Extraction and Characterization of Purple Coleus Blumei Natural Dyes

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Abstract- The natural dyes used in this research were poinsettia leaves (Coleus Blumei).The absorbance and energy levels of dye solutions were characterized using UV-Vis spectrophotometer and cyclic voltammetry. From UV-Vis absorption spectrum , itwas known that combination of anthocyanin and chlorophyll was thebroader region of the visible light spectrum in the range of 400 to 700 nm.All dyes were measured at different temperatures to estimate the energy of the highest occupied molecular orbital (HOMO) and the energy of lowest unoccupied molecular orbital (LUMO). Optical band gap was measured from the absorption spectrum of each dye sensitizer. Fourier transform inferred (FTIR) was used to characterize the dye active components from 4000 to 500 cm^{-1}. From FTIR results, the Coleus Blumei match with AMANO LIPASE (C_{11} H_9 N_3 Na O_2) compound corresponding to the carboxylic acidic group in dye solutions were observed.
Keywords – Natural dye, optical absorption, energy level

I. INTRODUCTION

DSSC is the basically a photo electrochemical devices used for the conservation of solar energy to electrical energy[1]. The sensitizing dye, as a part of photoelectrode plays a key role in absorbing sunlight and transforming solar energy into electrical energy[2]. The cell performance is mainly dependent on the type of dyes used as sensitizer[3]. Natural dye can easily extract from flower, leaves, seeds and fruits. Organic dyes are pigments extracted from organic molecules commonly found in natural dyes[5]. The leaves of most green plants are rich in chlorophyll and anthocyanin are natural compounds that give color to fruits and plants [6].Natural dye has several advantages over rare metal complexes because ease of extraction with minimal chemical procedure, large absorption coefficients, low cost, non toxicity, environmentally friendly, easily biodegradable and wide availability [2].

Natural dyes were extracted from purple coleus blumei (Family Lamiacae) (Kawzaw Ywet Hla) by using ethanol solvent. These plants were found in various part of Myanmar. These were characterized by UV-Vis absorption spectroscopy to observe the absorption spectra. FTIR spectral analysis was used to determine the functional group in the natural dye. Cyclic Voltammetry method was used to investigate the HOMO and LUMO energies and estimate the band gap energies of natural dye.

II. MATERIALS AND METHODS

2.1 Extraction of dye solution

The extraction of coleus blumei leaves were made following procedures. Purple coleus blumei leaves were washed with distilled water and kept them some time in room temperature to remove the surface water. 5g of leaves were weight and crushed adding 150ml of 70% ethanol (w/v %) and stored overnight in the refrigerator at 4˚C. On the following day, the extraction was mixed thoroughly by using a magnetic stirrer for two hours at 25˚C, 45˚C and 65˚C.The extraction was filtered using 110 mm filter paper to remove solid residues. Subsequently, the extract was centrifuged at 4000 rpm using a Denley BS400 (UK) centrifuge machine for 5 minutes to separate all residues.

2.2 Characterization

The natural dye was measured using UV-Vis spectrometer (Shimaszu UV-1800, Japan) the wavelength was used from 400 nm to 700 nm. The Fourier transform infrared spectroscopy was related using the (Spectrum 400 FTIR-NIR (PerkinElmer) with infrared light (4500-650)cm^{-1} is energetic enough to excite molecular vibration to higher energy state.

2.3 Cyclic Voltammetry Measurment

Cyclic voltammeter measurements were carried out using potentiostate (Digi-Ivy, DY2000) in three-electrode systems consisting of a glassy carbon working electrode, platinum counter electrode, and Ag/AgCl reference electrode at a scan rate of 50mV/s. A few drop of required dye solution were separately placed on the glassy carbon working electrode in a supporting electrolyte was 0.1 M KNO_3 in distilled water.

III. RESULTS AND DISCUSSION

The optical absorption spectra of Purple Coleus Blumei dye were shown in Fig 1 and it was found that the absorption peaks of dye solution of Purple Coleus Blumei dye with ethanol 150 ml at 25°C, 45°C and 65°C are 430nm (anthocyanin) and 665 nm (chlorophyll).

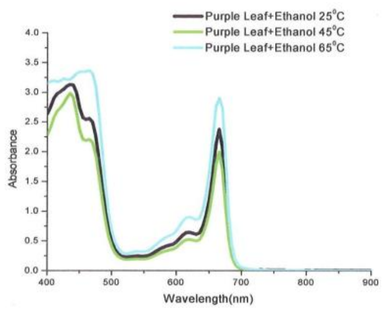


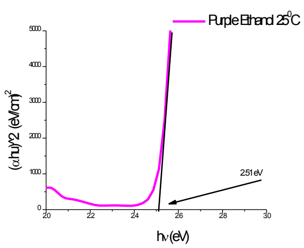
Figure 1. Absorption spectra of purple coleus by using ethanol solvent

Optical properties. the evaluation of the optical band gap of the coleus using UV-Vis ansorbance spectra was done by using Tauc relation. The optical band gap were determined by extrapolation of the linear region to zero absorbance from the plot that was drawn according to the Tauc relation when [7].

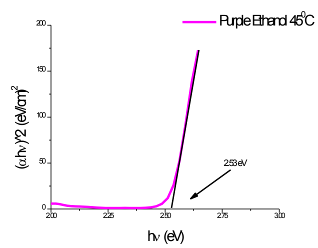
α

where A= absorbance, hν = photon energy and E_g = band gap energy

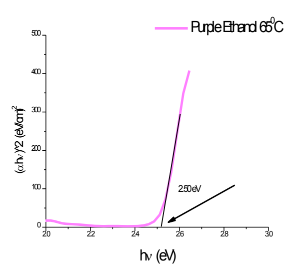
The change in (αh as a function of photoenergy (hν) of purple coleus blumei dyes at different temperatures (25 ˚C, 45 ˚C and 65 ˚C) was plotted and given as Fig 2(a-c). The pH values of Coleus dyes were measured to be 6.52, 6.26 and 6.41 for Coleus Blemei at different temperatures. From $(\alpha h\nu)^2$ v characteristic curve, it was obvious that the band gap energy values were observed to be 2.51eV, 2.53 eV and 2.50 eV for Coleus Blumei at25 ˚C, 45 ˚C and 65 ˚C.



(a)



(b)



(c)

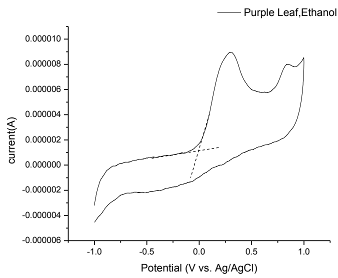
Figure 2.(a)The relation between energy (hν) and $(\alpha h\nu)^2$ for Purple Coleus dye at 25°C,2h (b)The relation between energy (hν) and $(\alpha h\nu)^2$ for Purple Coleus dye at 45°C, 2h (c) The relation between energy (hν) and $(\alpha h\nu)^2$ for Purple Coleus dye at 65°C,2h

3.1 Electrochemical properties

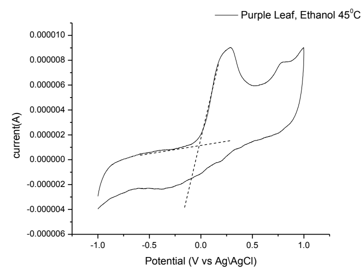
The energy levels of HOMO and LUMO of natural dye extracts were determined by the electrochemical cyclic voltammetry measurment. Fig 3(a) presented the cyclic voltammograms of purple coleus extracts. The onset reduction of the two tangents drawn at the rising current and baseline charging current of the CV traces. Using the values, the LUMO energy determined using the equation[8-11]. The electrochemical energy levels and optical band gap energies of the dyes are listed in table 1.

$$E_{LUMO} = -[E^{onset} + 4.4\ ]\ eV$$

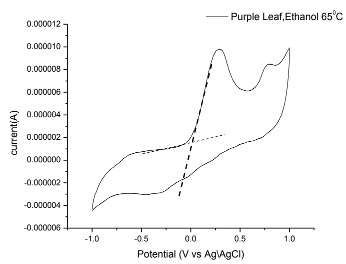
$$E_{HOMO} = E_{LUMO} + E_g$$



(a)



(b)



(c)

Figure3. (a) The Cyclic Volammetry curve for Purple Coleus at 25°C, 2h(b)The Cyclic Volammetry curve for Purple Coleus at 45°C, 2h
(c) Cyclic Volammetry curve for Purple Coleus at 65°C, 2h

Table -1 Energy levels (HOMO and LUMO)& Band gap energies for Purple Coleus with Ethanol at 25°C, 45 °C and 65 °C, 2h

Temperature(˚C)	LUMO(eV)	HOMO(eV)	E_g(eV)
25	-4.34	-1.80	2.51
45	-4.37	-1.82	2.53
65	-4.35	-1.85	2.50

3.2 Ftiranalysis

The Fourier Transform Infra–Red spectrum of purple coleus as shown in Fig 4.Purple coleus dye solutions were displayed the sharp peaks frequencies range (3300 cm^{-1} - 2500cm^{-1}) indicated the presence of C-H (Alkanes) and O-H (carboxylic acids), (1640 cm^{-1}-1580 cm^{-1}) indicated the presence of N-H(Amines) and (1320 cm^{-1}-1000 cm^{-1}) indicated the presence of C-O (carboxylic acids) respectively. In additional, typical bond corresponding to C-N groups were observed. The resultobtained from this research was similar as AMANO LIPASE Compound ($C_{11}\ H_9\ N_3\ Na\ O_2$)[12-15].

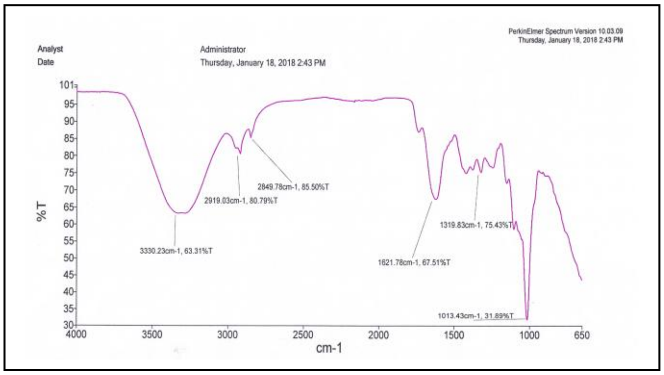


Figure 4.FTIR spectrum of Purple Coleus extracted from ethanol solvent

IV.CONCLUSION

Preparation and characterization of purple coleus natural dye have been successfully implements. The maximum energy band gap was determined to be 2.53 eV for purple Coleus ethanol solvent at 45 ^{o}C. Cyclic Voltammetry measurements were performed for these dye sensitizers to estimate their energy levels. According to the results, the largest value of LUMO was found – 4.37at 45 ^{o}C.pH levels of dye solution 6.52 at 25 ^{o}C, 6.26 at 45 ^{o}C and 6.41 at 65 ^{o}C. Therefore all solutions were acidic properties.The results of FTIR showed purple Coleus dye solutions were AMANO LIPASE Compound which contained Carboxylic acidic group. This study leads that dye extracted from Coleus blumei leaves can be used as sensitizer for DSSC.

V. REFERENCE

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