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CHLOROPHYLL AS A NEW ALTERNATIVE ENERGY SOURCE

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Abstract: Most of the energy resources that exist nowadays are non-renewable and not eco-friendly that cause major concern to the environment. It is therefore important to find a new type of alternative energy resource to substitute the non-renewable type. The main objective of this study is to investigate the potential of chlorophyll that extracted from fresh spinach leaves to be used as energy source in a battery cell. Carbon rod and strip of zinc are used as the positive and negative terminal of chlorophyll battery cell respectively. I-V characteristic of three chlorophyll battery cells connected to LED in series is tested. It is found that the battery has the ability to light up the LED. This study shows that chlorophyll has the potential to be used as a new alternative energy source in the future.

Keywords: Chlorophyll, Renewable energy resource, Chlorophyll battery cell.

INTRODUCTION

Energy is the main element for most human activities. For example, energy is needed to create end products from natural resources (Tiwari & Ghosal, 2007). 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. 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.

The common consumption energy resource is non-renewable energy resource such as fossil energy. Those resources cannot be produced, regenerated or reused. Since the non-renewable energy source is non-sustainable nor environment-friendly, the solar energy and biomass and others renewable energy sources are developed as an effort to substitute the non-renewable energy source. However, most of the solar energy as well as the biomass

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resources are not used commercially due to the high cost. Therefore, invention of a new type of alternative energy resouce is needed to replace those existing energy resources.

Chlorophyll is a green pigment found in all plants, algae, and cyanobacteria. It is the main component that contributed the process of photosynthesis of plant. It is capable to channeling the energy of sunlight into chemical energy. 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. This process is known as photosynthesis which is the basis for sustaining the life process of all plants (Heldt, 2005). The basic structure of chlorophyll is a porphyrin ring. It is a stable-ring-shaped molecule around which electron are 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. This energy retained by chlorophyll could potentially be used as a new type of renewable energy source and replace the common battery cell as what we most frequently used today.

The average consumption of the battery in an industrial country is about 10 batteries per man every year. Manufacturer of battery is now a multi-billion dollar industry as battery cells are widely used in the world nowadays. However as convenient as the batteries are, they are not environment friendly since most of them contain toxic chemicals. The battery waste is an environmental concerned issue since it brings toxic metal pollution and it may harmful or fatal if swallowed. In this project, we investigate the feasibility of applying chlorophyll in the field of renewable energy resource and demonstrate the potential use of chlorophyll cell. The manufacturing cost of chlorophyll cell will be estimated to be much lower than the renewable energy resources existing nowayas due to the abundancy of chlorophyll in plants everywhere especially in Malaysia.

MATERIALS AND METHODS

Chlorophyll Extraction Using 90% Isopropyl Alcohol

Chlorophyll was extracted from fresh spinach leaves. Spinach leaves were weighted out and were torn into confetti-sized pieces, excluding the large veins and obviously damaged portions of leaves. Pieces of chlorophyll leaves were inserted into a screw-cap container wrapping with aluminum foil and soaked it with enough 90% Isopropyl alcohol. The Isopropyl alcohol would break open the cell making the cell leaky or more permeable. This allows the chlorophyll to escape from the cell into the solution. The container was kept in the 4°C fridge for at least 3 hours and as long as overnight to recover more chlorophyll. Sufficient soak time will yield a dark green isopropyl alcohol solution.

Measuring of Absorption Spectrum

The light absorption of the extracted chlorophyll is measured by using spectrophotometric technique. A diluted aliquot of the extract was used to generate an absorbance spectrum from the wavelength 350 nm to 700 nm by using the scanning spectrophotometer

Chlorophyll Content Determination

The content of chlorophyll-a and chlorophyll-b in the extract chlorophyll was determined with spectrophotometric technique. Absorbance of chlorophyll was read at 645nm and 663nm, respectively. The extract was diluted with 80% acetone to obtain a value preferably in the range of 0.2 – 0.8 absorbance units. Concentrations of the total chlorophyll, chlorophyll-a and chlorophyll-b in the sample can be calculated from the equation below:

$$\text{Chlorophyll-}b\,(\text{mg/ml}) = 22.9\,A_{645} - 4.68\,A_{663} \tag{1.1}$$

$$\text{Chlorophyll-}a\,(\text{mg/ml}) = 12.7\,A_{663} - 2.69\,A_{645} \tag{1.2}$$

$$\text{Total Chlorophyll}\,(\text{mg/ml}) = \text{chlorophyll-}a + \text{chlorophyll-}b \tag{1.3}$$

Where,

A_{645} = absorbance at a wavelength of 645 nm
A_{663} = absorbance at a wavelength of 663 nm

***I-V* Characterization of Chlorophyll Battery Cell Over an LED**

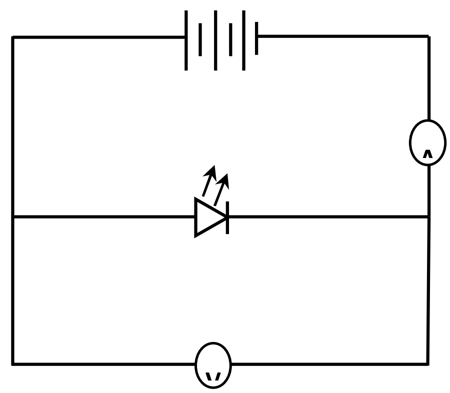

Figure 1 Circuit for measuring I-V characteristic of chlorophyll battery cell over an LED.

The I-V characteristic of chlorophyll with three different concentrations as battery cells connected to an LED in series was measured and recorded every 5 seconds for 30 minutes. Experimental setup for this test was shown in Figure 1 and the brightness of the LED was observed. To investigate the durability and consistency of the battery, the test was repeated for three consecutive days.

RESULTS AND DISCUSSIONS

Measuring of Absorption Spectrum

The absorption maxima of chlorophylls against the spectrum of visible light from 350 nm to 750 nm were obtained using the scanning spectrophotometer to verify the existence of the chlorophyll-a and –b. The absorption peak of chlorophyll is in the blue and red region of light spectrum. There is a peak absorption at the wavelength of 663 nm. Figure 2 below shows the spectrum of chlorophyll extract which consists of chlorophyll-a and chlorophyll-b.

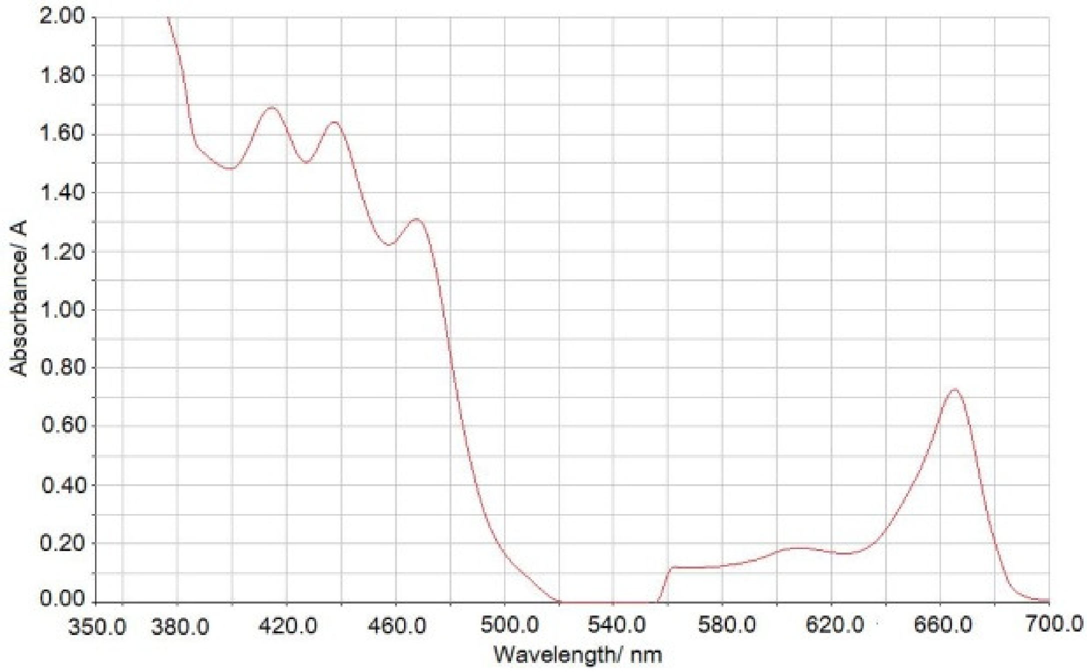

Figure 2 Light absorption spectrum of chlorophyll extract using 90% isopropyl alcohol.

Chlorophyll Content Determination

Chlorophyll was extracted from spinach leaves. Total chlorophyll content extracted from spinach leaves was determined by using formula (1.1), (1.2) and (1.3) as described above taking into consideration of the presence of chlorophyll-a and chlorophyll-b as the major chlorophyll present in plants. Absorption at A_{645} and A_{663} (with three and six times dilution factors) for three different samples were respectively 0.6836 and 0.4824 (sample 1), 0.7682 and 0.5700 (sample 2), and 0.7409 and 0.5969 (sample 3). Hence, the total chlorophyll content in sample 1, sample 2 and sample 3 are 76.46 mg/ml, 87.72 mg/ml and 88.00 mg/ml respectively.

***I-V* Characterization of 3 Chlorophyll Battery Cells with LED**

The *I-V* characteristic for 3 chlorophyll battery cells with samples 1, 2 and 3 of concentrations of 76.46 mg/ml, 87.72 mg/ml, and 88.00 mg/ml were studied over a LED (Figure 1). The result is shown in Figure 3. It can be seen that the sample 1 with 76.46 mg/ml of chlorophyll has the highest *I-V* value followed by sample 3 (88.00 mg/ml) and sample 2 (87.72 mg/ml). This indicates that the *I-V* value is not directly proportional to its concentration, and could be affected by other factors. Nonetheless, all chlorophyll samples with the range of concentration from 76.46 mg/ml to 88 mg/ml are able to light up the LED and produce the minimum power required to light up the LED.

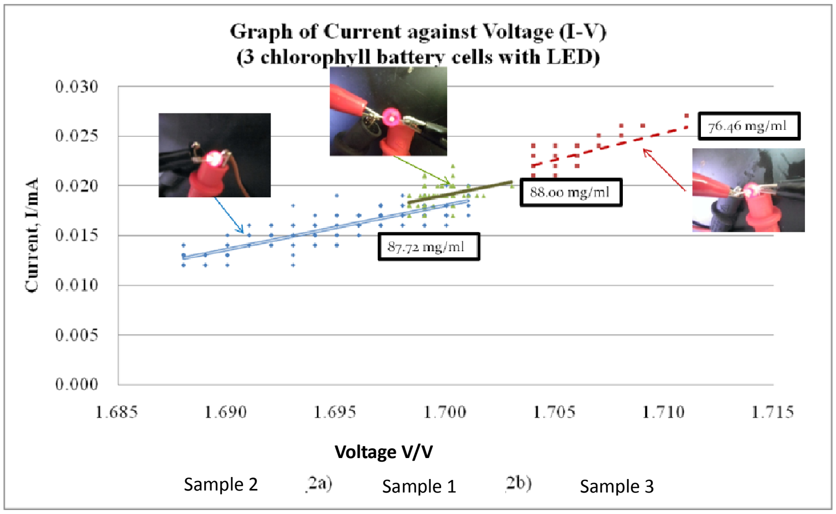

Figure 3 *I-V* characteristics of the chlorophyll battery over an LED.

Sample 1 was then proceed for day-to-day *I-V* characteristic measurement for a period of three consecutive days. The characteristic was measured every 5 seconds for 30 minutes every day in the morning (1100 hours). Again, there is no particular relationship between the duration of chlorophyll extract was kept with the *I-V* values. It can be seen from Figure 4 that the highest value is given by the sample on the second day followed by the first day and the third day of measurement. However, the ability to light up LED remains to be effective in the cholorophyll battery over the period of 3 days in this investigation.

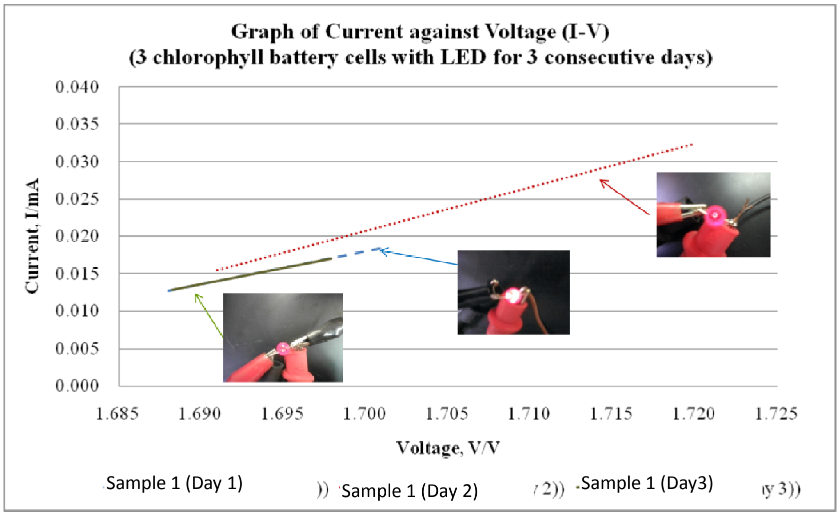

Figure 4 *I-V* characteristics of the chlorophyll battery over an LED for three day of measurements.

CONCLUSION

Chlorophyll is extracted from fresh spinach leaves which contains both chlorophyll-a and -b. It was found that although the *I-V* values of the chlorophyll battery cells vary as the concentration varies, the changes is not in the proportional manner. In addition, changes in the *I-V* values are not proportional to the duration of the chlorophyll battery cells kept. Nonetheless, this paper shows that with the chlorophyll concentration between 76.46 mg/ml to 88.00 mg/ml, the battery cell could be used to light up a LED. It is also shown that for at least three days, the battery could be used for the same purpose. The result presented in this paper indicates that chlorophyll from plants have the potential application to be used as a new source of alternative energy.

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