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Alternative Energy from Banana Peel Waste Through Natural Process

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Abstract: The term "alternative energy" refers to energy derived from sources other than fossil fuels. The challenge for the current situation is the price of the battery nowadays is getting expensive. Due to the manufacturing process. The aim of this study is to identify a natural process that can convert peel waste into anode material. This study focuses on using biomaterials from banana peel waste to make carbon-based materials for batteries, which might help us utilize less alkaline metal in our batteries. 1kg of banana peel waste was collected, dried, and grinded until it become ash and placed in a glass jar. The jar was then filled with a mixture of 300ml of lemon juice, and the mixture was allowed to steep in a warm location for 24 hours. After 24 hours, the mixture was strained and risen with water then spread on a baking tray. Then, dry it in the oven until it is completely dried. The combination of the lemon juice along with the heat will activate the banana peel carbon. The testing of the battery is done using a multimeter to get the voltage and current to light up the load. A scanning electron microscope is used to characterize the banana's active carbon. This study proves that using natural processes can activate carbon and become alternative energy for the future.

Keywords: Banana Peel Waste, Batteries, Alternative Energy, and Active Carbon

1. Introduction

Energy storage systems should be developed in tandem with renewable energy sources. Lithium-ion systems are one of the most extensively utilised energy storage technologies. Unfortunately, the problem with Lithium-Ion batteries is that there is a limited supply of Lithium-Ion. Thus, there will be a huge demand for Lithium-Ion batteries, and the price will increase. As a result of this challenge, this project is concentrating on developing alternate energy storage solutions. It is critical for the next generation of batteries to fulfill the increasing demand of energy storage systems such as those used in electric and electronic vehicles. Sodium-ion batteries are one of the alternative battery systems that replace them due to their non-toxicity and chemical similarities to lithium ions [4]. It is very early in

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the development of these sodium-ion batteries, therefore there is a long way to go before they can dominate the global market. As a result, fundamental research into Lithium-Ion batteries, particularly electrodes, is critical.

This research proposes a unique approach to resource depletion and waste build-up by using fruit peel trash as a potential reducing cost of constructing a battery. The notion of "waste-for-waste" refers to the intentional use of fruit-based waste products to remediate Lithium-Ion battery trash. Using orange peel as a prototype fruit peel waste, the effectiveness and safety of pulverized orange peel as a green reductant for the acid leaching of precious metals from Lithium-Ion batteries cathode materials were examined [5].

Previous studies show Malaysia is planning to enter the battery industry, with intentions to produce 18,650 cells soon. The manufacture of batteries has a greater impact on the environment than carbon emissions alone [1]. Lessons can be taken from Latin America when the water shortages and toxic spills happen when doing lithium mining. Hazardous metals and chemicals may be used in the battery cell's manufacture. Hence the disposal of chemical batteries should be emphasized. These metals and chemicals may seep into the environment and harm individuals if batteries are not properly disposed of [2]. Besides, the price of the battery nowadays is getting expensive. The reason it can be expensive is because of the manufacturing process. Batteries are manufactured using specific machinery and techniques. Setting up and maintaining this equipment and procedures are quite expensive.

Currently, the demand for batteries cell is increasing. The shortage of supply will occur if there’s no alternative to creating a new element for the battery. This new development could help reduce the costs of future energy storage systems by applying a cheap material with excellent electrochemical properties to the already promising field battery cell [3].

Finding a natural technique that can transform peel waste into anode material is the project's primary goal. It focuses on exploiting biomaterials from wasted banana peels to produce carbon-based batteries, which might reduce the amount of alkali metal that require in batteries. Next, prepare the wasted banana peels for biomass-activated carbon. It is properly investigated how to transform banana peels into biomaterial that may serve as a battery. Finally, look into the possibility of using newly developed biomass active carbon in a battery cell to generate electricity. The synthesis procedure for carbon anodes was used in this study. The processes of this method include activated carbon production, characterization, electrode preparation, and assembly.

2. Materials and Methods

Before any action is taken on the project, the process of completing this alternative energy from waste food was clarified in this section, and an appropriate plan was made to ensure that the project can be completed and implemented smoothly. This project's workflow included a list of which procedures needed to be completed first and which would take longer to complete. The project name, workflow system, and testing on the components utilized in this project is explained in figure 1.

This section was also completed in order to meet the project's goal and guarantee that the project's scope is followed. There are several main steps or procedures in completing this research which is combustion, synthesis process, and battery assemble.

2.1 Flow chart

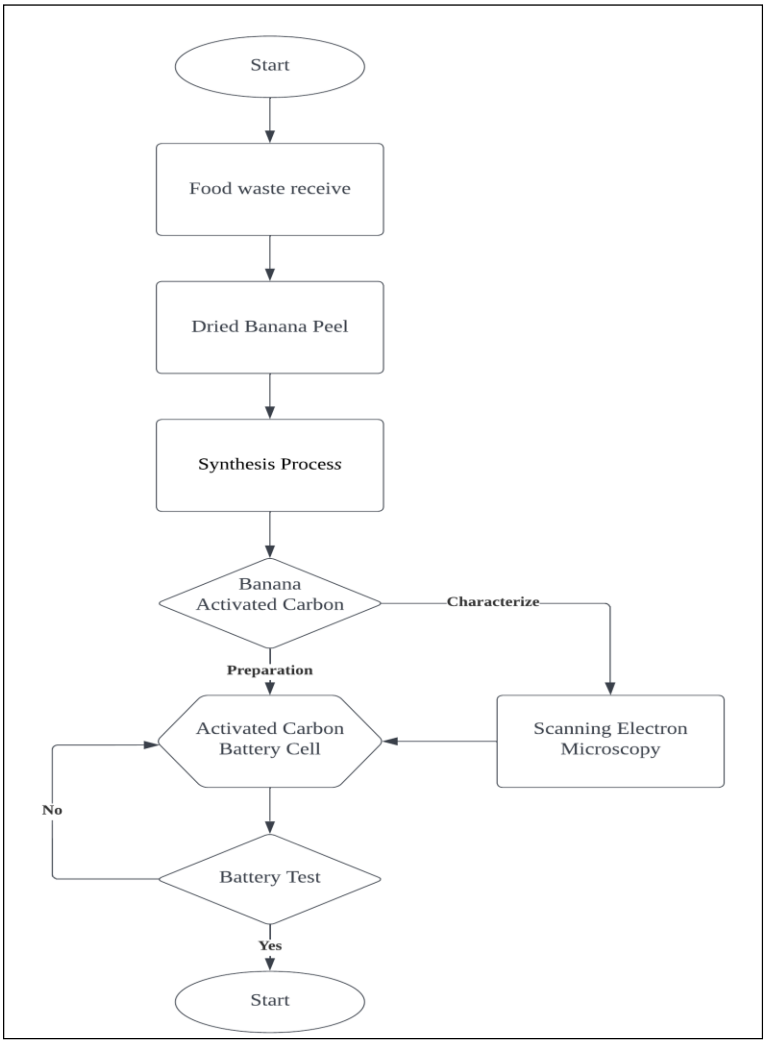


Figure 1: Flow Chart

2.1 Food waste receive

Fruits that have been damaged and cannot be salvaged are usually discarded. This food waste is collected from both residential and food disposal plants. Only certain types of food, such as fruits and legumes, will be segregated and taken after they are harvested. Lastly, the waste that is not selected will be disposed of and recycled.

2.2 Categorize sample

The purpose of this research is to create a manual-based food categorization and characterization system. At this stage, all food waste will be separated into categories, and only the peel will be utilized in the next phase. After some research, this experiment only uses banana peel waste because it can produce more voltage. In addition, if a different type of peel waste such as coconut or orange peel were used, the result would be changed. After the peels have been peeled and separated, they may now be crushed into a powder.

2.4 Dried Banana Peel

Banana peels, an abundant raw material is used to develop activated carbon as previously described. Banana peels were collected from the fried banana stall, then dried under sunlight for 1 day, and burned on the fire for 35 minutes. Figure 2 shows the condition of the banana peel after 35 minutes on the fire. The dried peel is then carefully transferred into the glass plate.

Figure 2: Banana Peel after 35 minutes burned

2.5 Synthesis Process

The synthesis process is the process to get the Activated charcoal. After the dried process, banana peels were burned for 35 minutes and then crushed into powder form. Next, the powder is transferred into the container that contains 300 ml of lemon juice. The container needs to be closed tightly and set aside for one night. The powder is transferred after 24 hours and washed with tap water before spreading it on a baking pan. Dry in the oven or using a dehydrator until it is totally dry. The charcoal is activated by the heat and lemon juice.

Figure 3: Mixture of Lemon juice and banana peel ashes

Citric acid makes up around 5.00 % of lemon juice and is responsible for the lemon's sour flavor. When an acid and ash are combined, a chemical reaction occurs, resulting in a new product with a neutral base carbon (Figure 3). To activate the carbon, it must be dried in a 250 °C oven for 2 hours. The greater the temperature, the more pores in the carbon will appear.

2.6 Activated Carbon

Due to its extraordinarily large surface area and excellent purity, which may be directly connected to performance in this application, activated carbon is the ideal electrode material in ultracapacitors, asymmetric batteries, and a variety of advanced batteries.

2.7 Characterization methods

Materials were characterized using Scanning Electron Microscopy (SEM). The morphology and structure of activated carbons were investigated by SEM analysis, and according to porogen applied in the combustion of fruit peels, all samples have the potential to form tiny aggregates of particles in the 10-micrometer range, which are formed of porous structures with inconsistent and complicated morphologies. Fruit peel waste carbon has a morphology that consists of tiny particle blocks with varying degrees of aggregation and sizes, rough surfaces, and irregular polygonal forms in certain situations. The existence of multiple randomly oriented macropores and mesopores of various dimensions and shapes can be seen at greater magnification, indicating that the structure of these particles is very porous.

2.8 Activated Carbon Battery cell

Fruit peel would be used to make activated charcoal, which then can be used to make an activated carbon battery cell. Activated carbon is used in batteries to boost the efficiency of dry cells with low energy density and low weight. The electron is released when aluminum reacts with salt water. The electron travels through the circuit and eventually lands on the charcoal. The electrons are absorbed by oxygen that was first adsorbed at the surface of the charcoal by air. Oxidation and reduction are taking place here. Until the oxygen in the charcoal is depleted or the aluminum is dissolved, the electric current continues to flow.

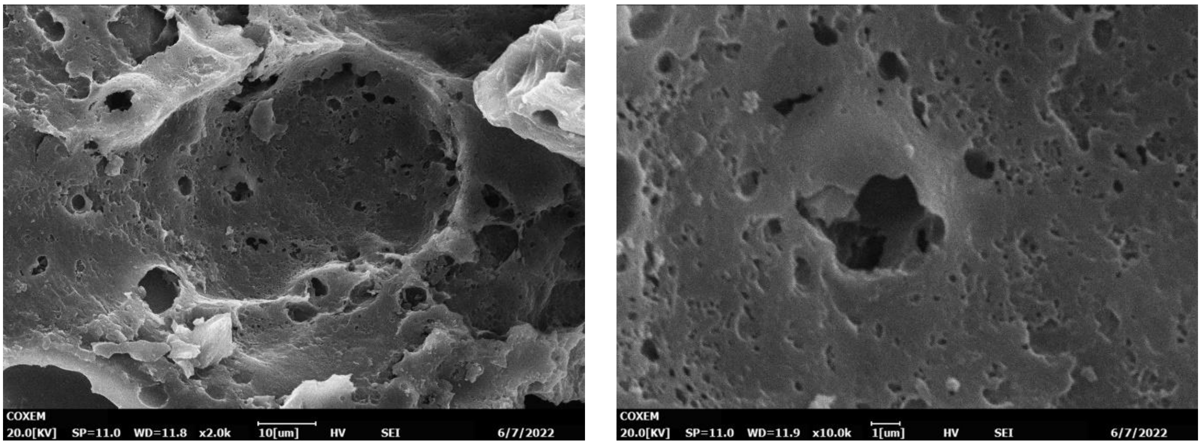
Figure 4: Materials in developing Active Carbon Battery cell

3. Results and Discussion

This section described the process of completing this project from the start of testing and the discovery of fundamental information and basic construction to the successful development of a prototype and the collection of data. All data relevant to the project's goals, such as scanning electron microscopy (SEM) results and battery testing, has been documented and explained.

3.1 Banana Peel Active Carbon; Structural characterization

The morphological and texture of banana peel waste active carbons were studied using SEM as shown in Figure 5.



a) 10 µm b) 1µm

Figure 5: SEM image with different magnification

In general, according to the porogen utilized in the carbonization of banana peels, all samples have a higher chance of developing small aggregates of particles in the tens of micrometer range, which are formed of porous materials with irregular and complicated morphologies.

The structure of banana peel waste active carbon is formed as tiny particle blocks with different degrees of aggregation and size (average size of 10 µm and 1 µm), rough surfaces, and irregular polygonal forms in certain cases. At a greater magnification Figure 5 (a), the structure of these particles can be shown to be very porous, with numerous randomly oriented macropores and mesopores of various sizes and forms (slit, cylindrical, or spherical).

The interconnecting microchannels in these carbons' exterior porous structure provide a large contact surface, which facilitates the early impregnation/penetration of the electrolyte. Meanwhile, their particles' amorphous shape offers active spots and disordered areas that aid electron adsorption and intercalation.

3.2 Electrical conductivity using a multimeter

In this section, the result of the voltage and current are tested using a multimeter. Multimeters are widely used in several fields including industrial maintenance and testing, research, appliance repair, and electrical installation.

There are four types of batteries that are connected in series to create a larger voltage. The battery is made using the same materials to get a consistence result and the voltage of the battery depends on the contact surface of the carbon.

Table 1: Voltage and current for each battery

Battery	Battery A	Battery B	Battery C	Battery D	Series connection
Voltage	0.702 V	0.504 V	0.722 V	0.712 V	2.6 V
Ampere	0.567 mA	0.407 mA	0.583 mA	0.575 mA	2.1 mA

As the result above, Battery A, C, and D have almost the same because it uses an equal size of cooper wire and capacity of active carbon. From table 1 the testing is focusing on the voltage and current of the battery when no load is connected. For each battery, it shows a different voltage from others because the capacity and the contact surface of the activated carbon are slightly different.

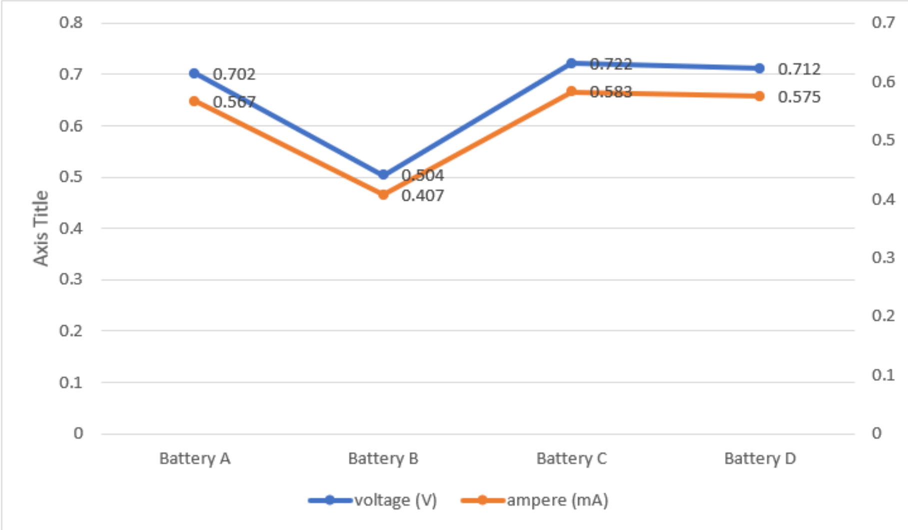


Figure 6: Graf voltage for batteries A, B, C, and D

Figure 6 shows the voltage and current of each battery are different. Battery A, C, and D get above 0.7 voltage when using a three-and-a-half spoon of banana active carbon and 2.5 mm copper wire. For Battery B, the size of copper wire used is 1.5mm for both anode and cathode terminals. The result is slightly lower than the other three batteries due to the contact of the copper wire and active carbon are low. Therefore, Battery B can only get around 0.5 volts after the testing. The value for the current tested is around 0.4 mA until 0.575 mA. When the batteries are connected in series, the total current and voltage have higher enough to light up a dc load.

3.3 LED testing

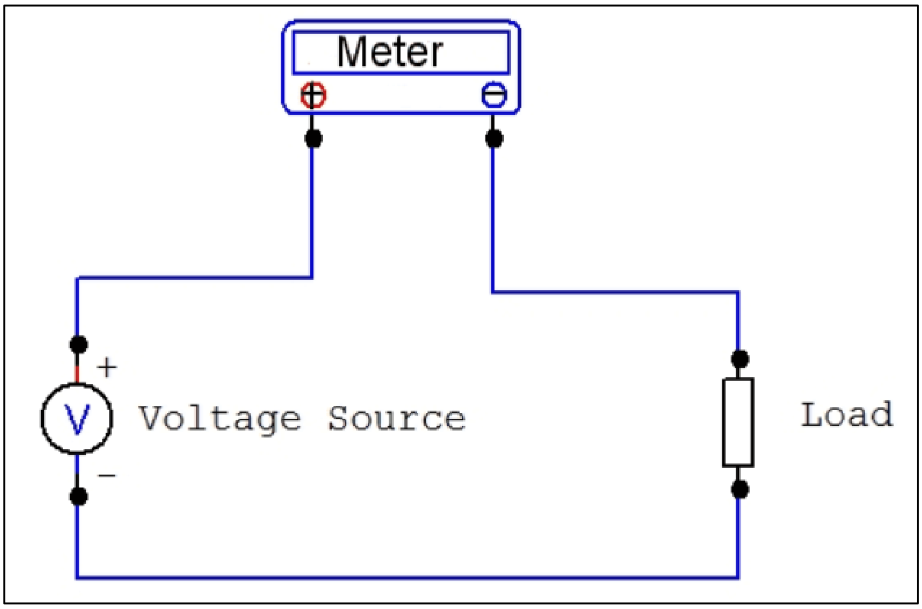


Figure 7: Schematic diagram

Figure 7 shows a connection of the LED to the battery. To test the LED, place the black probe's tip on the LED's cathode, or shorter end. Touch the anode with the tip of the red probe, which should be the taller end. During this test, make sure the two probes don't meet each other, as well as the cathode and anode.

3.4 Discharge Rate

Discharge rate is a testing of the voltage battery when it continuously connects to the load. From figure 8 the load that tests for the battery is the LED bulb. In this testing, the connection of four batteries is in series to the load. There are many types of loads, but basically, the devices are such as LED bulbs, motors, or electronic devices. To measure the voltage across the circuit, start by connecting the probe to both legs of the LED.

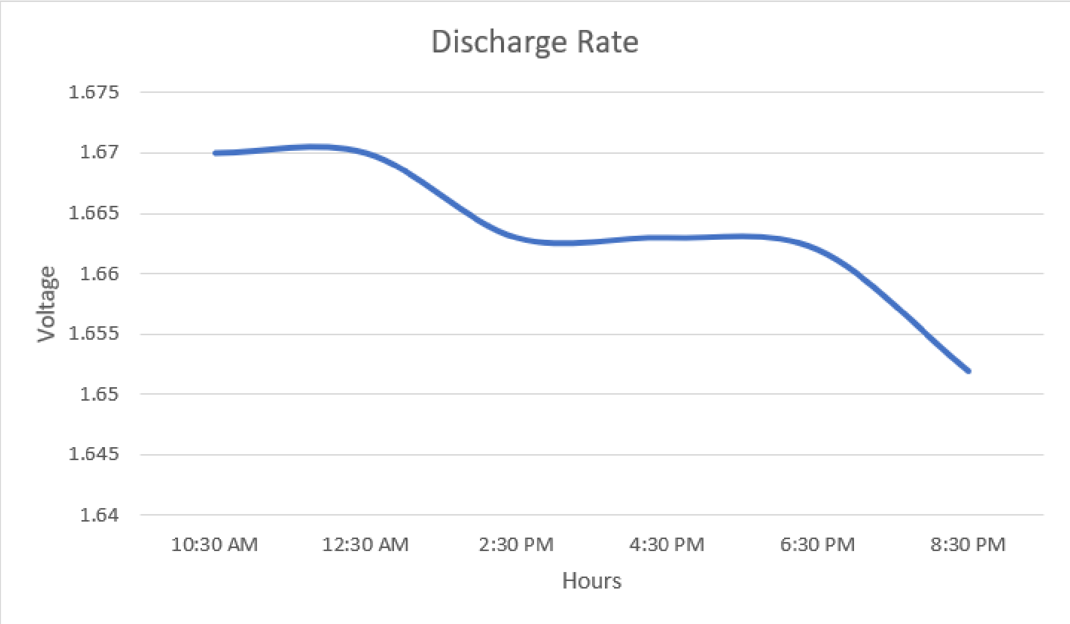


Figure 8: Discharge Rate Graf

The polarisation of the battery during discharge is the basis for battery discharge curves. The volume under the discharge curve, which represents the amount of energy a battery can deliver, is hugely affected by operating circumstances such as temperature range. The voltage of batteries drops during discharge. Figure 8 shows a decreasing graph of the voltage versus time in 10 hours. The voltage at 10.30 a.m. shows that it has a 1.67V. The next 4 hours show that the voltage has dropped to 1.663. It means in 4 hours, the voltage capacity of the battery has dropped only 0.04V and it will continuously drop until the battery capacity is zero.

3.5 Leakage current – Self-discharge

Self-discharge is a stage whereby internal chemical reactions decrease the battery's stored charge even without a connection between the terminals or external circuit. This situation happens due to the internal current flow that makes the voltage loss at the open circuit.

There are two types of cells which is a primary and secondary cells. Primary batteries are not intended to be recharged between manufacturing and use; hence it has a lower self-discharge rate rather than the secondary cells. Table 3.2 shows data collected for three days of the batteries. The data is taken at 5 am and 5 pm every day to see the battery self-discharge. The result is affected by the temperature of the room. When the batteries are stored at a high temperature, it can increase the rate of self-discharge and reduce the initial energy stored in the battery.

Table 2: Self-discharge battery

Days	Day 1	Day 1	Day 2	Day 2	Day 3	Day 3
Battery	5 am	5 pm	5 am	5 pm	5 am	5 pm

A	0.702	0.661	0.726 V	0.693 V	0.643 V	0.669 V
B	0.504 V	0.535 V	0.468 V	0.517 V	0.500 V	0.522 V
C	0.772 V	0.732 V	0.719 V	0.702 V	0.700 V	0.678 V
D	0.712 V	0.701 V	0.700 V	0.710 V	0.681 V	0.638 V

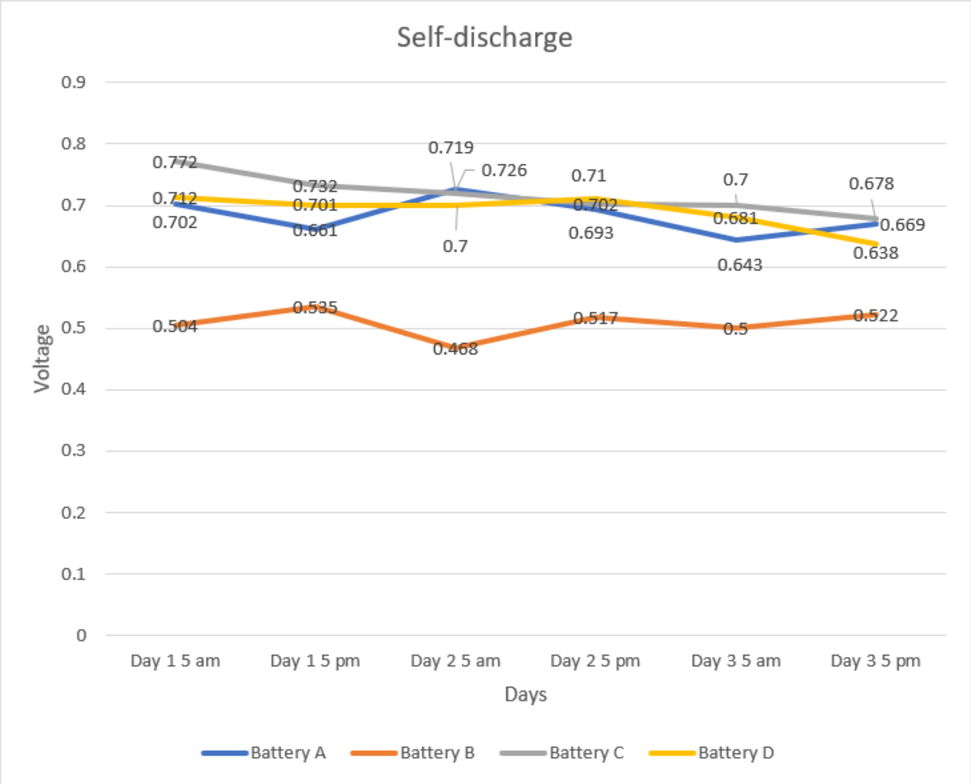


Figure 9: Self Discharge Graf

Figure 9 shows a self-discharge rate for each battery A, B, C, and D. It shows how an active carbon battery self-discharges over time and at various temperatures. Self-discharge is around 3.3 percent for 3 days at room temperature (25-28 °C), and the battery may potentially be kept for 90 days without any load. The self-discharge rises by a percentage when the temperature is raised to 30 °C.

However, the outer battery cell is made from aluminum foil that will oxide during a certain time. It happens when the salt water reacts with the aluminum foil. To prevent that, a good casing is required to store the battery so only a little oxidation will happen.

3.6 Discussion

Figure 10 illustrates the amount of banana peel used in the production of a 7.8 V battery. The data was collected from the actual experiment and plotted in the graph.

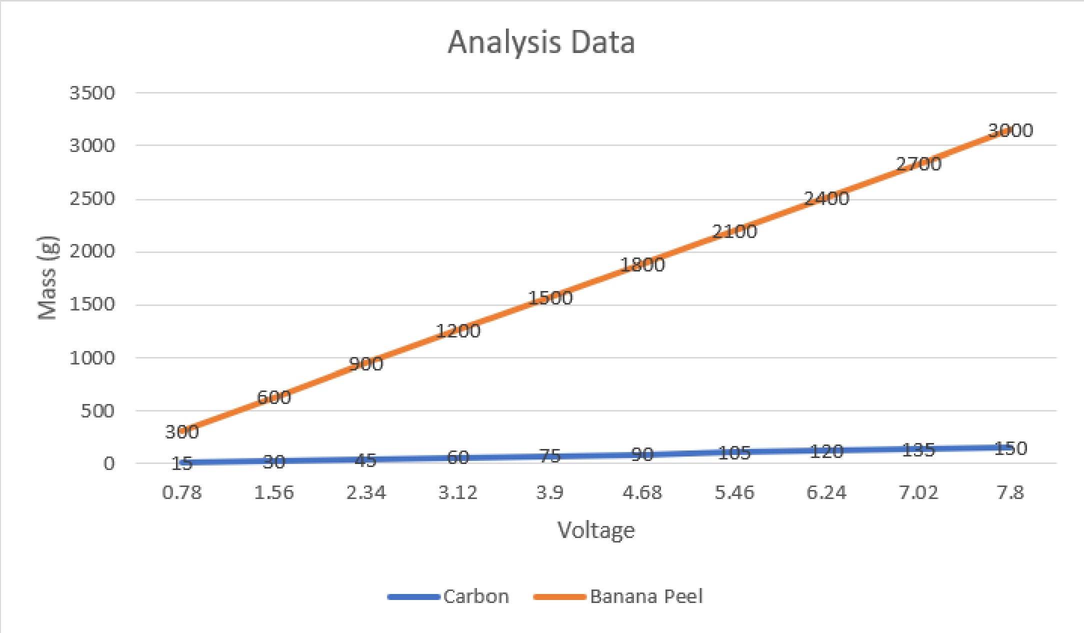


Figure 10: Data Analysis

In the experiment carried out while performing this procedure, 1 kg of banana peel produced 50 g of activated carbon. Furthermore, the voltage created is in the 2.6 V range. The total power that we get from this experiment is around 5.46 mW. That's a hypothesis based on small sample size. Many banana peels are discarded as a consequence of commercial enterprises such as fried bananas and banana cake, as we all know. According to the graft, 3k g of banana peel can be used to make a 7.8 V battery, which is one of the savings that can be made only from food waste. As a result, the battery's manufacturing cost may be reduced while simultaneously replacing a depleting source of battery supply.

4. Conclusion

Alternative energy from banana peel waste through natural process has built an activated carbon battery cell for this project. This project's overall voltage is roughly 2.3 V. This value may be used to power an LED bulb for a certain period. The technique for making alternative energy to light up an LED bulb may be done at home using this battery cell. Due to the motor's need for at least 3V, a DC motor will require a larger battery. An electron may be created by a chemical interaction between aluminum and salt water, which then flows to the activated carbon for the anode terminal. the most appropriate use for this project, which can replace existing lighting energy.

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