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CHARACTERIZATION OF ETHANOLIC EXTRACT OF *TECHOMA STANS* FLOWER FOR POSSIBLE APPLICATION IN DYE SENSITIZED SOLAR CELL

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ABSTRACT
Research on dye sensitized solar cells is of recent attraction to the researchers and academicians in the present scenario. Dye sensitized solar cells are a viable alternative to the conventional silicon based photovoltaic devices due to their remarkable conversion efficiencies. Photosensitizer is an essential component in this novel technology in order to enhance the overall conversion efficiency of a dye sensitized solar cell. In this work, we have extracted the natural dye from *Techoma Stans* flower and the ethanolic extract was further subjected to characterization studies to understand the nature of the dye and to find its suitability for dye sensitized solar cell application.
Keywords: Renewable energy, Sensitizer, Solar cells, Natural Dyes

INTRODUCTION

The most pressing problem in the present world is the generation of toxic air pollutants such as carbon monoxide, oxides of sulphur, and oxides of nitrogen into the atmosphere due to the combustion of fossil fuels thereby interfering with the survival of living organisms on earth. Clean energy is the most essential need for any society and the world is in great need for renewable sources of energy. One of the most challenging renewable resources is the clean and freely available solar power to replace the conventionally preferred fossil fuels [1,2]. The success of accessing advanced and modern energy sources leads to the sustainable development of any developing country [3]. Dye sensitized solar cells (DSC) is considered as a modern photovoltaic (PV) technology for energy production at low cost and a promising alternate to the conventional silicon based PV cells [4]. They were first invented by Prof. Michael Gratzel and his coworkers in 1991 [5]. DSC is considered as a technology that fall between second and third generation solar cells, which has gained recent attraction due to its flexible nature, less weight, simple fabrication procedures, low cost, environment friendliness and reasonable conversion efficiencies [6-8]. Since the invention of this innovative technique, various researchers have investigated on various aspects of the device and reported with reasonable conversion efficiencies [9-11].

A DSC is constructed of a wide band gap semiconductor layer such as titanium dioxide (TiO_2) onto which a layer of dye molecule with suitable anchoring groups is strongly attached. The dye acts as a photosensitizer and initiates the process of generating electric power. A photosensitizer plays a major role in determining the overall conversion efficiency of the device and some of the essential requirements of a photosensitizer are its intense absorption in the visible and near infra- red regions, ability to bind itself to the semiconductor layer with suitable anchoring groups, its ability to withstand numerous oxidation and reduction cycles without undergoing any degradation, cost effectiveness etc [8,12,13].

Since two decades, the advancement in dye sensitized solar cell technology is observed to be tremendous and has attracted various researchers in this modern and unique field. Ruthenium metal based sensitizers are well recognized as efficient dyes for photosensitization in the near infra red region, owing to their metal to ligand charge transfer transition [9]. Though, ruthenium sensitizers are reported for their high conversion efficiencies, some of the drawbacks are their rare availability, cost, skilled synthesis and purification procedures involved [14]. Porphyrin based sensitizers are also explored for DSC applications. A porphyrin sensitizer employing cobalt based redox electrolyte was reported to exceed 12% efficiency [15]. Additionally, the potential of metal free organic dyes have been extensively investigated for photosensitization due to their wide absorption bands, high molar absorption coefficient and intense fluorescence [16.] Natural dyes obtained from the various parts of the plant have been explored as photosensitizers with the aim of fabricating low cost and environmental friendly devices. Plant pigments such as chlorophylls, anthocyanins, tannins, β carotene and betalains have been widely investigated in this unique technology [8,17-21,27,28].The importance of green chemistry is emphasized in recent days to protect our environment [30].

In this work, spectrochemical investigations of natural dye extracts from *Techoma Stans* flower are carried out to find its suitability as a photosensitizer for possible application in dye sensitized solar cells. *Techoma Stans* is an ornamental plant commonly known as yellow bells belonging to the bignoniaceae family. The various parts of the plant have been reported for their anticancer activity, anti fungal, anti diabetic, anti oxidant activities [22,23] . The extracted dye solution was further subjected to absorption spectra and Fourier Transform infrared (FTIR) techniques.

EXPERIMENTAL

Natural dye preparation and characterization

The flowers were collected afresh from the Sathyabama University campus. 10 g of the flower was weighed and the petals were separated and washed with distilled water to remove the impurities present on its surface. It was then heated in an oven for few min to remove the moisture content. The flowers were then crushed in a mortar and pestle and 60 ml of 97% ethanol was added to the crushed flowers and left in dark for 45 h. The crude extract was filtered with a filter paper to remove the solid material and to obtain a clear natural dye solution. The clear ethanolic extract was stored without exposure to sunlight and subjected to the basic characterization studies to be used as a sensitizer for DSC application[24,29] . Figure 1 shows the flowers chosen for dye extraction and Figure 2 shows the ethanolic extract of the flower. UV-Vis absorption spectra and Fourier transform infrared spectra of the freshly extracted dye were recorded.

Fig.-1: Flowers chosen for dye extraction

Fig.-2:Ethanolic extract of the flower

RESULTS AND DISCUSSION

Absorption Spectrum

The absorption spectrum of the dye was recorded to understand its light absorption behavior. L6 in Figure- 3 shows the recorded spectra of the ethanolic extract of the flower. The dye exhibited a broad absorption peak between 300-500nm.*Techoma Stans* flower is identified to contain β carotene [23].The peaks observed in the present work closely matches with the reported absorption spectra of β carotene in the literature [25,26].

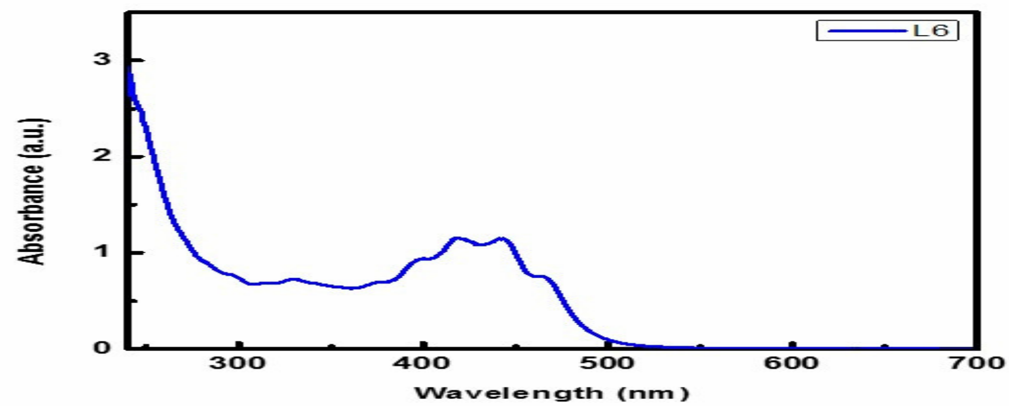

Fig.-3: Absorption Spectrum of the dye

FTIR Spectrum

The FTIR spectrum is recorded to observe the nature of the bonds in the extracted natural dye. The term B in Figure 4 shows the recorded FTIR spectrum of the dye .The spectrum is observed to closely match with the characteristic peaks of β carotene reported. [25]

The peaks observed at 1648 and 1402 cm $^{-1}$ corresponds to C = C stretching and CH_3 scissoring mode. A band at 1066 cm $^{-1}$ corresponds to C-O-C vibration mode. The peak observed at 2926 cm $^{-1}$ corresponds to the CH stretching mode.

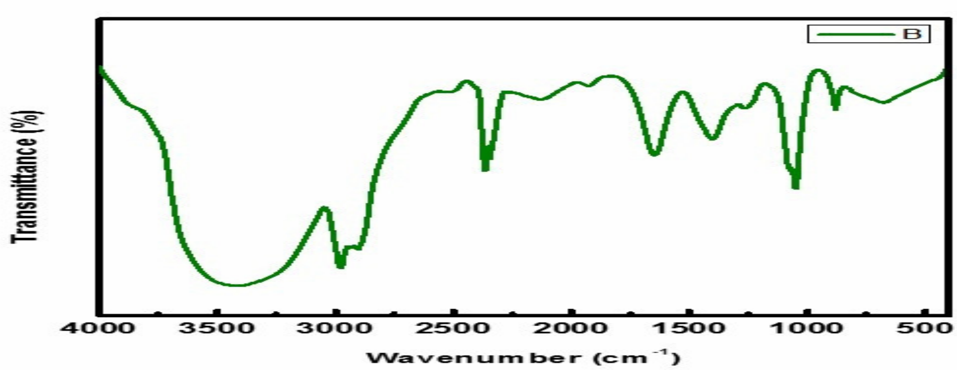

Fig.-4: FTIR Spectrum of the dye

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CONCLUSION

Dye sensitized solar cells is an innovative photovoltaic technology to convert the abundantly available solar energy into electrical energy. The potential of natural dyes as a photosensitizer are explored in recent days to increase the conversion efficiency of the cell. The dye was extracted from the *Techomas Stans* flower and subjected to basic characterization studies .The studies carried out reveal the light absorption characteristics and its suitability as a photosensitizer for dye sensitized solar cell applications. Though the efficiencies exhibited by the natural photosensitizers are low compared to the synthetic ones, the results are interesting and emphasis the need for exploring more natural sources for DSC applications.

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