

Original Research Article**LIFESPAN OF ASPILIA AFRICANA DYE SENSITISED SOLAR CELL
USING BENZOIC ACID.****ABSTRACT**

Aspilia africana flower dye was extracted by using ethanol as solvent. Absorbance of the extracted dye were measured at different wavelengths and used in fabricating Dye sensitized solar cells. The mixture of dye with TiO_2 indicates changes in absorbance values and the phytochemical screening shows the presence of anthocyanin and flavonoids in the plant. Benzoic acid was added to the solar cells to prolong the effectiveness of the dye and the solar cell was observed for a period of time. The sintered film for the control cell was characterized by FTIR and reported. We noticed that benzoic acid has a variety impacts on life span and electrical characteristics of the dye Sensitized solar cell. This can be concluded that the addition of benzoic acid can increase the life span of DSSC.

Keywords: Dye sensitized solar cells (DSSCs), Titanium dioxide (TiO_2), Aspilia Africana flowers, and benzoic acid.

1. INTRODUCTION

The worldwide demand for energy is expected to double by the year 2050 and triple by the end of the century (O' Regan B. et al 1991). There is a growing concern, however, that the production of oil will soon not be able to keep up with the growing demand leading to dire economic consequences (J. R. Hughes, 2008, R. L. Hirsch, 2008).

Light from the sun is arguably the ideal source of energy. The solar flux striking the earth contains 10,000 times the average global power usage. An alternative type of solar cell made from simple common and relatively cheap materials is the dye sensitized solar cells (DSSCs) invented by Michael Grätzel and Brian O'Regan in 1991. The first solar cells were only capable of using light at the ultraviolet and blue end of the spectrum but by the turn of the century advances in technology were able to broaden the frequencies in which cells were able to respond. Grätzel, M, (2001) is composed of a porous layer of titanium dioxide nanoparticles covered with organic dye that absorbs sunlight, similar to chlorophyll in green leaves.

Dye sensitised solar cell (DSSCs) have extensively researched over the past decades due to their high energy – conversion efficiency and especially low production cost as cheaper alternatives to silicon solar cells (O' Regan B. et al 1991). DSSCs typically consist of a nanocrystalline TiO_2 film covered by a monolayer of dye molecules, redox electrolyte and counterelectrode.

While technologies have been developed to harness solar energy efficiently, they are not yet an economically viable alternative to fossil fuels (Lapornik B. et al 2007). The abundant supply and environmental friendliness of solar energy make the efficient and cost – effective conversion of solar radiation in electricity a compelling scientific goal. Hence, it is necessary that devices like dye-sensitized solar cells are produced even at commercial scale to help meet Nigerians electricity and energy demand.

DSSCs are not currently suitable for commercial use due to their short lifespan. The three main factors that affect the lifespan of DSSCs are bacterial growth on the dye pigment, evaporation of the liquid electrolyte and the decrease in efficiency due to photo bleaching (Ali, Samina. (2007)).

The objective of this work is to investigate the electrical performance of the combination of *Aspilia africana* and benzoic acid as dye sensitised solar cells. *Aspilia africana* is a common weed of field crops in West Africa found in fallow land, especially in the forest zone. The flowers are showy yellow florets and the fruits are bristly and minutely hairy. The plant is used to treat different diseases in different ecological zones due to varying chemical composition as a result of various ecological conditions of different places. Benzoic acid is used as a preservative in foods. It inhibits the growth of mold, yeast and some bacteria. The mechanism starts with the absorption of benzoic acid into the cells.

In this study we are preparing DSSCs using *Aspilia africana* mixed with benzoic acid due to the availability of the plants' parts in parts of Nigeria. This research work is to determine the lifespan and electrical characteristics of the cell by adding benzoic acid.

2. METHODOLOGY

a. Sample source and preparation

Samples of the flower for *Aspilia africana* were obtained along Lagos – Badagry Expressway, Lagos state, Nigeria. The sample was pulverized with the aid of mechanical blender (liquidizer). 25g of the pulverized sample was weighed using OHAUS Electronic weighing balance model brain weight B1500 made in USA and soaked in 250ml acidified ethanol.

The extracting solvent and the mixture were placed in an orbital shaker (SLAUART SSL1 ORBITAL SHAKER at 25 rpm) for 5 hours .The extract of the sample was decanted to remove the residual part of the samples. Simple distillation was carried out at 650C in order to concentrate the dye of the samples. The Jenway pH meter model 3505 was use to determine the pH of extracts. To prolong the effectiveness of the dye 0.05M of benzoic acid is added to the dye. It was predicted that adding benzoic acid to the dye would be most effective as this inhibits bacterial growth.

b. Preparation and construction of cells

Conductive ITO glass with dimension of 2.5 X 2.0cm is to be used. The photo anode would be prepared using two slides of the conductive ITO glass. A digital multimeter was used to check the conductive side of the ITO glass and the value is 22Ω. Adhesive –tape are applied to the face of the conductive glass plate in order to create an opening of dimension 2.3X1.8cm² at the centre of the glass The cells were assembled and tested using the method reported by (Boyo et al,(2012)).

c. Measurement of photoelectric conversion efficiency of DSSC

The absorption spectra of dye solution and dyes adsorbed on TiO₂ surface were recorded using a VIS Spectrophotometer (Spectrumlab 23A GHM Great Medical England). The control and modified solar cell was observed for a period of 120 hours, with current readings taken every 24 hours.



Figure 1: TiO₂ paste on conducting glass



Figure 2: sintered TiO₂ paste



Figure 3: assembled solar cell

3. RESULTS AND DISCUSSION

		Isc (mA)	Voc(mV)	FF	Efficiency
DAY 1	Control cell	0.020	11.3	0.547	0.000502
	Cell+ benzoic acid	0.020	16.8	0.784	0.00105

DAY 2	Control cell	0.060	38.4	0.620	0.00571
	Cell + benzoic acid	0.064	40.9	0.606	0.00635
DAY 3	Control cell	0.042	31.3	0.710	0.00374
	Cell + benzoic acid	0.0372	33.8	0.810	0.00408

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108 When benzoic acid was added to the ethanol extract of *Aspilia africana* in order to extend the
 109 lifespan of the cell. It was observed that there was an increase in the output voltage and
 110 current when compared to the output from the control cell. After 24hours the readings were
 111 recorded again but there was no output reading without electrolytes but when electrolyte was
 112 added to the cells, output voltages and currents were recorded. The cell containing benzoic
 113 acid showed better efficiency compared to the control cell. Also, 48hours later the readings
 114 were taken and there was no output without electrolyte but when electrolyte was added the
 115 cells gave an output voltage and current with the cell containing benzoic acid showing better
 116 efficiency when compared with the control cell.

117 The cells were left for over 2weeks and when the readings were to be recorded there was no
 118 output voltage and current without electrolyte and when electrolytes were added.

119 The spectra show broad band between 500cm^{-1} and 700cm^{-1} which is due to normal TiO_2
 120 stretching. Also, the spectra shows one broad band at 3435cm^{-1} which can be attributed to the
 121 O-H bond in the sintered film. Other spectra peaks could be as a result of the dye constituent
 122 in the sintered film.

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124 4. CONCLUSION

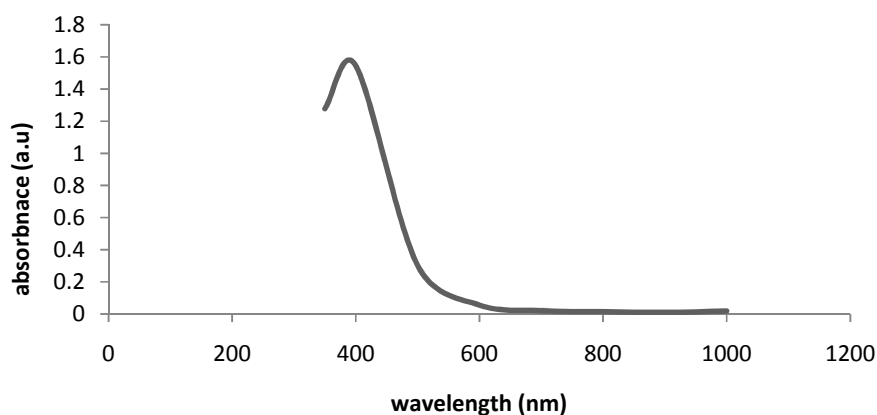
125 In summary, we have successfully extracted the dye from *Aspilia africana* flower and
 126 determined the absorption spectra for the dye. Also, we determined the level of anthocyanin
 127 to be low compared to the flavonoids in the flower. FTIR studies shows considerable increase
 128 in intensity with respect to peak. The benzoic acid cells exhibited higher current readings
 129 than the control cell, and maintained the increased current over the entire duration of the
 130 experiment.

131 REFERENCES

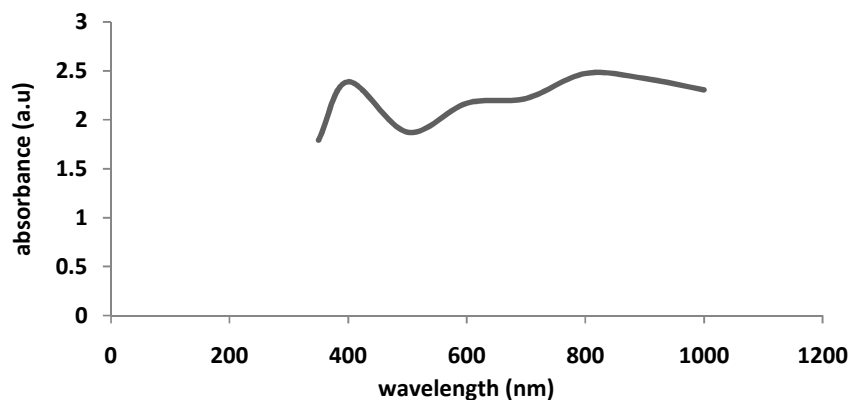
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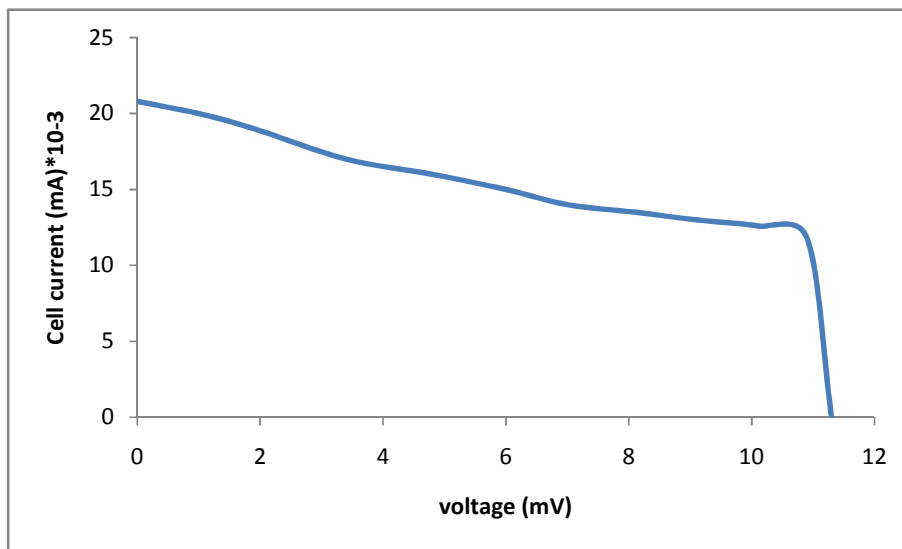
GRAPHS



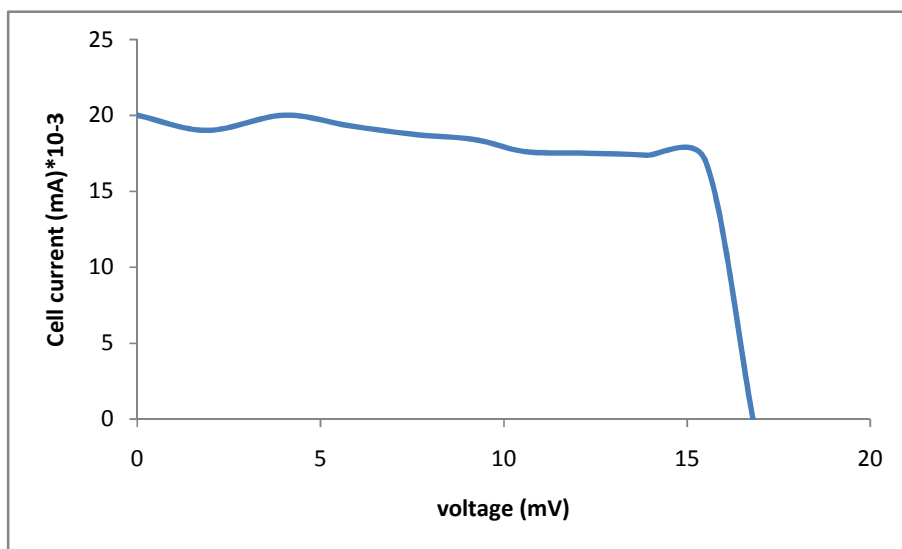
Graph 1: graph of absorbance against wavelength for ethanol dye



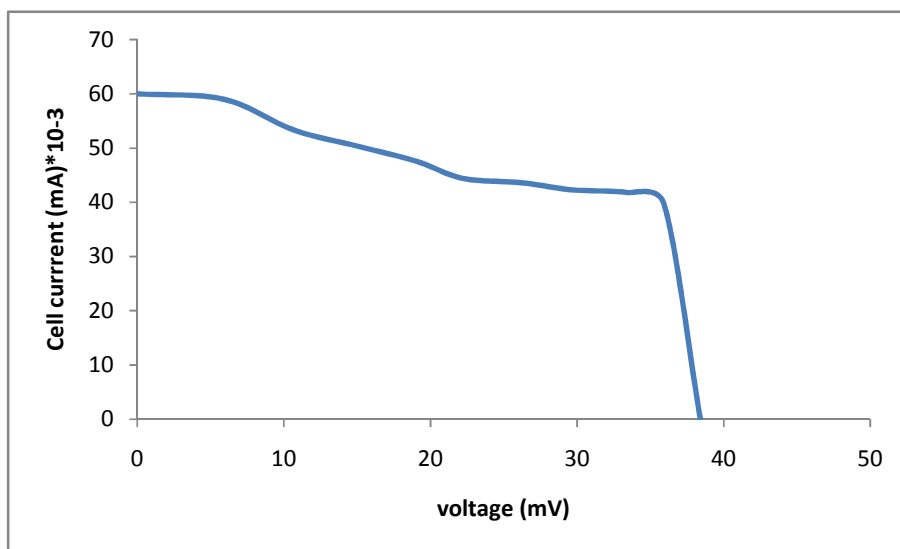
Graph 2: graph of absorbance against wavelength for dye plus TiO₂



Graph 3: I-V curve for *Aspilia africana* indoor measurement (control, day 1)



Graph 4: I-V curve for *Aspilia africana* dye (ethanol) with benzoic acid (day 1)

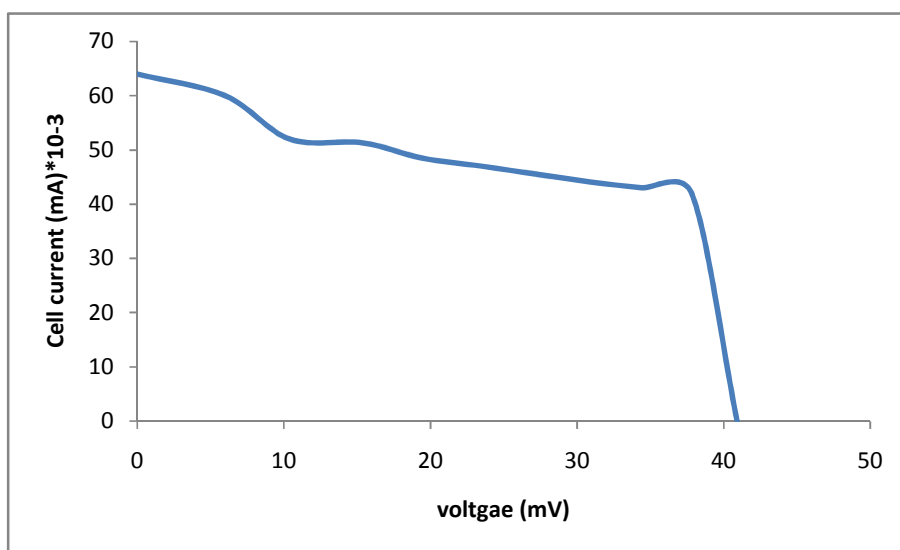


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174 Graph 5: I-V curve for *Aspilia africana* dye (ethanol) control (day 2)

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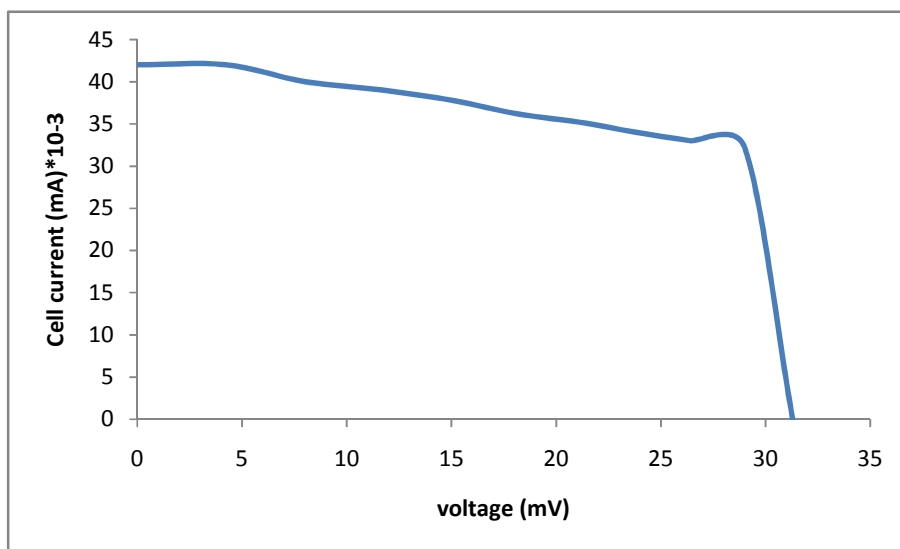
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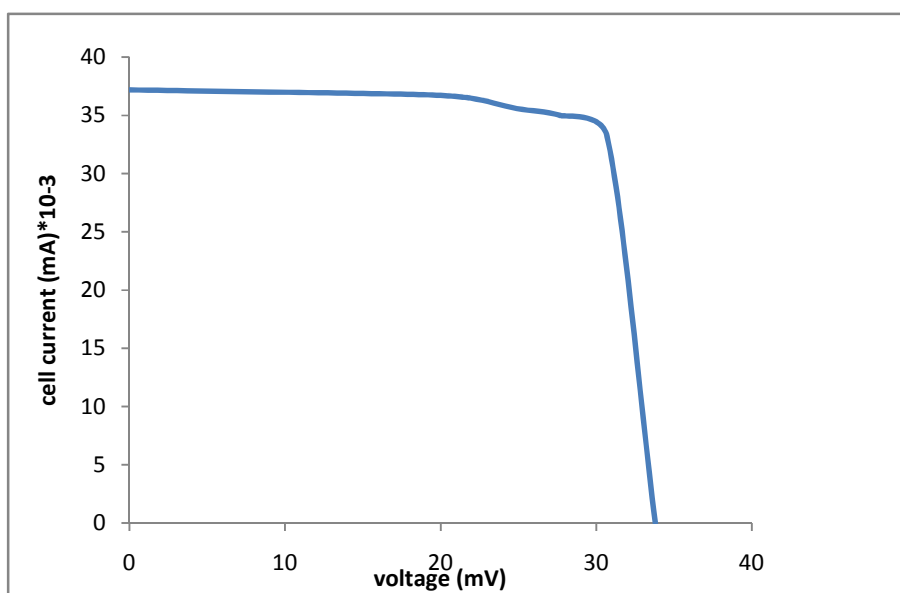
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178 Graph 6: I-V curve for *Aspilia africana* dye (ethanol) with benzoic acid (day 2)

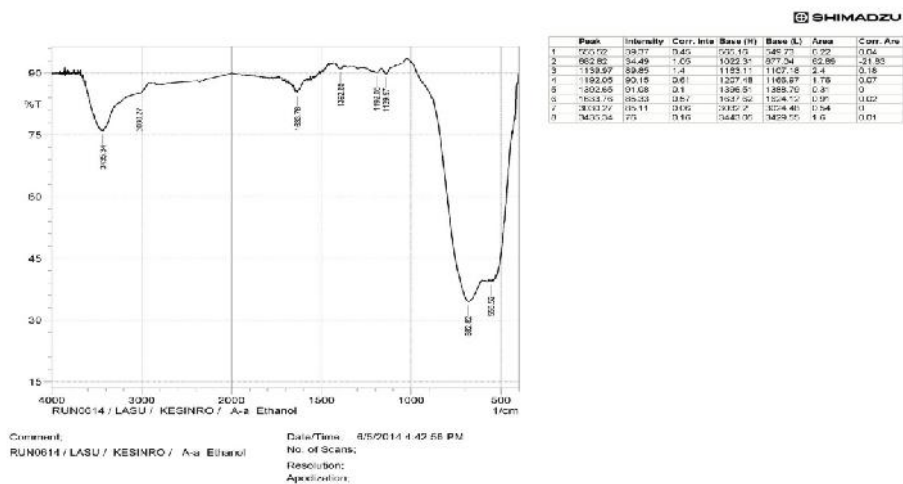
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Graph 7: I-V curve for *Aspilia africana* dye (ethanol) control (day 3)



Graph 8: I-V curve for *Aspilia africana* dye (ethanol) with benzoic acid (day 3)



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187 Graph 9: FTIR for control cell

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