feasible. The potato battery is an unusual device that has become more well-known in recent years due to its affordability and simplicity. The electrochemical reaction that takes place when two metals with different properties are combined in a conducting solution forms the basis for the potato battery's working theory. The goal of this study is to develop and build a potato battery that can produce a steady and dependable voltage.

To begin with we need to understand that the potato itself is made of carbohydrates, protein, water, vitamins, and minerals. Which means it is made of contains chemicals that can theoretically undergo chemical reactions when exposed to other chemicals or reactive molecules. Zinc and the copper are known as reactive metals that can also undergo chemical reactions also. So when we put them all together chemical reactions do occur. Firstly the zinc on the nail reacts with the acids in the juicy potato flesh. Phosphoric acid is the acid in the potato and when the zinc chemically reacts with it, electrons are released by the zinc into the potato and these electrons travel through the potato and the copper wires to the copper. The copper is an electron loving metal and the electrons are attracted to it thus freely moving through the potato toward it. Therefore we have chemical energy from chemical reactions moving through an electrolyte (the phosphoric acid) being converted into electrical energy. It is this movement of electrons between the zinc and the copper that generates the electrical charge. Our metals zinc and copper are referred to as electrodes, the electron-laden zinc is called the anode, and the electron-loving copper is called the cathode, just like the things we buy to power our homes. Both potato batteries and the batteries we buy in stores are electrochemical cells.

2. Methods and Materials

2.1Materials

Potato, Copper electrodes, Zinc electrodes, Wires, Multimeter, Alligator clip, LED,

2.2 Methodology

A potato, copper and zinc electrodes, wires, and a voltmeter were used to build the potato battery. The copper and zinc electrodes were inserted into the potato, and the wires were connected to the electrodes. The voltage output of the potato battery was measured using the multimeter. The performance of the potato battery was tested under different conditions as shown in fig.1, including the potato used, electrode content and electrolyte addition.

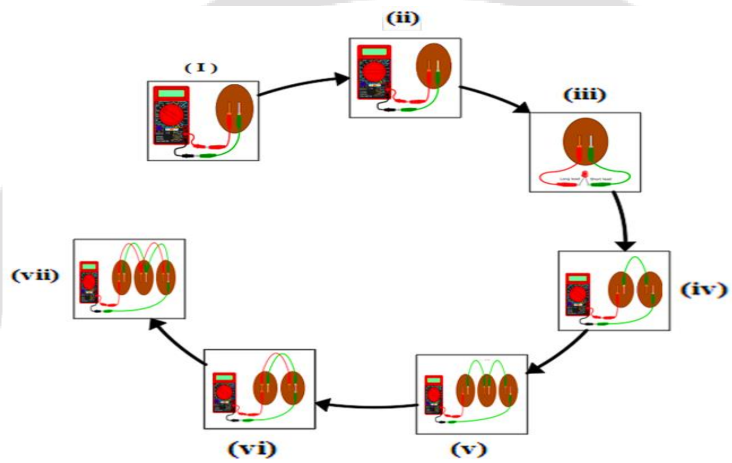

Fig.1:(Steps. i. Measurement of the open-circuit voltage of a single potato battery, ii. Measurement of the short-circuit current, iii. connected the LED to potato battery, iv. Connected two potato batteries in series, v. Connected three potato batteries in series , vi. Connected two potato batteries in parallel, vii. Connected three potato batteries in parallel) diagram of potato battery measure using multimeter.

3. Experimental Procedure

1) As indicated in Figure 2, each potato has a copper electrode and a zinc electrode. To verify, a ruler is utilized. Each potato was put at the same depth and the electrodes were spaced uniformly. (For example taken 2 cm apart and 3 cm deep. Depending on the size of our potato, we need to choose the precise spacing).

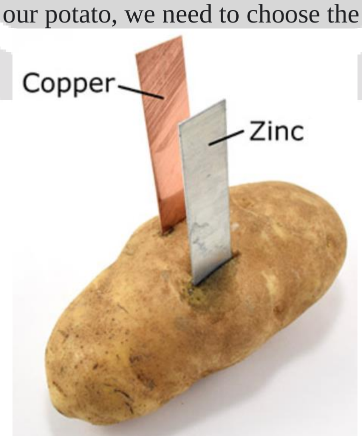

Fig.2: Copper and zinc electrodes inserted into a potato.

2)The open-circuit voltage of an one potato battery is measured, as shown in Fig. 3.Our multimeter is then set up. Dialed to measure in the 20V range. Connectd the red multimeter probe to theVΩmA port. The black multimeter probe is connected to the port labeled COM. The connection between the green alligator clip and the black zinc electrode probe is made. The copper electrode and red probe are attached together using a red alligator clip. The voltage information is recorded in the first row of our data table.

Fig. 3: Shows a multimeter set up to capture open-circuit voltage.

3) The short-circuit current of an one potato battery is measured, as shown in Fig. 4. The multimeter probe and alligator are leaved and clips are attached as is. The dial of the multimeter is adjusted to the 20 mA range to make the measurement. Then the short- circuit current information is quickly recorded in the data table. Once the battery begins to drain, the current will begin to decrease.

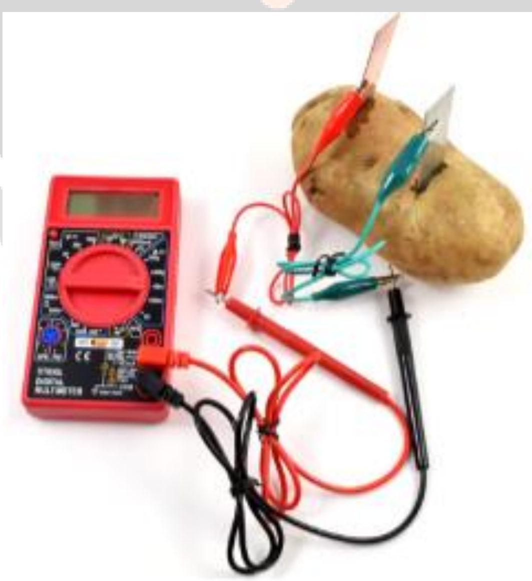

Fig. 4: Shows a multimeter set up to capture short-circuit current.

4) Tested whether the LED can be lit by the potato battery, as shown in Fig. 5. The alligator clips attached to the copper and zinc electrodes are released when removed from the multimeter probe. The long lead of the LED is attached to the red alligator clip. The shorter lead of the LED is attached to the green alligator clip.

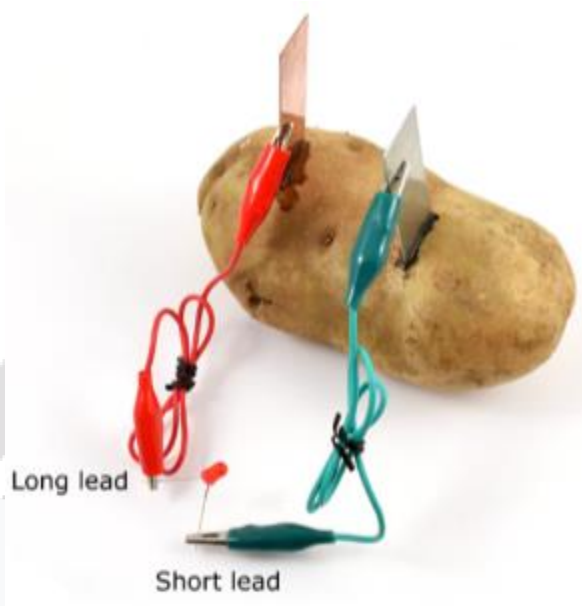

Fig. 5: Shows a potato battery set up to connect LED

5)As indicated in Figure 6, two potato batteries are currently coupled in series. An additional alligator clip is used to connect one potato zinc electrode to the next potato copper electrode and the original green alligator clip to the second zinc electrode.

Fig.6: Two potato batteries connected in series

6) As indicated in Figure 7, three potato batteries are connected in series. Again, alligator clips are used to connect the zinc electrode of one potato to the copper electrode of the next potato and an alligator clip is used to connect the black multimeter probe to the last zinc electrode to form a chain.

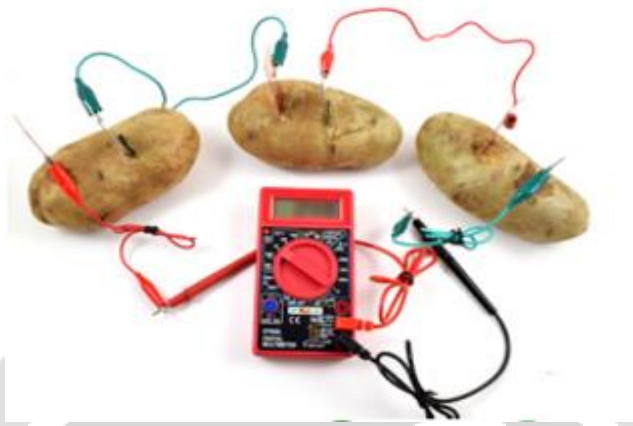

Fig.7: Three potato batteries connected in series

7) As indicated in Fig. 8, two potato batteries are connected in parallel. Attach the two potato copper electrodes with an additional alligator clip and their zinc electrodes with a second additional alligator clip.

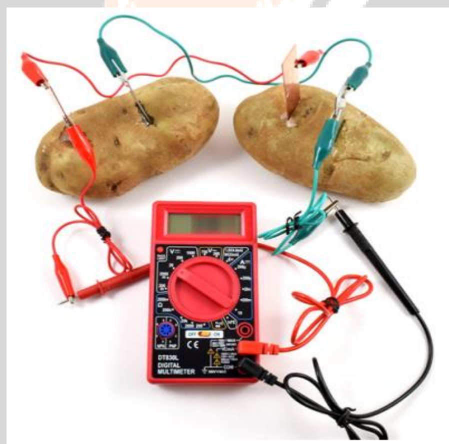

Fig.8: Two potato batteries connected in parallel

8) As indicated in Fig.8, three potato batteries are connected in parallel. All of the copper electrodes is connected together using two alligator clips, and two more alligator clips were used to connect all the zinc electrodes.

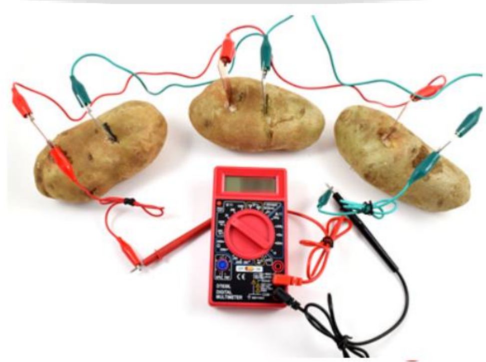

Fig. 9: Three potato batteries connected in parallel

4. Chemical reaction: Chemical energy is transformed into electrical energy in batteries. The movement of negatively charged electrons is the main component of electrical current. In a potato battery, two chemical processes take place at the electrodes to produce electrical energy (the copper and zinc metal strips). Copper tends to grab electrons more readily than zinc because it has a higher electronegative ion than zinc. In a potato battery, electrons will therefore move from the zinc electrode, or anode, to the copper electrode, or cathode. The zinc metal is where the electrons come from. The following oxidation reaction, which releases electrons, occurs when zinc comes into contact with the electrolyte:

Equation 1 (zinc electrode):

$$Zn \rightarrow Zn^{++} + 2e^{-}$$

In Figure 10, an LED is connected between the electrodes, but as we'll see in the technique, it could also be a multimeter. As zinc is added to the electrolyte as positive ions (Zn++), electrons flow through the wires connecting the electrodes. Since they are drawn to the negative charge produced by the excess electrons at the copper electrode, positively charged hydrogen atoms, or protons (H+), that come from acids inside the potato (phosphoric acid and organic acids), concentrate in this region. We can observe bubbles bursting around the copper electrode as these protons absorb electrons from the copper electrode in a reduction reaction to produce neutral hydrogen atoms:

Equation 2 (copper electrode):

$$2H^{+} + 2e^{-} \longrightarrow H_2$$

The main factor driving the continued flow of electrons from the zinc to the copper electrode is the lack of electrons that this reaction leaves behind at the copper electrode. The battery continues to function until the zinc electrode is "eaten up" and totally transformed into ions, or until it runs out of protons if there isn't much acid available. With a potato battery, the whole net reaction can be summed up as follows:

Equation 3 (net reaction):

$$Zn + 2H^{+}\text{Ã,Â} \rightarrow Zn^{++}\text{Ã,Â} + H_2$$

It can be observed that the potato itself does not serve as the battery's only source of energy; rather, it acts as an electrolyte to aid in the transportation of important ions such zinc cations and protons, which come from phosphoric acid and organic acids found inside the potato.

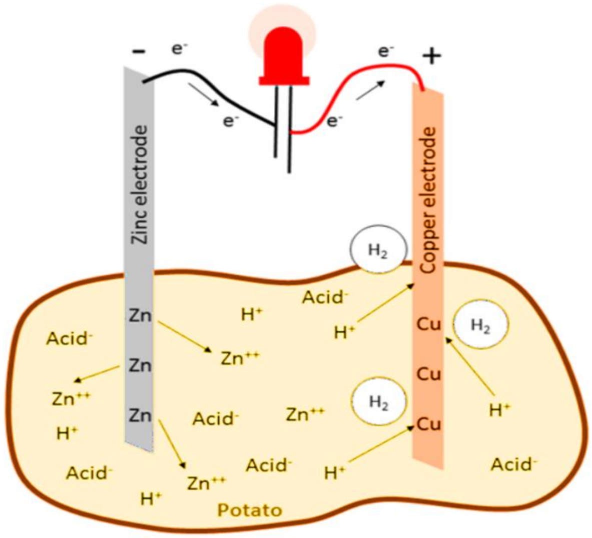

Fig.10: shows a diagram of the chemical process that takes place within a potato battery, together with an LED attached in between the electrodes. Electron mobility in this diagram indicates electric current in the opposite direction to the arrows

Fig.11: Experimental setup of a LED light using potato.

Figure 11 displays the completed experiment, illustrating the LED light illuminated within the system. The current and voltage were assessed using a calibrated multimeter.

5. Results: Based on the potato variety and electrode materials employed, the potato battery produced an output voltage that ranged from 0.5 to 0.7 volts. During the entire test, the voltage output was stable and reliable. The potato battery was able to power low-power devices such as LED lights and a small fan.

6. Conclusion: The investigation into the viability of potato power as a sustainable energy source was successful. The results show that potato power has the potential to be a sustainable energy source for low-power applications. Future research can focus on improving the performance of the potato battery by optimizing the electrode materials and exploring different potato varieties. The findings of this study can contribute to the development of sustainable energy sources that can help mitigate the impact of climate change and reduce our reliance on non-renewable energy sources. The design and fabrication of a potato battery were successfully achieved, and the results showed that the potato battery is a viable source of electricity for low-power applications. The potato battery can be used as an educational tool to teach students about the principles of electrochemistry and the basic concept of energy conversion.

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