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Deployment of Fruit Juices as Battery Electrolyte

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ABSTRACT: *This study presents a battery system whose electrolytes were extracted from Nigeria fruit juices. The fruit juices experimented with were; lime, lemon, orange, grape, coconut and water melon. Chemical test was carried out in the laboratory to determine the acidity and PH level of these fruit juices. Lime has the highest level of acidity followed by lemon. While watermelon has the highest PH level followed by coconut. Battery cell blocks of two cells in series per block were constructed, eight blocks were constructed. Copper and Zinc electrodes were embedded to produce positive and negative terminals of the battery. Six fruit juice were filtered and purified and fed into the battery cells by a syringe mechanism. Test and measurement carried out shown that lemon, grape, and lime produced 0.8V per cell while coconut and watermelon produced 0.7V per cell, giving a total battery voltage of 12.8V and 11.2V respectively. Voltage and current was determined from developed battery fruit juices electrolyte, it was observed that the battery system produces slight voltage and the current that can power LED light. However, lime juice electrolyte produced higher voltage compared to other fruit juices electrolytes. Also, it was observed that the cells could not sustain a stable voltage for a prolonged period due to oxidation process.*

Keywords: *Acidity; Current, Lime; PH level and Voltage.*

I. INTRODUCTION

In Recent time, there is call to preserve our environment, which is referred to as climate change. International bodies, Nations of the world, Cooperates Organizations and Nongovernmental Organization (NGO) etc. are all putting your voices together to combat climate change. Mankind are yeaning for comfort and dominance, which lead to human exploration and industrial revolution. This human activities from industrial revolution on earth as create an effect on the environment which include deforestation, mining leading to erosion, and release of Carbon Monoxide (CO) into the atmosphere leading to the depletion of the ozone layer. In addition, industrial revolution also leads to noise pollution from design and uses of locomotive devices.

Our environment is being affected by waste generated by man activities on earth which lead to climate change. This waste if not properly manage it can become hazardous to man exist on earth. These human wastes are neither in solid state, liquid state or gaseous state. The solid waste are recycle to the produce same material or relative materials, while liquid waste are converted to not hazardous liquid which can be reuse in the industry or domestic use. Materials that are not biodegradable are discourage, while the production of degradable materials are encourage which lead to this study on deployment of fruit juices as battery electrolyte. The development of clean and renewable energy resources has become a more important task than ever to safe our environment.

Batteries are electrochemical devices which convert chemical energy into electrical energy or the batteries are device that store chemical energy and convert it to electrical energy by electrochemical oxidation and reduction reactions, which occur at the electrodes (Saheed et al, 2018). A cell consists of an anode where oxidation takes place during discharge, a cathode where reduction takes place and an electrolyte which conducts the electrons (via ions) within the cell (Theraja, 2004), The reaction typically occurs between two pieces of metal, called electrodes, and a

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liquid or paste, called an electrolyte. For a battery to work well, the electrodes must be made up of two different types of materials. This ensures one will react differently than the other with the electrolyte. This difference is what generates electricity. Connect the two electrodes with a material that can transport electricity well (called a conductor) and the chemical reactions fire up; the battery generates electricity (Atetegeb et al, 2016). All batteries have a 'positive' and 'Negative' terminal. One of the electrodes will tend to loss electrons and the other electrode will tend to gain electrons. The metal electrode that loses electrons is called the negative terminal or anode. The other metal electrode that gains electrons will become the positive terminal or cathode. The copper wires act as conductors, allowing electrons to flow through them. Electric current is a flow or pushing of electrons through a circuit from the "negative" terminal, through a conductor, towards the "positive" terminal. A volt (voltage) is a measure of the force moving the electrons (Theodosios et al, 2019).

An electrode is the part of a cell through which charges enter or exit. Each cell has a pair of electrodes from conducting materials. There are chemical changes between both the electrodes and the electrolytes. These changes convert the chemical energy to electrical energy. There are two kinds of cells in electricity. There are wet cells and dry cells. Wet cells are liquid cells like the cells in a car battery. A fruit juice also has wet cells which is a reason why it acts like a battery and is able to produce Jakia et al, (2018).

Abdul and Muhammad, (2015), presents a research work was to determine whether lemon can produce electricity or not. Lemon has a voltaic cell which changes chemical energy into electrical energy. By a series circuit, conductor (copper) inserted into lemon to generate voltage.

Saheed et al, (2018), presents a study, on using fruit as battery acts like a wet cell that consists of a negative and positive electrode with an electrolyte which conducts ions, also, copper and zinc metals acts as electrodes while citric acid of the fruit is the electrolyte. In a nutshell, apple generated the highest voltage out of all the fruits tested, the higher the acidity and size of the fruit, the higher the voltage, also, the far apart the electrodes inserted into the fruits, the higher the voltage using copper and zinc as the best electrode over copper and steel or steel and zinc electrode.

II. Materials and Methods

The materials used for the development of the Nigerian fruit juices as battery electrolyte are presented in Table 1.

Table 1: Materials used for developing fruit juices as battery electrolyte

S/N	Materials
1	Various Fruit juices
2	Zinc strip
3	Copper strip
4	Cotton wool
5	Syringe
6	Epoxy gum
7	Multimeter
8	Filter paper
9	PH meter
10	alligator clips

$$\text{Acidity} = \frac{1\text{N of base x titre value x } 2000}{\text{vol.of sample used}} \quad (1)$$

Table 2: Sample, Volume and Titre Value

Sample	Vol. of Sample (ml)	Titre values of cm^3
Coconut	25	0.4
Watermelon	10	0.5
Grape	10	3.3
Orange	25	1.9
Lime	25	28.2
Lemon	25	21.7

Table 3: Acidic content of Fruits used PH Value

Product	Acidity (mg/L)	pH value
Lime	2256.00	2.40
Lemon	1736.00	2.30
Orange	152.00	3.35
Grape	660.00	3.38
Water melon	100.00	6.80
Coconut	32.00	5.40

Preparation of the Battery Electrolyte

The fruits used are lime, lemon, grape, orange, coconut and water melon for each fruit juice it was carefully washed to reduce External impurity and cut into two. The juices were extracted into a bowl. The content was filtered (sieved) severally to obtain a solution that has less impurity, shown in Figures 2 to 5

Figure 3: Lime Fruit Juice Extract

Figure 4: Water Melon

Figure 5: Fruit Juice Solutions Ready for Titration to Determine their Concentration

The Choice of Battery Electrode

Iron wire, copper wire, zinc wire and aluminium wire were put into test, the electrodes were immersed into 10ml of each fruit juice at different time and it was observed that zinc and copper produced the highest voltages and were thereby selected for the experimental process.

Figure 6: Zinc Electrodes

Figure 7: Copper Electrodes

Construction of the Cell Case and the Overall Battery Casing

The battery casing is cut out with dimension of 6.5cm by 23cm by 6.5cm and epoxy gum was used to fix the various parts together to form a container. The diagram of the container is shown in the Figure 10a &10b.

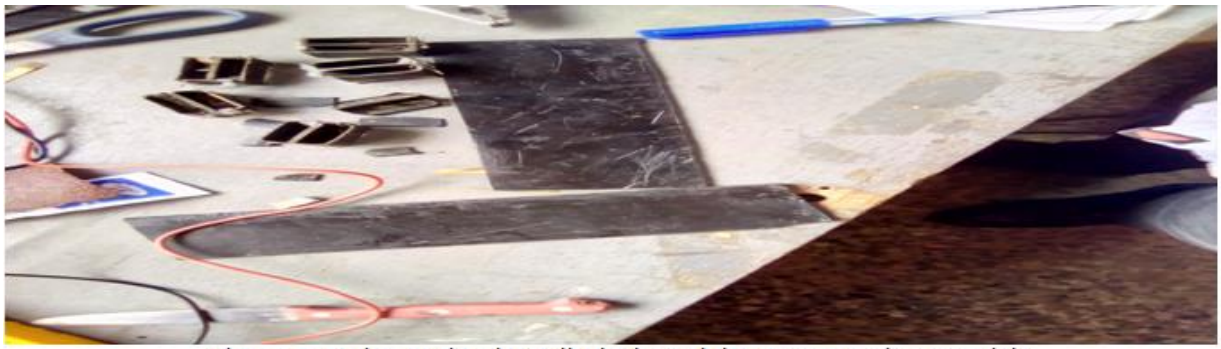


Figure 8: Cutting to Size the Cell Blocks and the Battery Casing Materials

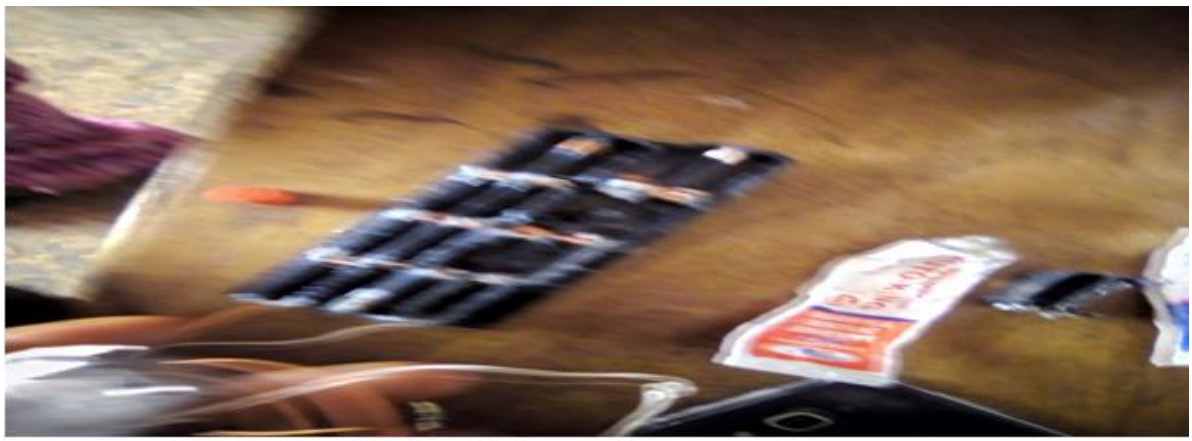
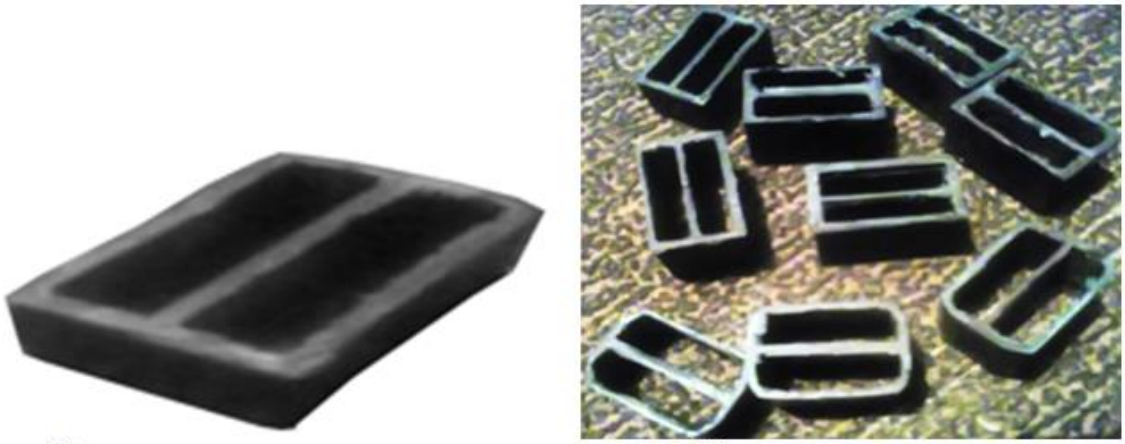


Figure 9: Coupling the Cell Blocks with Epoxy Gum



(a) (b)

Figure 10a: Battery cell made up of plastic materials and 10b: Battery cells

The battery cells of dimension 3.5cm by 1.5 by 1cm is carefully mounted on the base of the overall battery container to form cells of the battery, the battery container contains 16 cells that are connected together in series to achieve 12.8V and each cells was calibrated in such a way that it can carry 10ml of the electrolyte in other to achieve the 12.8V, side edges were filled to a smooth edge so that it can be glued properly to the base of the overall battery casing which is of the dimension of 6.5cm by 23cm by 6.5.

The arrangement was left for five minute to ensure that the container is dried up then the syringe mechanism was used to suck the electrolyte to fill it cells of the battery and electrodes were introduced into the container at both ends of the battery.

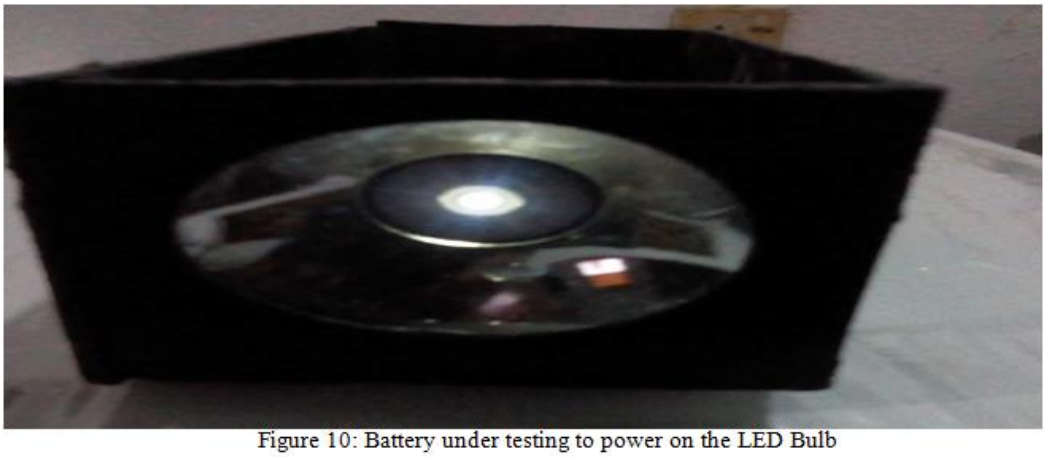


Figure 10: Battery under testing to power on the LED Bulb

III. Results and Discussion

Multimetre was used to measure the voltage across the battery made of the different fruits Juice electrolyte and this was repeated for each of the fruits mentioned above and measurement and reading were taking to plot graph of current against time as shown in Figure 11.

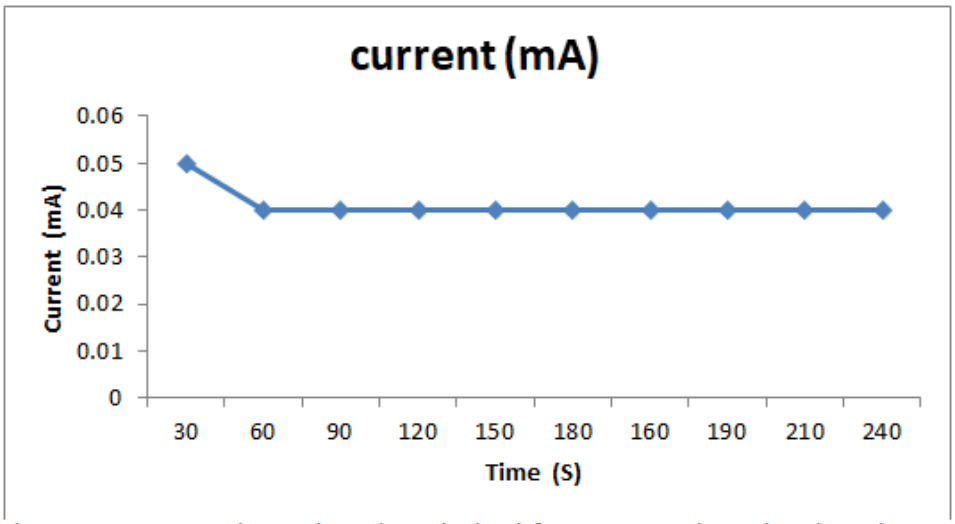


Figure 11: Current value against Time obtained from water Melon Juice electrolyte

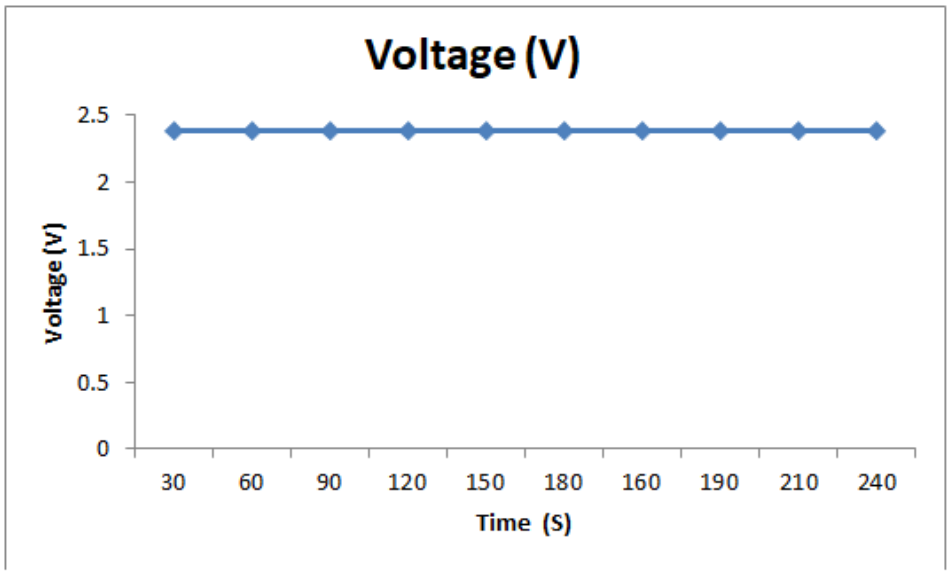


Figure 12: Voltage value against Time obtained from water Melon Juice electrolyte

In Figure 11, the current obtained from water melon juice electrolyte against time. It is observed, that the initial drop in current values, then after maintains constant current values against corresponding time. However, similar Figure 12, the voltage obtained from water melon juice electrolyte against time generated linear distribution process with time and with open circuit voltage (V0 = 11.55) at T0 = 0.

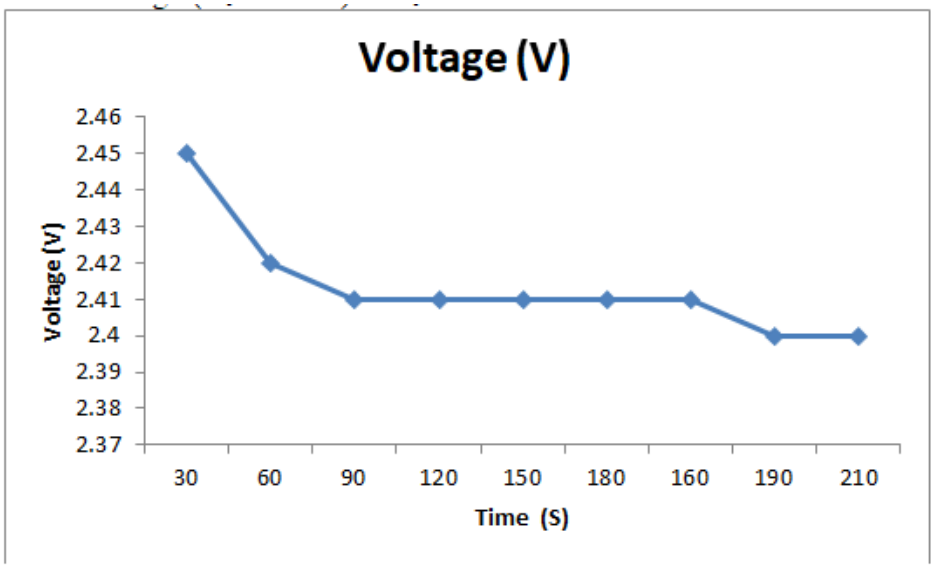


Figure 13: Voltage against Time obtained from Grape Juice electrolyte

It is observed that voltage values obtained from grape juice electrolyte decreases sharply, thereafter it maintain a constant time, it decreases again, this is probably due to oxidation process on the electrolyte process with time. In Figure 14, the current obtained, also followed the voltage distribution pattern, V0 = 12.75 (Open Circuit Voltage) T0 = 0.

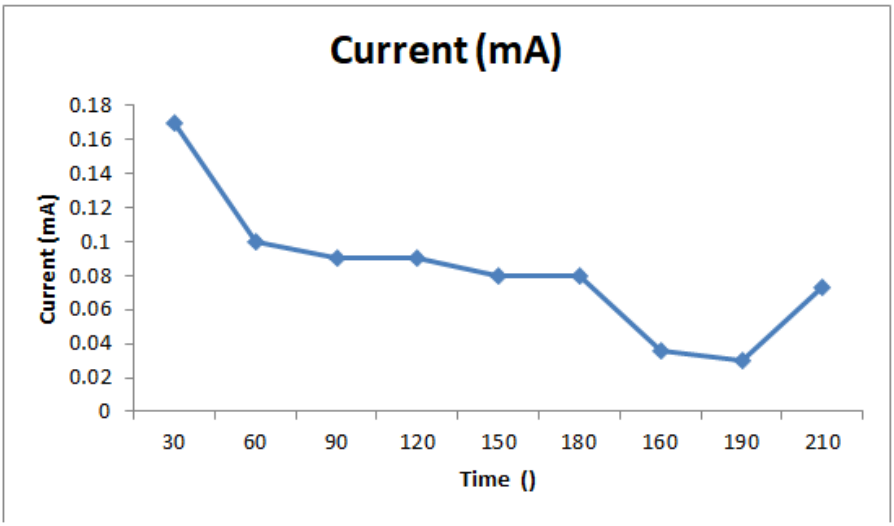


Figure 14: Current against Time obtained from Grape Juice

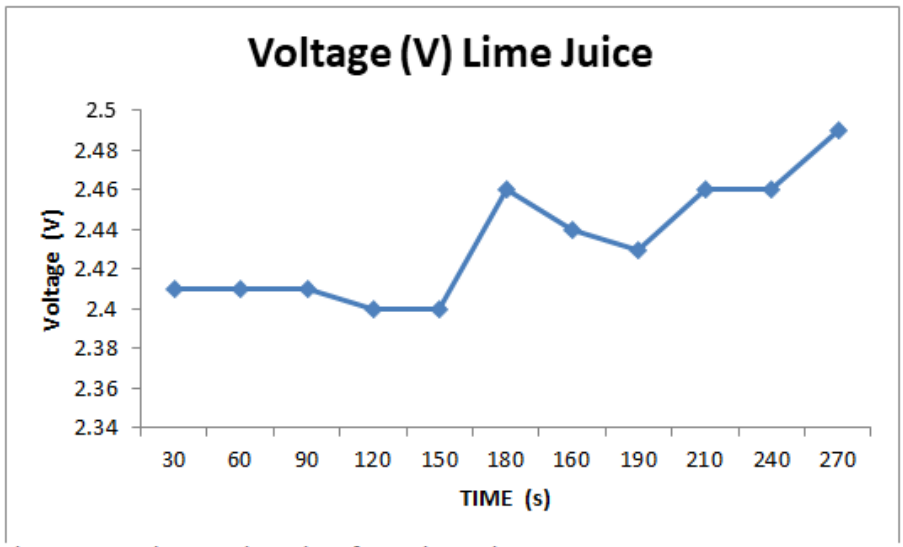


Figure 15: Voltage against Time from Lime Juice

It is observed that voltage values increases with time, from lime juice electrolyte, probably due to oxidation process on the electrolyte leading to increase in voltages in Figure 15. While, a slight decreases is witnessed from the current with the corresponding time, in figure 16 V0 = 12.4V (Open Circuit Voltage) T0 = 0.

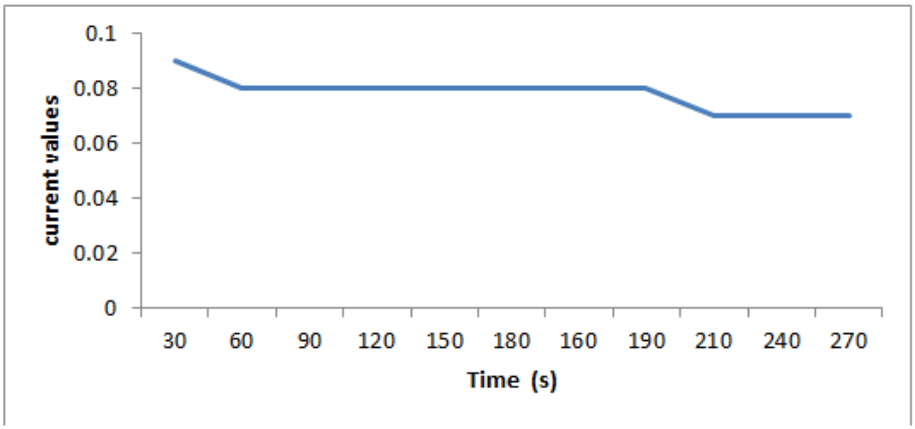


Figure 16: Current against Time from Lime Juice

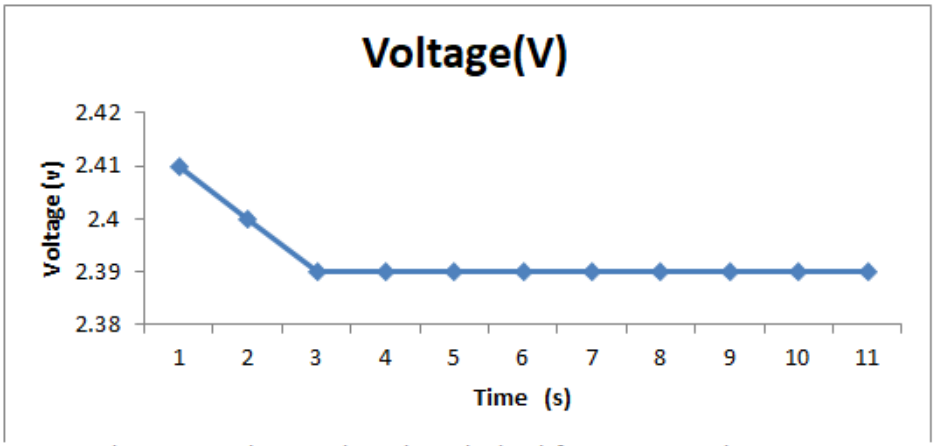


Figure 17: Voltage against Time obtained from Orange Juice

It is observed that voltage values obtained from orange juice electrolyte decreases sharply, thereafter it maintain a constant time, this is probably due to oxidation process on the electrolyte, in Figure 17. While the current in Figure 18, slightly decreases with time from orange juice electrolyte.V0 = 11.30V (Open Circuit Voltage) T0 = 0.

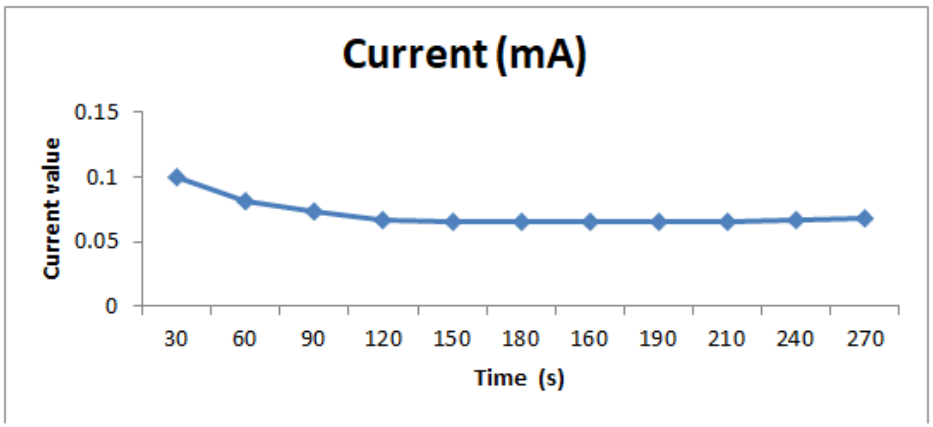


Figure 18: Current against Time obtained from Orange Juice

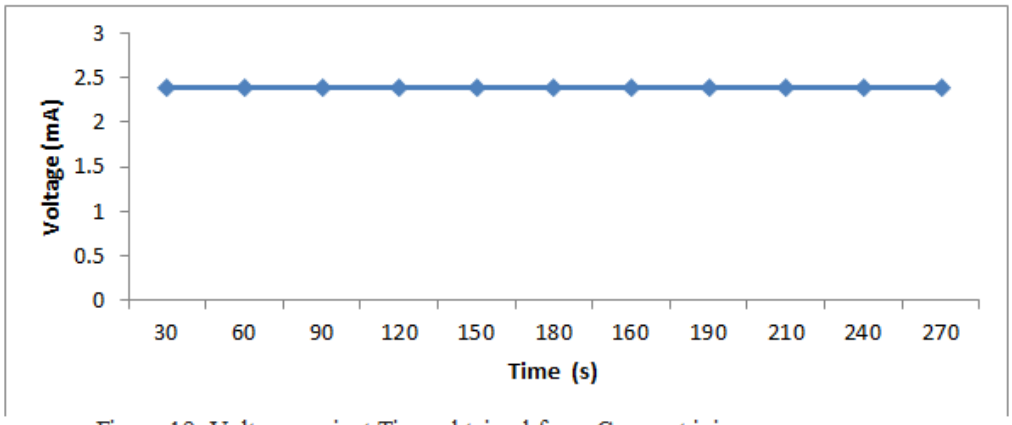


Figure 19: Voltage against Time obtained from Coconut juice

It is observed that current values obtained from coconut juice electrolyte decreases with time, this is probably due to oxidation process on the electrolyte, V0 = 11.90V (Open Circuit Voltage) T0 = 0.

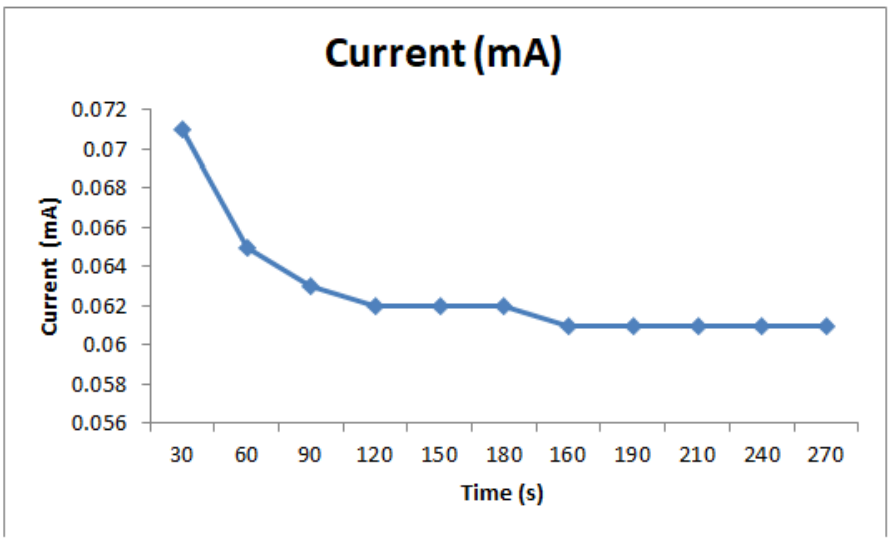


Figure 20: Current against Time obtained from Coconut Juice

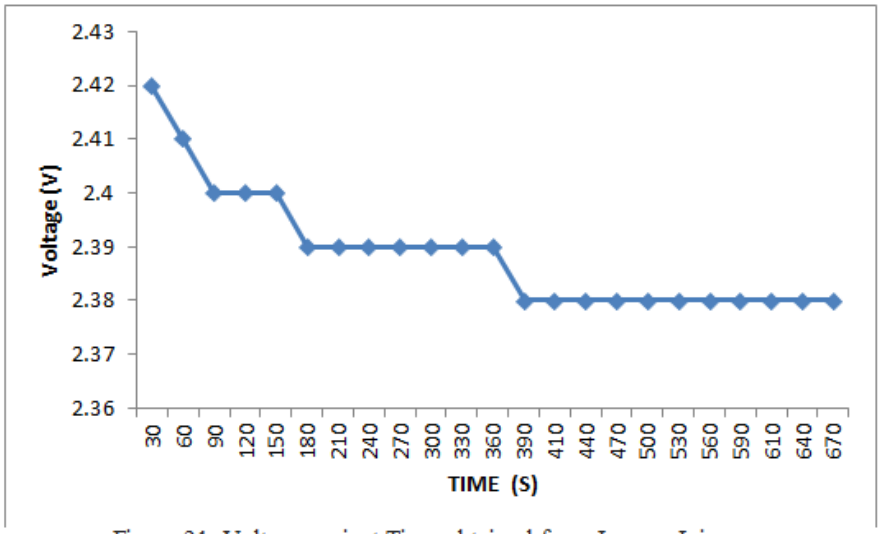


Figure 21: Voltage against Time obtained from Lemon Juice

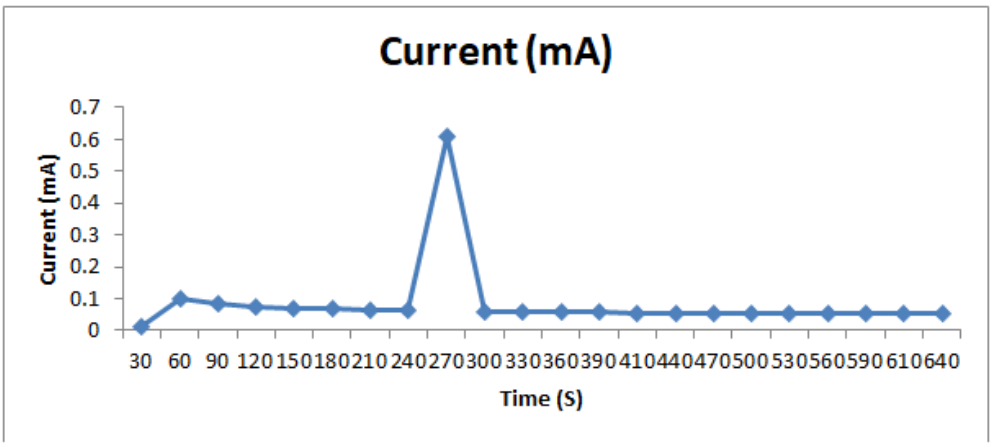


Figure 22: Current against Time obtained from Lemon Juice

It is observed that voltage from Lemon Juice electrolyte decreases with time, this is probably due to oxidation process on the electrolyte, while current is partially possess linear distribution pattern, V0 = 12.50V (Open Circuit Voltage) T0 = 0.

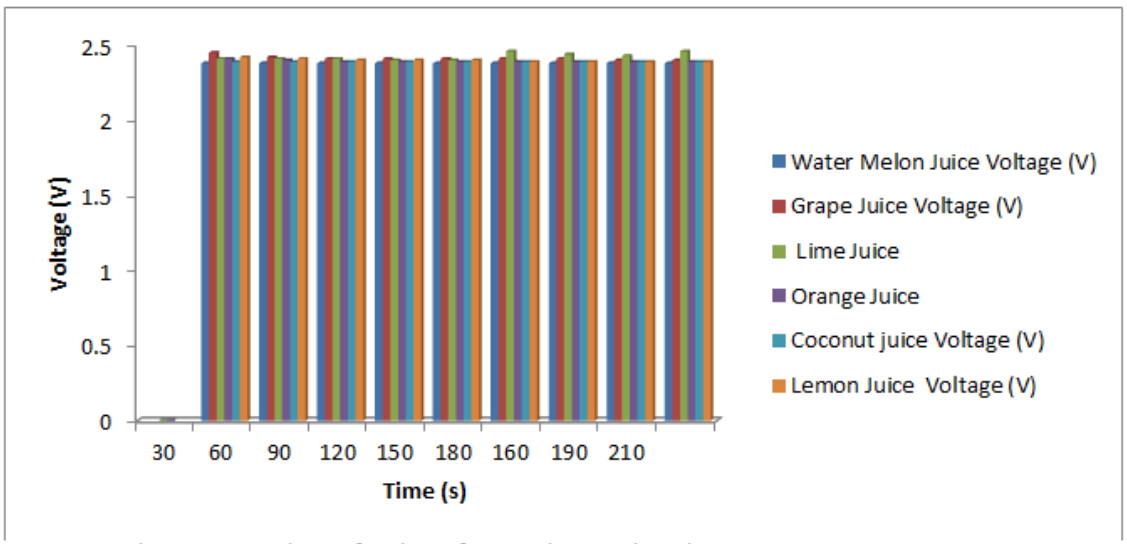


Fig 23: Comparison of Voltage from various Fruits Juices

It was observed that voltage obtained from the entire fruit juice electrolyte, possess similar characteristic shown in Figure 23. While, the current obtained from fruit juice electrolyte observed to be random in nature in line with various fruit juices electrolyte.

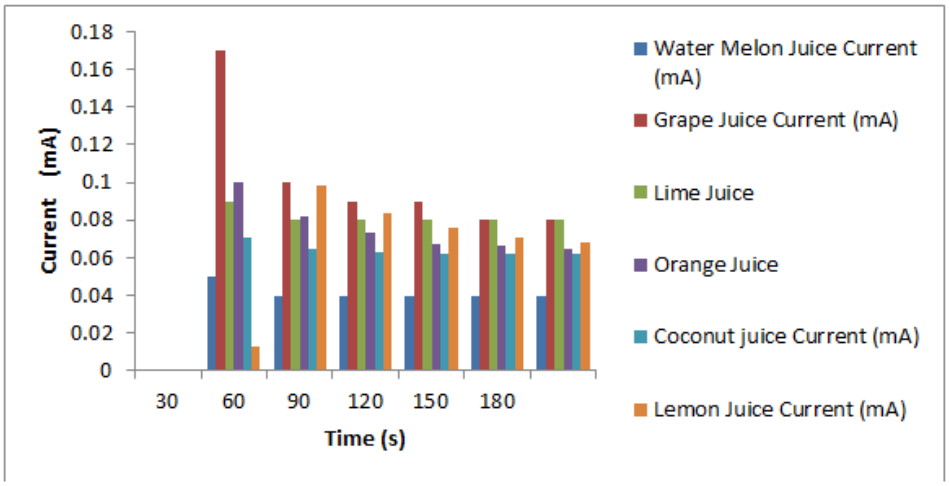


Fig 24: Comparison of Current from various Fruits Juices

Table 4: Deployment of Various Electrodes

S/N	Zinc Electrode	Copper Electrode
1	Iron	Wire
2	Copper	Wire
3	Zinc	Wire
4	Aluminium	Wire

The electrode where immersed in 10ml of lime juice and a Digital multimeter was used to measure the voltage between the electrode. The result is shown in Table 5.

Table 5: The Corresponding Electrode and the Volume of Juice

S/N	Electrode	Volume of Lime Juice	Voltage DVM (Volt)
1.	Copper- Copper	10ml	0.09
2.	Copper- Zinc	10ml	0.79
3.	Copper- Zinc	10ml	0.03
4.	Iron- Copper	10ml	0.23

Table 6: The Measurement of the Lime Battery Construction

S/N	Lime Electrolyte	Specific Gravity = 255.7gram per (metric cup)
1.	A cell voltage	= 0.8 volt (open circuit)
2.	One block of cell	= 1.6V (open circuit)
3.	8 block of cell	= 12.8V (open circuit)

The study, was able to established that voltage is generated from Nigeria fruits juices with relative PH level were determined with suitable electrical electrodes. However, a LED Bulb was energize from the voltage generated, the acidity (mg/L) and PH level values were determined from Nigeria fruit juice electrolyte.

The performance of the battery system was conformed to the design. It produced a bright light (high level of illumination) and it was used to power a pocket radio, it worked for a short pe three minutes. Subsequently, an air tight material should be use to construct the cell blocks of the battery to avoid bacterial oxidation to attain a stable voltage. However, the fruit juice could be improved by increasing the concentration of fruit juice electrolyte and it

should be air tight to avoid oxidation process.

IV. CONCLUSIONS

This study presents deployment of fruit Juices as battery electrolyte, using available Nigerian fruit juices such were Lemon, Lime, Orange, Grape, Watermelon, and Coconut. In addition, various materials were deployed such Zinc strip, Copper strip, Cotton wool, Syringe, Epoxy gum, Filter paper and PH meter etc. the PH level, Vol.ume of Sample (ml), Titre values of cm^3 and the acidity for various fruit juice electrolyte are determined in line with the deployed Copper and Zinc electrode. Voltage and current was determined from developed battery fruit juices electrolyte, it was observed that the battery system produces slight voltage and also, the current that was obtained used to power LED light. However, lime juice electrolyte produced higher voltage compared other fruit juices electrolyte.

V. REFERENCES

1. Abdul Majeed Khan and Muhammad Obaid, (2015). Comparative bioelectricity generation from waste citrusfruit using a galvanic cell, fuel cell and microbial fuel cell, *Journal of Energy in Southern Africa,* Vol 26, No 3.
2. Atetegeb Meazah Haregewoin, Aselefech Sorsa Wotango and Bing-Joe Hwang, (2016). Electrolyte additives for lithium ion battery electrodes: progress and perspectives *Energy & Environmental Science Review Published*. Downloaded by National Taiwan University on 31/05/2016 22:41:07. View Article Online View Journal at the Royal Society of Chemistry
3. Jakia Sultana, Komor-E-Jahan Dola, Sayed Al Mahmud, Md. Anisur Rahman Mazumder, (2018). Construction and Evaluation of Electrical Properties of a Lemon Battery, *journal of Chemical, Biological and Physical Science* (17). Available from: https://www.researchgate.net/publication/324744104_Construction_and_evaluation_of_electrical_properties_of_a_lemon_battery [accessed Mar 30 2020].
4. Saheed Adebowale Shittu, Sunday Adeola Ajagbe, Racheal Foluke Oloruntola, (2018).Conversion of Fruit to Battery, *International Journal of Scientific & Engineering Research*, Volume 9, Issue 1
5. Said Ali Akbar, Dilla Armelianda, Muttakin (2018). Electrolyte Performance of Non Fruit Extracts (Morinda Citrifolia L.) for C–ZnBatteries, *Chemical Engineering Research Articles,* CHEESA, Vol. 1 No. 2Hal 74-81
6. Theodosios Famprikis, Pieremanuele Canepa, James A. Dawson, M. Saiful Islam
7. and Christian Masquelier (2019).Fundamentals of inorganic solid-state electrolytes for batteries, *nature materials review articles,* www.nature.com/naturematerials https://doi.org/10.1038/
8. Theraja B.I. and A.K. Theraja, (2004), Electrical Technology, *Publication Division of Nirja Construction and development co.* Ltd New Delhi-110055, Pp1759-1782.