Exploring the Photo sensitivity of Mimosa Pudica for Solar cell Production

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EXPLORING THE PHOTO SENSITIVITIES OF *Mimosa Pudica* FOR SOLAR CELL PRODUCTION

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Abstract**:** The aim of the research is to investigate the possibility of generating electricity from extract of *Mimosa pudica* leaves and to design a 'mimosa accumulator' to store the energy obtainable from the *Mimosa pudica* isolates. The leaves were dried in the oven, pulverized to enhance extraction with light petroleum and aqueous methanol. Fractions of chlorophyll **a** and **b** were separated. The second half of the pulverized leaves was placed in the muffle furnace to remove organic insulators. The ash was placed in sohxlet extraction unit and digested. The filtrate concentrated, purified and identified as thio-sulphite.Laboratory investigations show that light absorbed catalysis oxidation – reduction reaction between the chlorophyll, an oxidizing agent and thio-sulphite, a reducing agent. The challenges were how to utilize the electrons released by redox activity, and convert them to solar renewability. Hence, the isolates of chlorophyll **b** and thio-sulphite were mixed in three different ratios of 1:1, 1:2, and 2:1. Using lead oxide and lead plates. 2:1 mixture gave the highest value - 250mA output and 0.9V that lit an LED bulb. The innovative exploration of the electrical potential of mimosa plant for solar cell production is possible and presents a novel way of making green electric power available.

Keywords: *Mimosa pudica,* solar sensitive isolate, solar cell, green electricity, chlorophyll, thio-sulphite, absorption.

1 INTRODUCTION

Mimosa pudica is a medicinal plant of African origin. it is native to many parts of the northern hemisphere, near the equator. This plant is a short evergreen sub-shrub. It has prickly stems and small, fluffy ball shaped pink flowers in summer. A perennial plant it grows to a height of 0.5 metres with a spread of 0.3metres. In some areas, this plant is becoming a noxious weed. The stem is erect, slender and branching. It is adaptable to most soils in an open, sunny position, and is drought and frost tender. Due to its ability to fix nitrogen from the air it does well on poor soils. This plant requires a medium high exposure and evenly moist soil and temperatures between 60- 80^0C.

[1] Raintree Nutrition, Inc Carson City NV89701 (1996).

Fig. 1: Collection of Mimosa pudica with flowering features fully illustrated
Family: fabacae, Genus: mimosa, Species: pudica
Common names: mimosa, sensitive plant

Mimosa pudica has physical features characterized by its ability to spread out the leaves during daylight and fold them at sunset. It baffles why the leaves close when touched only to re-open within minutes under the sun. The search for these behaviours led to this study. Wherever there is movement, there is energy. It became clear that this plant is sensitized by solar radiation. The phenomenal movement of the leaves indicates electrical transmission. Also, the touch response exhibited by this plant when touched resulting to sthe leaves closed is attributed to charge induction on the leaves.

Fig. 2: Mimosa at sunrise

Fig. 3: Mimosa at sunset

Fig. 4: Before charge induction

Fig. 5: After charge induction

2 AIM AND OBJECTIVES

To determine the possibility of generating electricity from the solar responsiveness of *Mimosa pudica* weed. The general objective is to explore the photo sensitivities of *Mimosa pudica* plant for solar cell production.

In the actualization of this objective, attempts were made.

a. To generate electricity power using Mimosa solar cell.
b. To design a Mimosa accumulator to store the energy obtainable from the *Mimosa pudica* leaves.
c. To establish a *Mimosa pudica* farm for the production of solar electric power.
d. To estimate the amount of electric power derivable from per gram of the isolates, the active electrical constituent.
e. Determination of the daytime optimal current output from the assembled Mimosa solar panel.

3 MATERIALS

Materials used in the research included *Mimosa pudica* leaves, mortar and pestle, drying oven, muffled furnace, soxhlet extractor unit, scissors, beaker 100ml, conical flask 250ml, pH meter, Avo-meter, soldering iron, Lead and Lead oxide plates, PVC cell compartments, distill water, adhesive, analytical balance.

Fig. 6: Principal raw material – a common weed readily available in abundance

4 METHODOLOGY

The *Mimosa pudica* leaves were collected using scissors and placed in the hot air oven at $100^{O}C$ for an hour to dry. The initial weight recorded was 335g.

Fig. 7: Placing mimosa leaves in the oven

The dried leaves were pulverized using mortar and pestle. Two units of 50g were weighed out.

Fig. 8: Pulverising the dried mimosa leaves

The pulverized leaves were placed in the soxhlet extraction unit to completely extract the chlorophyll constituents using distill water.

Separation of chlorophyll from other constituents was effected using a mixture of petroleum ether and aqueous methanol. This yielded two components of chlorophyll *a* and *b*. The chlorophyll of interest is chlorophyll *b* present in aqueous methanol layer. After concentration the yeild was 6g.

Fig. 9: Soxhlet Continuous extraction unit

The second half of the pulverized leaves weighing 50g was placed in the muffled furnace to remove organic constituents.

Fig. 11: Removal of organic constituents to obtain active inorganic sulphite.

The ash was placed in 100ml beaker, washed with distilled water and concentrated. Yield 4g. The isolates of chlorophyll ***b*** and thio-sulphite were mixed in three different ratios of 1:1, 1:2, and 2:1

Fig 10: Separation of chlorophyll *a* and *b*

4.1 Results

Lead oxide and lead electrodes were used in tapping current generated. 1:1 mixture gave an output of 100mA, 1:2 mixture gave an output of 150mA while the 2:1 mixture gave the highest value of 250mA output and 0.9V that lit an LED bulb.

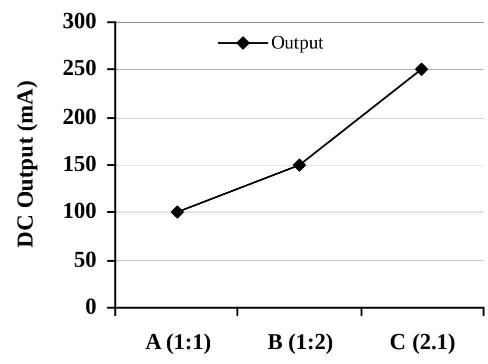


Fig. 11: Concentration Ratio (Chlorophyll - Sulphite Mixture) vs Current Output

4.2 Reaction test for thio-sulphite

For thio-sulphite radical, a pinch from the ashed sample was taken, placed in test tube. Distilled water was introduced to wash out the soluble part it was later decanted into another test tube. To the solution barium chloride was added. A heavy white precipitate soluble in dilute HCl confirmed thio-sulphite (sulphate (IV))
[1] Lambert & Muir, Practical chemistry (1973) 389.

Table 1: Summary of design parameters and comparism with other electrolytes

	Para-Meters	**Mimosa Electrolyte**	**Sulphuric acid Electrolyte**	**Water Electrolyte as control**
1	Specific gravity	1.15	1.2	1
2	DC current output	200mA	>250mA	Zero
3	DC voltage potential	0.9v	1.2v	Zero
4	No of cells	6 cells	6 cells	6 cells
5	pH	Basic	Acid	Neutral
6	Recharge mode and duration	Solar Duration – 30mins	AC power duration – 12hrs	Non
7	Reaction	Normal temperature	Exothermic	Non

A Mimosa solar accumulator was produced. The panel generated energy in form of Dc current. After exhaustion and subsequent exposure to solar radiation, the energy is renewed.

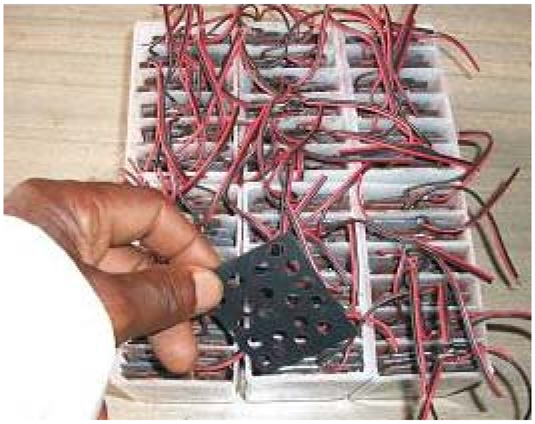


Fig. 12: Insulator being placed in a cell component, with the tapping electrodes already positioned.

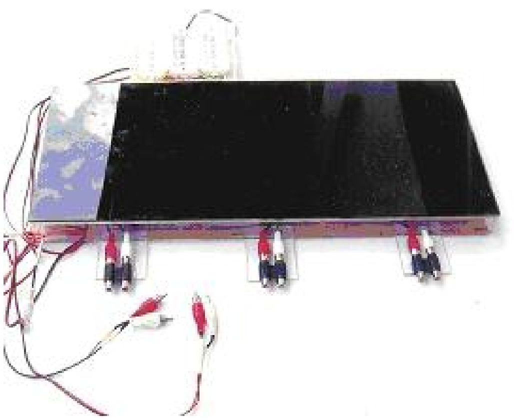


Fig. 13: Developed Solar panel from mimosa accumulators

5 DISCUSSION

Chlorophyll is a green compound found in leaves and green stems of plants. Initially, it was assumed that chlorophyll was a single compound, but in 1964 Strokes showed by Spectroscopy that chlorophyll was a mixture. In 1912, Willstarter et al showed that chlorophyll was a mixture of two compounds, chlorophyll *a* and chlorophyll *b*[1]

When chlorophyll absorbs light energy, an electron is excited from lower energy to a higher energy. In this higher energy state, electron is more readily transferred to another molecule. This starts a chain of electron transfer steps, which ends with an electron being transferred to thio-sulphite.

Meanwhile, the chlorophyll which gave up an electron can accept an electron from another molecule.

Proposal mechanism of current generation from chlorophyll

Sodium thiothio-sulphite being a reducing agent generates the electrons during the half cell oxidation process.

The electron(s) released will be captured by the chlorophyll component of the plant during the half reduction reaction.

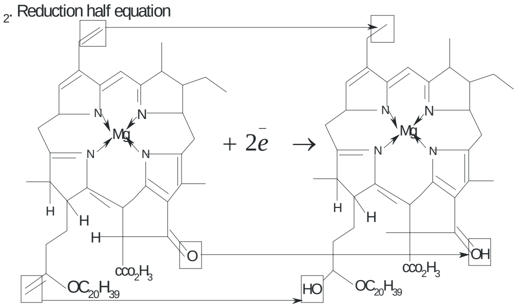
The electron(s) reduce the chlorophyll and generates electricity subsequently.

This generation can stop from t0 time until a reversible process occurs to allow the chlorophyll regains its reduction potentials.

1. Oxidation half equation:

$$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2\bar{e}$$

2. Reduction half equation



3. Overall Equation of Reaction

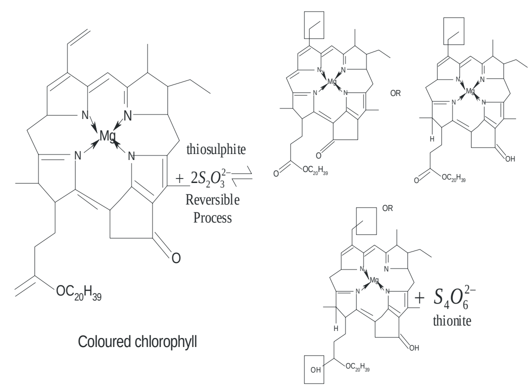


Fig 14: Mechanism of current generation from chlorophyll *b* and thio-thio-sulphite

6 SUMMARY

Energy makes all things move. Wherever there is movement, there is energy. This notion is the motivational instinct to embark on this project. Look around you, observed as many (living and non-living) as you can that are in motion. Identify the immediate source forms of energy; you will see that, indeed, there is energy in everything. All energy released on the earthm apart from atomic energy and tidal energy, comes from the sun.

Humans have successfully derived energy from a variety of inanimate source-forms, sun, water, fossil, deposits etc. That is why the generation of functional electricity from an obscure plant strikes me as extra-ordinary, perhaps unprecedented.

The beauty of this discovery is that the materials needed for its development are common weed, locally available and can be assembled at minimum cost. The technology is simple solar accumulator of ***Mimosa*** electrolytes made of combined ratio of ***chlorophyll*** and *thio*-***thio-sulphite*** isolates. The energy storage is renewable at no further costs; all it requires is exposure to the sun.

Mimosa solar cell is a deviation from the conventional solar electricity production. I am confident that when fully developed, the ***Mimosa*** solar-electric cells will turn out to be more cost effective and more functional than the current available panels.

7 CONCLUSION

Critical laboratory investigations show that what is responsible for the sensitivity in ***Mimosa pudica*** leaves is light absorption catalysis of oxidation reaction between the *chlorophyll b* an oxidizing agent and ***thio-sulphite***, a reducing agent.

The tested electrical properties of Mimosa isolate yielded 0.9V potential and 250mA DC current output. Practical demonstration of the electrical potential of ***Mimosa*** isolates (***chlorophyll*** and ***thio-sulphite***) was the arrangement of cells in parallel which energized a LED bulb. The accumulator is renewable after exhaustion and takes only 30mins to attain full charge.

In all, the explored electrical potential of ***Mimosa*** plant isolates has shown that it is possible to use ***Mimosa pudica*** plant product to trap solar energy. This is a novel attempt of making green electric power available.

The innovative exploration of the electrical potential of mimosa plant for solar cell production is possible and presents a novel way of making green electric power available.

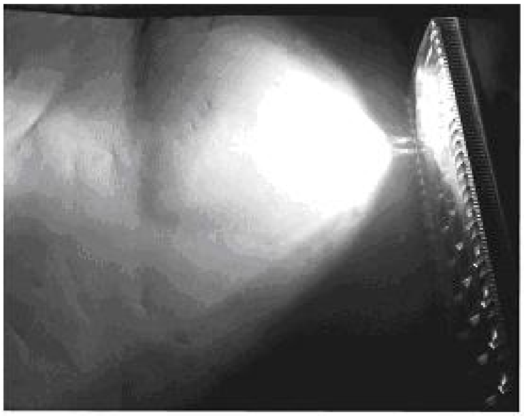


Fig 16: The solar accumulator used to power an LED lamp at night. 6.5V, 250mA

Fig. 17 Renrwable activities of mimosa panel at rural setting

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I wish to appreciate the efforts of Pharm Nnadi C of Pharmaceutical and Medicinal Chemistry for his contribution in designing the structural formula of the chlorophyll and thiosulphite reaction. The input of Pharm David C is acknowledged. I will not forget the suggestions from Mr. James Ezema of the Department of Physics and Astronomy, University of Nigeria, Nsukka.

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