International Journal of Engineering and Applied Physics (IJEAP)
Vol. 2, No. 3, September 2022, pp. 580~586
ISSN: 2737-8071

Optical properties and efficiency studies for Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla dye sensitized solar cell

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Article Info

Article history:

Received May 19, 2022
Revised jul 02, 2022
Accepted Sep 12, 2022

Keywords :

DSSCs,
UV-vis,
FTIR,
IV characteristic

ABSTRACT

The sun light, that gives the clean, fleckless and the cheapest energy which is an environmental friend; becomes the demand and on-call of the researchers in the last century. In this paper, the three natural dyes, namely, (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) were successfully and swimmingly synthesized by dissolved in acetone solvent. The optical properties: absorbance, transmission, reflection, absorption coefficient and energy band gap were carefully and solicitously studied using ultraviolet visible spectrometer UV-VIS. The efficiency of dye sensitized solar cell DSSC was studied using an utilization IV characteristic for three natural dyes (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla), where the cell was fabricated and processed by coating a conducting proceeding substrate of (FTO) using a titanium dioxide TiO_2. The power conversion efficiency was calculated and reckoned, which found to be [0.583, 0.539 and 0.285], respectively. The highest efficiency obtained or acquired from this DSSC sensitized by Beta Vulgarize which was 0.583%, and thus might be due to its concentrated, focussed dye and color.

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1. INTRODUCTION

The solar cell energy is one of the most important renewable energy, that's due to its easy availability, cleanness and the cheapest energy resource, the number of solar energy approaching (come close) are in progress or advancing and where solar cells have been boosting more attention and interestingly or heeds due to their rapidly developing technology and potential application. There are different types of solar cells such as amorphous silicon solar cell, biohybard solar cell, cadium terllurid solar cell (CdTe), dye sensitized or sensualized solar cell and other different types (Bahman Zohuri, Hybard Energy Systems: Driving Renewable Sources of Energy Storge, Springer, first edition, ISBN: 978-3319889832, 2018). Natural dyes had been used extensively in the past for many purposes, such as, to color fibers and to produce inks, watercolors, and paints, but their use was declined rapidly after the discovery of synthetic colors. Nowadays,

we assist to renew or furbish an interesting and caring, the natural dyes are neither toxic nor polluting [Stefania Acquaviva1, Pietro Baraldi[2], Emilia D'Anna[1], Maria Luisa De Giorgi[1], Andrea Della[3] (2010). The researchers are looking forward into the physical and chemical investigations on natural dyes, presently. Article in Applied Physics [A·DOI:10.1007/s00339-010-5676-2]. Dye-sensitized solar cell (DSCs) is some types of solar cells belonging to the group of thin film solar cell, it's the based on semiconductor formed between photo-sensitized an anode and the electrolyte [1]. The attention and heedfulness of (DSSC) have been increasing, rapidly because of their good photovoltaic performance, specically under low-light conditions, as well as their exibility or excitability in terms of colors and appearance, their relatively simple fabrication procedures and their potential low cost[1].

Beta vulgaris [beet] is a plant native to Mediterranean, the Atlantic coast of Europe, the Near East, and India belong to Amaranthaceae, Genus Beta [2]. Beta vulgaris is an herbaceous biennial or, rarely, perennial plant with leafy stems growing to 1–2 m tall [3]. The leaves are heart-shaped, 5–20cm long on wild plants[4]. The flowers are produced in dense spikes. The fruit is a cluster of hard nutlets, dyes extracted from this fruits have color tends to dark red which means it has a good absortion to light antifungal [5-11].

Curcuma longa has been used as a spice since ancient times, especially in Asian countries [12]. Moreover, it has also been gaining an importance and prominence and memorableness, that is due to its use in ayurveda and in traditional Chinese medicine, as a phyto-therapeutic for the treatment of various conditions such as gastric and hepatic disorders, wound healing, and infectious diseases [13,15]. Practical experience as well as an emerging number of studies also implicate and embroil the involvement of turmeric and its active constituents in the regulation of oxidative stress and neuroinflammation [14,16].

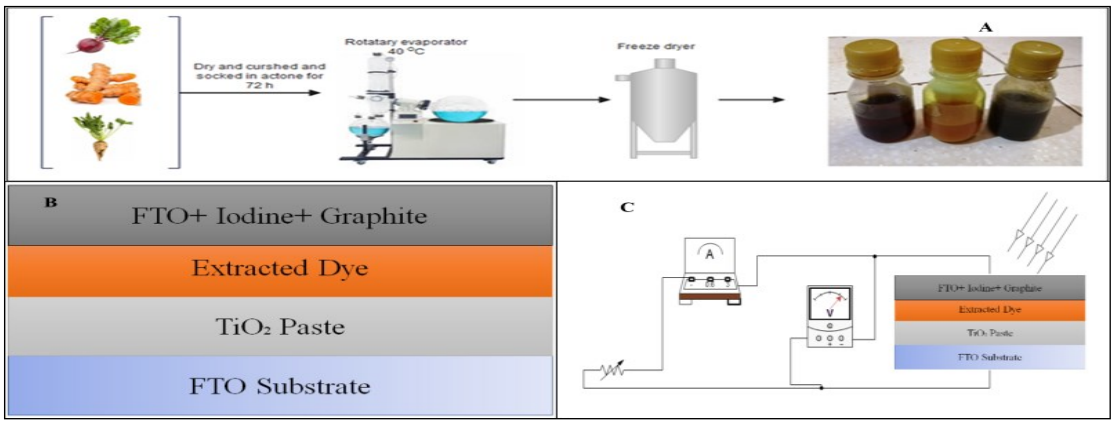


Fig (1) Experiment Steps:

(A) Dye Extraction process, (B) Dye solar cell cross section and (C) Electrical Circut.

Swiss chard *(Beta vulgaris, Cicla, BVc)* is a vegetable belong to the Chenopodiaceae family, widely consumed in traditional western cooking. These vegetables represent a highly renewable and cheap source of nutrients. Swiss chard (*Beta vulgaris*) is an herbaceous biennial leafy and foliated vegetable cultivated in many parts of the world, low cost and wide use in many traditional dishes. The leaves can be used in salads or cooked like spinach, and the stems are usually chopped and cooked like celery. The leaves of chard contain nutritionally significant concentrations of Vitamins A, B and C, calcium, iron and phosphorus. *Beta vulgaris L.* species are used as a popular folk remedy for liver and kidney diseases, for stimulation of the immune and hematopoietic systems, and as a special diet in the treatment of cancer [17].

The main purpose of this present work is to apply and request the extracted dyes from Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla in dye sensitizes solar cells fabrication after studying their optical properties, thoroughly.

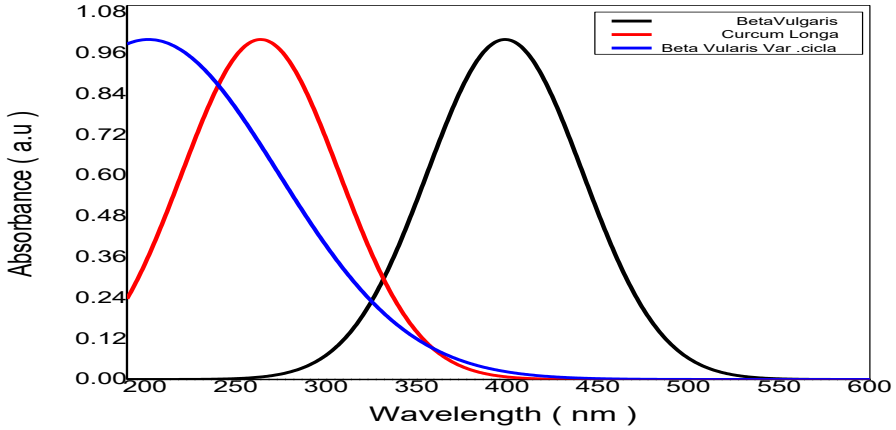
2. RESEARCH METHOD

In this study, the three dyes of **(**Beta Vulgarise, Curcuma Longa and Vulgaris var. cicla) were firstly, extracted or elicited and then used to bulid solar cells. Beta Vulgarise, Curcuma Longa and Vulgaris var. Cicla which were Collected from local market. Curcuma Longa sample was crushed and sieved or sifted while the other samples **(**Beta Vulgarise and Vulgaris var. cicla) were washed by distall water. Then all samples were saved from exposure and liableness to avoid or avert the lossing of active components. One handered grams from each powder were defatted with 200 ml of acetone solvent, then the filtrated was extracted for up to 72 h and then kept in dark for the same reason, too. And then, filtered twice with filter

paper (Whatman(1)150mm). The filtrated solvent was combined and evaporated using a rotary evaporator (at 40°C) to give semi-solid residues (remnants) and transferred to freeze dryer to dry[18][19], as in fig (1) .
The paste of TiO_2 was prepared by taking (2g) of TiO_2 powder in 10 ml of acetone. Then the (FTO) substrate was cleaned by distilled water and acetone. Then the paste or putty of small amount of TiO_2 was taken and spread or diffused uniformly, on the (FTO) substrate using the glass rod to refine and smoothed it as well. After this step the coated substrate was put in an oven and backed and supported at 100^{O} C for an hour. On the other hand the dye was prepared as the dissolved with acetone and filtered, then the substrate was injected in the dye dissolved for (15 minutes) as the cathode. Another substrate of (FTO) was cleaned and coated by graphite pencil on the conductive surface and this graphite coated substrate was placed on the top of (FTO) substrate that coated with TiO_2, and the dye used two binder clips in order to attach the glass and put iodine electrolyte solution between the two substrate slides as well as now was formed. The fabricated solar cell inserted on an electrical circuit containing the (voltmeter, ammeter, light source (Lamp) and solar cell) and where formerly the I-V characteristic of solar cell were recorded.

3. RESULTS AND DISCUSSIONS

The results were carried out with (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla), dyes of samples characterizations using Ultra violet-visible spectroscopy (UV-min1240 spectroscopy, Shimadzu company, Japan) at range from 200 to 600nm, The electrical circuit (fabricated solar cell, voltmeter, ammeter and a light source) were being connected to record I-V measurement and so that the solar cell parameters were evaluated.



maximum absorption observed was equal to 1.003 a.u for all samples at wavelength of (400nm) with corresponding photon energy of (3.1eV), but for Curcuma Longa sample at 263 nm correspondingly to photon energy of (4.7eV) and for the Vulgaris var. cicla sample at 200 nm correspondingly to photon energy of (6.2 eV) .

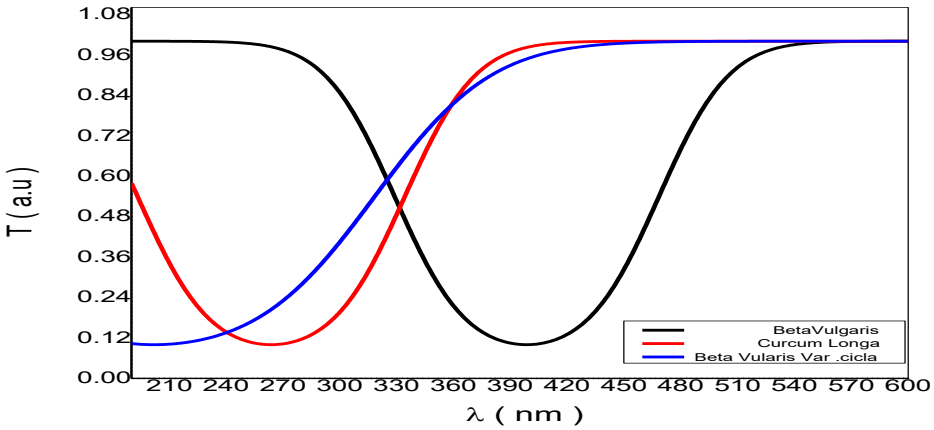


Figure 3. Optical Transmission spectra of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples.

The optical transmission spectra of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples where as shown in Fig (3). The minimal transmission was recorded at maximal absorption region which were of (400nm) for Beta Vulgarize, and for Curcuma Longa sample at 263 nm and for the Vulgaris var. cicla sample at 200 nm.

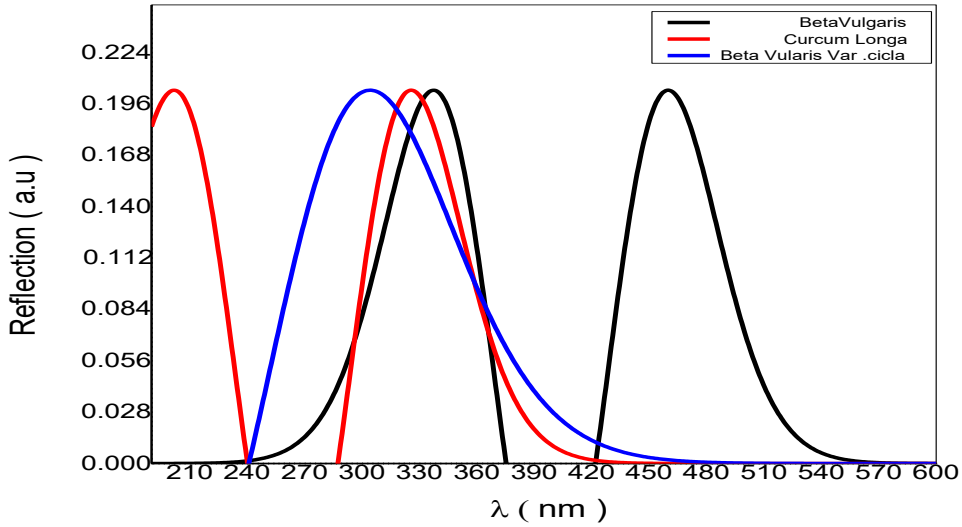


Figure 4. Optical Reflection spectra of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples

Fig (4) shows the reflection spectrum of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) dyes of samples, the maximal value of reflections equal 0.201 a. u for all samples at wavelength (330 nm and 450nm) for Beta Vulgarize, at (210 and 325 nm) for Curcuma Longa sample and at (300 nm) for the Vulgaris var. cicla, whereas above mentioned wavelengthses of the samples were bent to mirrors.

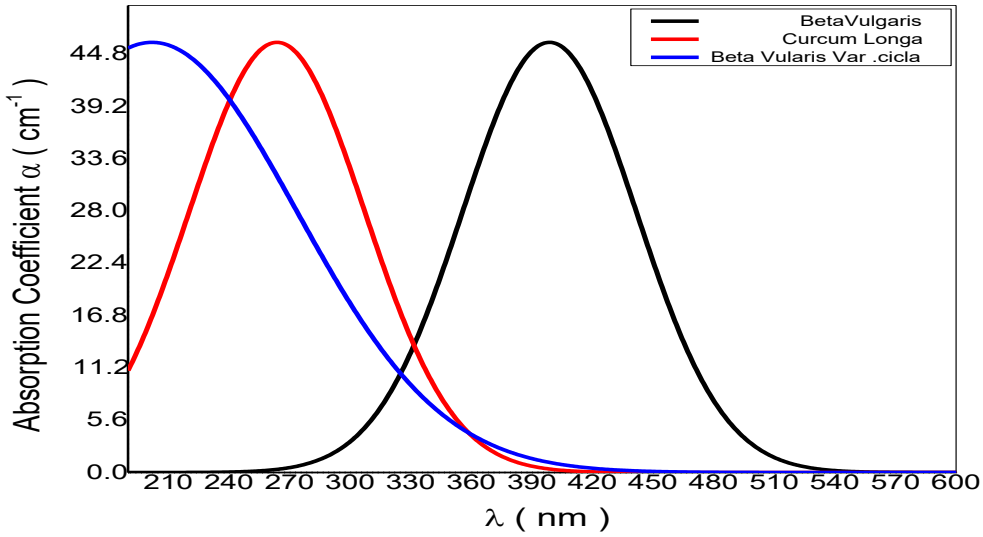


Figure 5. Optical Absorption Coefficient spectra of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples.

Fig (5) shows the relation between absorption coefficient of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples and wavelengths, the absorption coefficient was calculated using equation

$$\alpha = \frac{Ax2.303}{d}$$

where (A) is the absorbance and (d) is optical axes length on the sample, the maximal value of absorption coefficient was equal to 46.1 cm^{-1} for all samples at wavelength (400nm) for Beta Vulgarize, (263 nm) for Curcuma Longa sample and at (200 nm) for the Vulgaris var. cicla sample.

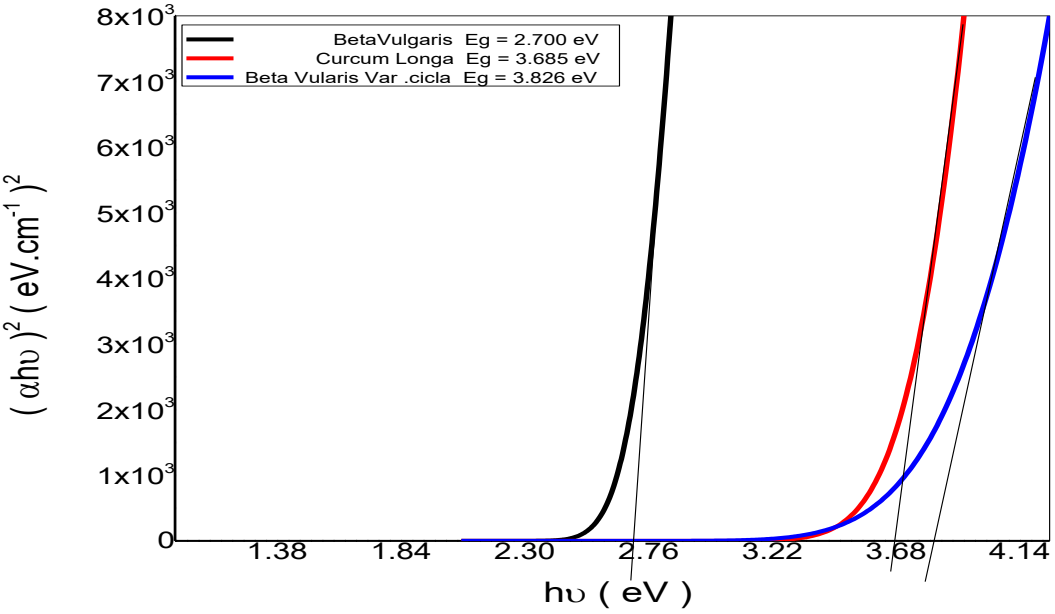


Figure 6. Optical Energy Band Gap spectra of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) the dyes' samples

The energy band gap of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) dyes of samples were determined using the absorption spectra. According to the absorption coefficient (α) for direct band gap material is given by the relation $(\alpha h\nu)^n = B(h\nu - E_g)$ where Eg the energy gap, B constant which different for different transitions, (hv) is energy of photon and (n) is an index which assumes the values 1/2, 3/2, 2 and 3 depending on the nature of the electronic transition responsible for the reflection. Fig(6) shows the optical energy band gap of (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) dyes samples, Beta Vulgarize sample (Eg) value equal (2.700 eV), for Curcuma onga sample equal (3.685 eV) and for Vulgaris var. cicla sample equal (3.826 eV). The value of (Eg) was changed due to differences in the dye source.

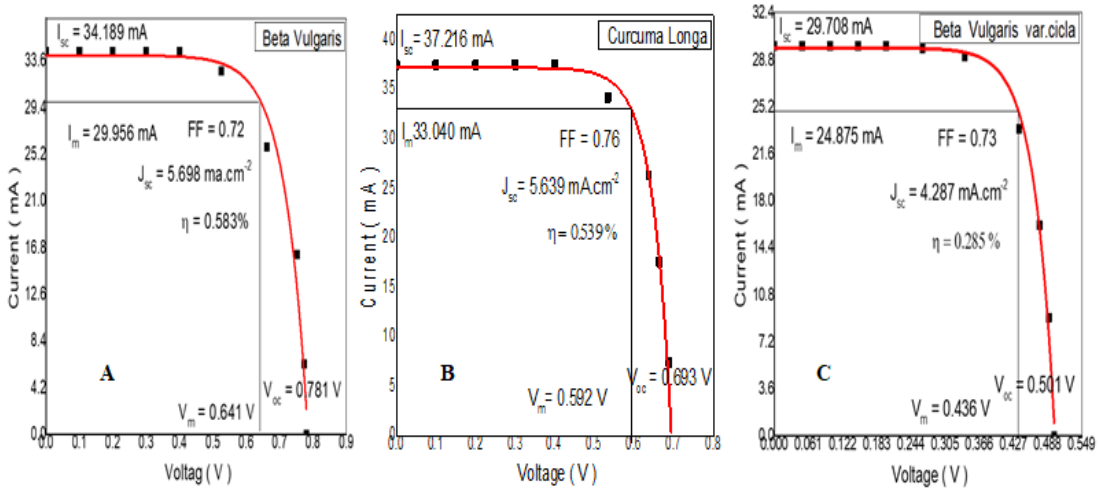


Figure 7. V-I Characteristic curve for (A) Beta Vulgaris var. cicla dye solar cell, (B) Curcuma Longa dye solar cell and (C) Vulgaris var. cicla dye solar cell

Dye sensitized solar cell was fabricated using titanium dioxide at different dyes to studies the effect of dyes on efficiency of solar cell. Fig (7) shows the current-voltage characteristics curve of (Beta Vulgarize,

Curcuma Longa and Vulgaris var. cicla) solar cells . According to the dyes that used in this study, the best and obtained efficicency related to Beta Vulgarize dye sensitized solar cell by efficicency (η=0.586%) with an absorption edge photon energy of 3.1 eV and an optical energy band gap of 2.700 eV.

4. Conclusion

In this pepar, the efficiency of $DSSC_s$ fabricated from dyes extracted from different sources (Beta Vulgarize, Curcuma Longa and Vulgaris var. cicla) and using nano crystalline TiO_2 as a base material for a solar cell was being studied, successfully. The best performance that obtained and acquired was from the DSSC sensitized using the Beta Vulgarize than other dyes.

ACKNOWLEDGEMENTS

This work was done in the materials science laboratory at physics department faculty of science and technology, Alneelain University, Khartoum Sudan.

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