Characterization of Cherry Pigment Extract and its Application in Dye-Sensitized Solar Cells

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Abstract

Solar cells gather energy from the sun and convert it to electrical energy. A dye-sensitized solar cell uses molecules with strong absorption characteristics in the visible range to broaden the absorption spectrum of semiconductors like TiO_2, which only absorb in the ultraviolet range. Natural fruits like cherries are known to contain anthocyanin pigments which absorbance peaks between 500 and 600 nm. An ethanol extraction procedure with cherries (*Prunus avium*) was used to obtain a deep red color. After filtration, the extract was characterized using a spectrophotometer, and an absorption peak was found at 535 nm. Application of this extract in the dye-sensitized solar cells will be investigated.

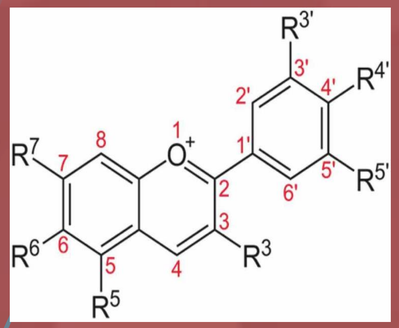

Figure 1. Basic anthocyanin structure.

Figure 2. Cherry puree in large beaker. Funnel, filter paper, and filtrate in Erlenmeyer flask are behind.

Introduction

For this experiment, cherries (*Prunus avium*) were chosen for their characteristic bold red color. For use in a dye-sensitized solar cell, this organic dye could occupy maximum light absorption in the visible spectrum, improving efficiency. In this pigment investigation experiment, a high content of anthocyanin molecules is responsible for the deep red, purple color in the cherry extract. These pigments are water soluble and members of the phenolic group. Light, pH, temperature, and structure of anthocyanins all affect the color and stability of the pigments.[3] Analyses of fruit color and pigment determined that anthocyanins absorb between 510 and 540 nanometers, 510 nanometers being the maximum.[4] Fluorescent emission peaks for anthocyanins tend to be between 590 and 675 nanometers.[1] This peak data for absorbance and fluorescence in the visible light spectrum coincides with the hypothesis of increasing efficiency of a dye-sensitized solar cell with these anthocyanin pigments. In Figure 1, a basic model of the pigment molecule structure is shown where R groups can be oxygen, hydroxide, or methoxy groups depending on the specific type of anthocyanin.[3]

Methods

A similar, published fruit pigment extraction experiment procedure was followed, halving each of the necessary components.[2] About 50 grams of pitted cherries were weighed and placed in a mortar. 59.5 milliliters of ethanol and 3 drops of 2M hydrochloric acid were added to the solution and the cherries were muddled to a puree consistency. The puree was then filtered using a glass funnel with filter paper and collected in a large Erlenmeyer flask. The deep red filtrate was then capped using aluminum foil and stored in the department cold-room. Both solutions can be seen in Figure 2.

For characterization, the cherry solution was diluted by a 10x dilution method using ethanol (2700 µL solvent, 300 µL sample). The diluted sample was placed in a cuvette for absorbance measurement using a Shimadzu UV-3600 ultraviolet-visible spectrophotometer. For fluorescence scanning, the cherry solution was diluted by a 40x dilution method (2900 µL solvent, 100 µL sample). Both Emission and Excitation scans were completed using a Horiba Photon Technology International fluorimeter.

Results

The absorbance spectra for the 10x diluted cherry solution is shown in Figure 3. It shows two peaks, at 536 nm and 322 nm. This spectrum was scanned from 300 to 800 nm. The peak at 536 nm characterizes anthocyanin pigments and matches with known absorption wavelengths.[4] The fluorescence emission scan has many small bumps for both trials. The fluorescence data shown in Figure 4 shows peaks between 642 and 659 and a broad background signal which indicates anthocyanin presence according to previous data. A scan at lower wavelengths is needed to identify a maximum under 600 nm. The solid line of Figure 5 shows the excitation scan with emission detected at 652 nm does not match the absorbance properties of anthocyanin pigments. However, the excitation scan shown in Figure 5 dotted line detecting emission at 520 nm has a peak at 536 nm which correlates to the maximum absorption for the same extract, indicating presence of anthocyanins.

Conclusion

Cherry and other natural products containing anthocyanins could be used as source of natural pigments. The pigments like anthocyanins could be extracted and used to increase efficiency of dye-sensitized solar cells depending on their absorption and fluorescent properties. In this investigation, the characterization of extracts fro cherries using absorbance and fluorescence methods showed the presence of anthocyanins. Further work is necessary to use this extract to modify the surface of nanoparticles in dye-sensitized solar cells.

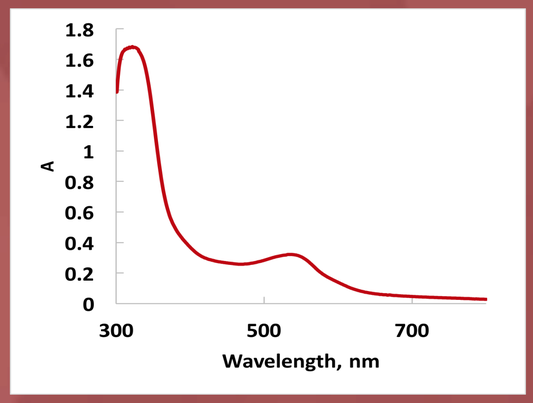

Figure 3. Absorption Spectra of Cherry Extract (ethanol) from 300 to 800 nm.

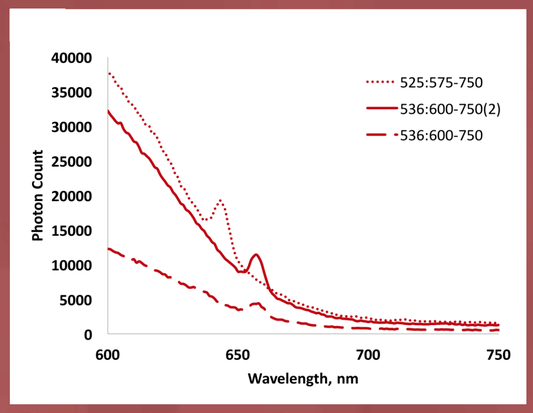

Figure 4. Emission Scan Fluorescence Spectra for Cherry Extract (ethanol).

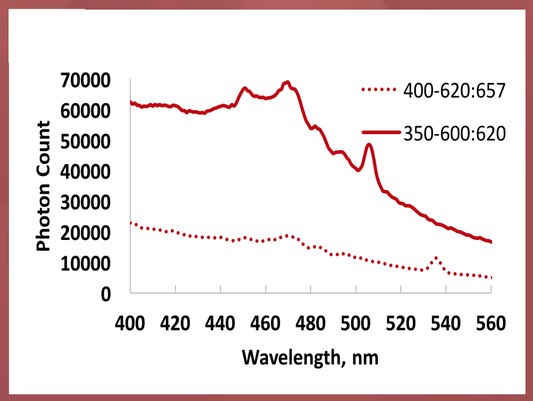

Figure 5. Excitation Scan Fluorescence Spectra for Cherry Extract (ethanol).

Acknowledgements

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