COMPARATIVE STUDY OF ELECTRICITY GENERATION OF CHLOROPHYLL OF GREEN SPINACH (*Spinacia oleracea*) AND ALOE VERA (*Aloebarbadensis* Miller) PLANT.

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Abstract: In this study, the potential of chlorophyll from spinach and aloe vera leaves to produce electricity was investigated. Double sided copper plates of approximately three inches long and 2 inches wide were used to form a copper sheet. Positive and negative sheathed copper leads are soldered onto opposite sides the solar cell. The absorption spectrum of the extracted chlorophyll of the plants was measured against the spectrum of visible light from 350 nm to 750 nm using scanning spectrophotometer. The highest absorbance for chlorophyll from spinach was 4.438 at 352 nm while the least was at 0.298 at 750 nm. Chlorophyll from aloe vera had the highest absorbance rate of 3.546 at 350 nm while least absorbance was 0.546 at 750 nm. Voltmeter and ammeter (V/A) readings of the plants chlorophyll at room temperature and under exposed sunlight at different time intervals (0-6 minutes) were recorded. Aloe vera had higher voltmeter and ammeter reading than spinach under room temperature with 1.73 volts and 0.03 amperes respectively. Spinach generated higher V/A readings under sunlight at time intervals of 0, 2 and 4 mins respectively with 1.74 v and 0.03 a being the highest reading at 0 mins while at 6 mins, aloe vera had a higher volt reading of 1.71v while a constant ampere of 0.01a for both spinach and aloe vera was recored at the same time interval. This study demonstrates that chlorophyll from these plants (spinach and aloe vera) has the ability to produce electricity at varying capacities.

Keywords: Amperes, Chlorophyll, Energy, Electricity

INTRODUCTION

Energy is the main element for most human activities. Energy is needed to create end products from natural resources (Tiwari & Ghosal, 2017). Since the use of energy resources has relieved us from much drudgery and made our efforts more productive, it is very important to the economic and technology development in the world (Hooi & Nyet, 2013). Unfortunately, most energy source brings a lot of negative effect to the ecosystem and earth climate such as pollution, global warming, acid rain, and radioactive waste (Gilani, 2018). The common consumption energy resource is non-renewable energy resource such as fossil energy (Walsh, 2019). Those resources cannot be produced, regenerated or reused (woodford, 2020). Since the non-renewable energy source is non-sustainable norenvironment-friendly, the solar energy and biomass and others renewable energy sources are developed as an effort to substitute the non-renewable energy source (Helgi, 2013). However, most of the solar energy as well as the biomass resourcesare not used commercially due to the high cost (Heldt, 2015). Therefore, invention of a new type of alternative energy resource is needed to replace those existing energy resources.

Chlorophyll is a green pigment found in all plants, algae, and cyanobacteria (Sapkota, 2020). It is the main component that contributed the process of photosynthesis of plant (Walsh, 2019). It is capable to channeling the energy of sunlight into chemical energy (Heldt, 2015). It tends to obtain energy by absorbing the sunlight through process photosynthesis. The molecules of chlorophyll absorb sunlight and use the sunlight energy to synthesize the carbohydrates and oxygen from carbon dioxide, CO_2 and water (Wikipedia, 2020). This process is known as photosynthesis which is the basis for sustainingthe life process of all plants (Heldt, 2015). The basic structure of chlorophyll is aporphyrin ring (Trapp, 2016). It is a stable-ring-shaped molecule around which electron is free to migrate and transfer absorbed energy from sun light by resonance energy transfer to a specific chlorophyll pair in the reaction center of the photosystems, in which areas of a leaf containing the molecule will appear green (Wikipedia, 2020). This energy retained by chlorophyll could potentially be used as a new type of renewable energy source and replace the common batterycell as what we most frequently used today (Wikipedia, 2020).

Plants use the process of photosynthesis s to convert sunlight into chemical energy using specialized cells (Aparna, 2018). "Plants use energy from the sun intiny energy factories called chloroplasts (Khan Academy, 2020). Using chlorophyll in the process called photosynthesis; they convert the sun's energy into storable form in ordered sugar molecules such as glucose. In this way, carbondioxide from the air and water from the soil in a more disordered state are combined to form the more ordered sugar molecules." Inside the chloroplasts arestacks of discs called thylakoids (Encyclopedoia Britannica, 2020). They are located within the walls of the chloroplast, and they act to trap the energy from sunlight. These coin-like stacks of thylakoids are called grana. These structures are connected with an extensive system of interconnecting tubules which transports necessary materials to the proper location.

The thylakoid membranes are the structures that actually contain chlorophyll and other pigments that give plants their green color. The thylakoids are arranged in antenna arrays to capture light energy. There are two photosystems called Photosystem I and Photosystem II, and in most plants, both photosystems are used in an electron transport process. This yields energy in the form of Adenosinetriphosphate and reduced coenzymes to the stroma of the chloroplast to be used in the synthesis of carbohydrates (Hooi & Nyet, 2013). The green pigmented chlorophyll has the desirable photovoltaic properties that are utilized in today's organic photosynthetic solar cells. Chlorophyll is a light harvesting pigment that

absorbs light in the visible spectrum of solar radiation which promotes electron transfer (Wikipedia, 2020). Carotenoids are also an important part of the photosynthetic process (Trapp, 2016). They aid in energy transfer to the chlorophyll molecule, and serve to supplement the light gathering properties of chlorophyll (Aparna, 2018). Explicitly, the overall chemical equation for plant photosynthesis is given by the following equation:

$$6CO_2 + 6H_2O + hv \rightarrow C_6H_{12}O_6 + 6O_2,$$ (Aparna, 2018)

In this double replacement reaction new, more complex compounds are synthesized from smaller ones. In this particular equation, *hv* represents the amount of energy from a one photon of light (Aparna, 2018). Two types of chlorophyll that are found throughout organisms with chloroplasts are known as chlorophyll alpha (α) and chlorophyll beta (β) (Sapkota, 2020). These pigment systems are necessary in order to properly absorb the different parts of the visiblesolar spectrum. Once absorption of light energy occurs and photosynthesis takesplace, a process known as electron transfer begins (Walsh, 2019). Without the transfer of electrons, no energy will flow through the photovoltaic system (Trapp, 2016). One way to increase electron transfer of chlorophyll is to replace the magnesium (Mg) atom with another metal such as copper (Cu) or iron (Fe) (Sapkota, 2020). This must be done carefully. The introduction of too much heavy metal will cause damage to sensitive plant cells and tissues. This will ultimately interrupt the process of photosynthesis and cause the system to fail if care is not taken (Virtanen *et al.,* 2020).

Electricity is the flow of electrical power or charge (electrons) in a form of energy (Bellis, 2018). It is a secondary energy source which means that we get it from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources (Crank, 2018).

MATERIAL AND METHODOLOGY

The Study Area

This present study was carried out at the Federal University of Technology,Owerri Imo State, Nigeria. Owerri is the capital city of Imo State found on longitude $5^{0}30^{1}$ North and $7^{0}10^{1}$ East. The University is situated between three villages- Eziobode, Ihiagwa and Obinze. There are two distinct seasons within these area, namely; rainy seasons, which begins in the month of April and lasts until October, with annual rainfall varying from 1,500-2,200mm (60-80 inches),while the dry seasons is ushered in by harmattan period and are characterized by hot weather and low humidity. The rainy season is associated with very high humidity of about 80-85% with very heavy rainfall. Temperature varies according to season between 25^{0}c to 32^{0}c in sunny days. The forest/vegetation in Owerri is a rain forest with lots of plants diversity, growing under the described climatic conditions. The people of Owerri are predominantly farmers who produces many agricultural products. However, there are few traders, private business owners, artisans, civil servants and professionals like doctors, engineers and lawyers.

The Study Sample

The sample used for this present study is spinach and Aloe vera

Material Uses

The materials used for this particular project are as follows: Erlenmeyer flask, Buchner flask, shallow beaker, centrifuge, centrifuge tubes, solder, soldering iron, sheathed copper wire, and double-sided copper plating. The chemicals used in this process are Ethanol. The main source of chlorophyll is finely fragmented leaf blades of a chlorophyll-rich spinach and Aloe vera plant.

METHODS

Collection, Processing and Authentication of Sample

Fresh and healthy plant sample of spinach and Aloe vera will be bought from Relief market, Owerri, Imo State and authenticated by a Biosystematist at the Department of Biology, Federal University of technology Owerri. The plant sample is washed gently in a running water so as to remove sand particles and debris prior to chlorophyll extraction.

Chlorophyll Extraction Process and Solar Cell Configuration

Methodology is as reported by Hoerner, (2013). The collected leaf sample of spinach which is rich in chlorophyll will be trimmed using scissors to remove the petiole, mid rib, and any leaf veins. The leaf blades are then trimmed further to achieve the smallest size of leaf without causing too much damage to the fragile chlorophyll cells. Next, the blade particles will be placed into an Erlenmeyer flask with sufficient volume to contain all the blade pieces and ethanol. Ethanol will then be poured into the flask containing the blades and the amount of ethanol will be enough to completely cover the leaf blades.

The flask is then swirled lightly for approximately 30 seconds to ensure the ethanol has saturated the plant matter. The flask will then be left undisturbed for approximately 24 hours in a completely dark location. The mixture of ethanol and leaf blades is run through a Buchner flask to separate the particulate matter from the chlorophyll-containing ethanol and stored in centrifuge tubes, with an addition of a complimentary amount of hexane. The hexane will ensure the separation of the chlorophyll from other less dense material.

The mixture will be centrifuged for approximately 5 minutes around 5000 rpm, with the formation of two distinct layers and the chlorophyll will be pipettedaway. Then a small double sided-copper plate approximately 3 inches long and 2 inches wide is cut from a larger sheet. The copper plate will be scoured by a fine course sandpaper in order to allow the chlorophyll to have a good contact surface, after which the semi-rough copper plate will be placed in a shallow beaker that is as close to the shape of the plate as possible and the chlorophyll solution is then poured into the shallow beaker covering the entire surface of the copper plate. The beaker is then left to sit undistributed in a dark room until everything excepta layer of chlorophyll is dried on the copper plate. Finally, negative and positive sheathed copper leads are then soldered onto opposite sides of the copper plate and the solar cell is complete. Then at this point, sensors can be connected to the leads to take various readings at different time intervals.

RESULTS

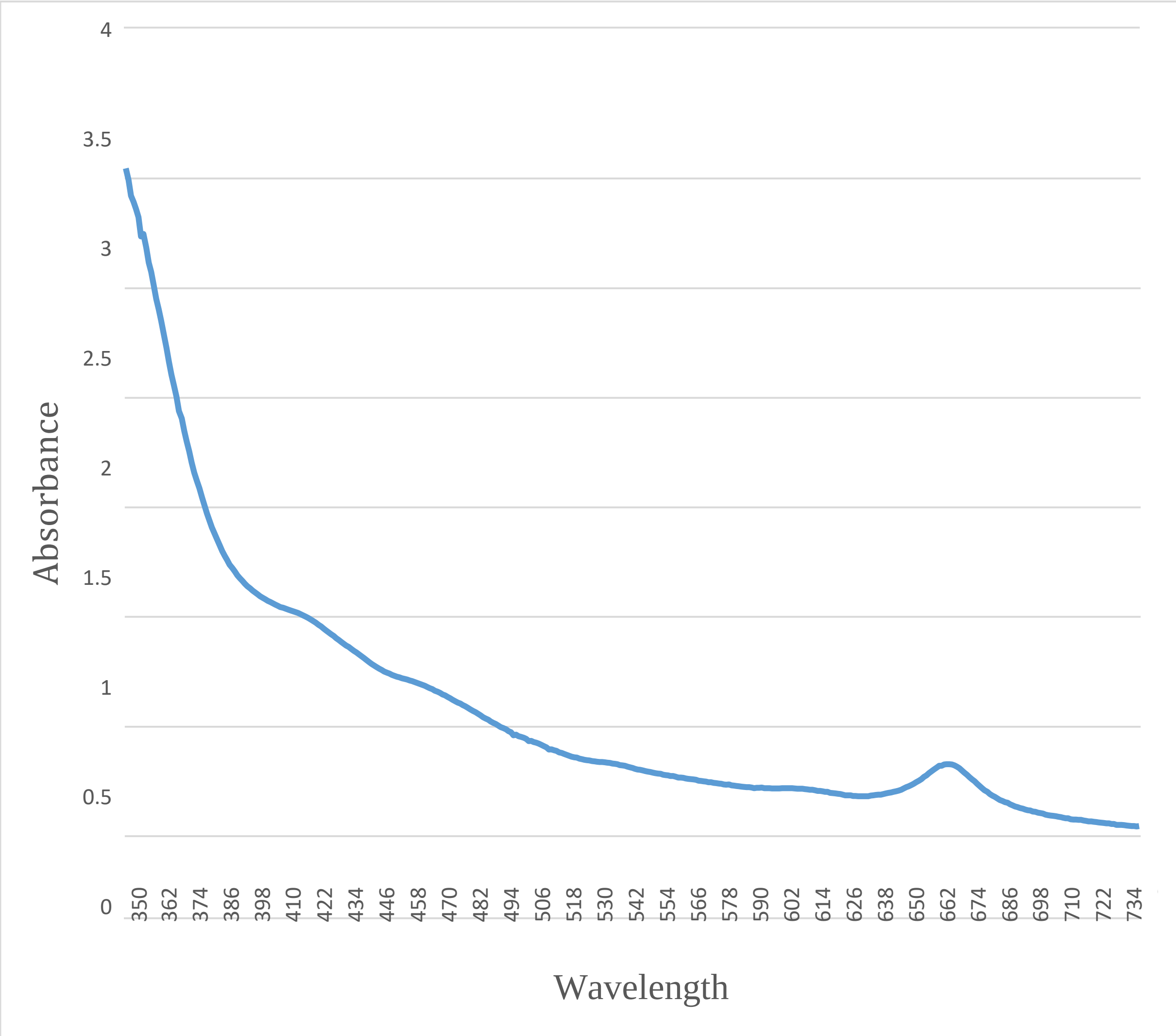
Measuring absorption spectrum for chlorophyll extract

Absorption spectrum for spinach

The absorption maxima of spinach chlorophylls against the spectrum of visible light from 350 nm to 750 nm were obtained using the scanning spectrophotometer to ascertain the absorption rate. The highest absorbance was recorded at 4.438 against 352 nm wavelength while the least was recorded at 0.298 against 750 nm wavelength. But the peak for the graph is 1.602 against 678nm which starts from 0.765 against 642 nm and 0.494 against 712 nm

Absorption spectrum for Aloe vera

The absorption maxima of Aloe vera chlorophylls against the spectrum of visible light from 350 nm to 750 nm were obtained using the scanning spectrophotometer to ascertain the absorption rate. The highest absorbance was recorded at 3.546 against 350 nm wavelength with the least at 0.546 against 750 nm wavelength and the peak is at 0.817 against 678 nm wavelength.



Voltmeter/Ammeter Reading for Spinach and Aloe vera

Table 4.1 summarizes the voltmeter/ammeter reading for spinach and aloe vera at room temperature and under exposed sunlight at a particular time interval. The voltmeter reading at room temperature for Aloe vera was shows slight difference with that of spinach while under exposed sunlight spinach is slightly different from that Aloe vera. Conversely, voltmeter and ammeter readings dropssimultaneously but in some instances remain static.

Table 4.1: Voltmeter/Ammeter reading for Spinach & Aloe vera

Time (Min)	Room Temperature				Exposed Sunlight			
	Samples				Sample			
	Spinach		Aloe vera		Spinach		Aloe vera	
	V-reading	A-reading	V-reading	A-reading	V-reading	A-reading	V-reading	A-reading
0	1.72	0.02	1.73	0.03	1.74	0.04	1.72	0.02
2	1.70	0.01	1.72	0.02	1.73	0.02	1.71	0.01
4	1.70	0.01	1.71	0.01	1.72	0.02	1.71	0.01
6	1.70	0.01	1.72	0.02	1.70	0.01	1.71	0.01

Discussion

Electricity as an essential form of energy for numerous purposes can be generated from plant chlorophyll- a green energy that is eco-friendly and renewable. The voltmeter reading and ammeter reading for spinach and Aloe vera shows that there were flow of current when the set-up was closed (Hooi *et al.*, 2017). But the readings for spinach at room temperature became constant from 2-6 minutes, the reason for the constant may be due to poor illumination, while under direct sunlight, as the value of voltmeter reading decreases with time, the value of ammeter reading also decreases. In comparison, the readings obtained under direct is just differ slightly from that of room temperature, though expected to be higher due to the fact that sunlight will help in improve the current flow. Similarly, the readings for Aloe vera under room temperature drops proportionately but under direct sunlight the readings remain constant. Hence, current generated from the chlorophyll of spinach and Aloe vera were able to power a led bulb but more effective at series connection. This is in agreement with the works of Lee *et al*. (2018); Aoki, (2018); Parithra *et al*. (2018).

Furthermore, the peak absorbance of spinach and Aloe vera were the same indicating that there was no difference between them. But spinach shows a higherabsorbance at 352 nm while that of Aloe vera was at 350 nm (Hooi *et al*., 2017).

CONCULSION:

Findings from this study revealed that the various plants chlorophyll were able to produce electricity at varying degrees. More research should be structured towards optimizing techniques to produce electricity in megawatts and in sustainable quantity using various plant sources.

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