Optimizing Baobab and Neem Leaf Dye Blends for Enhanced DSSC Performance: An Optical Characterization Study

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Background

Introduction

- Dye Sensitized Solar Cells (DSSC)s use natural dyes to convert light to electricity, mimicking photosynthesis.
- Dye blending improves absorption and efficiency.
- Neem gives high J_{SC}; baobab gives high V_{OC}.
- Study explores how their blends affect optical bandgap.

Problem statement

- DSSCs are eco-friendly and low-cost but suffer low adoption due to low efficiency.
- Natural dyes have narrow absorption, limiting performance.
- Most offer either high J_{SC} or V_{OC}, not both.

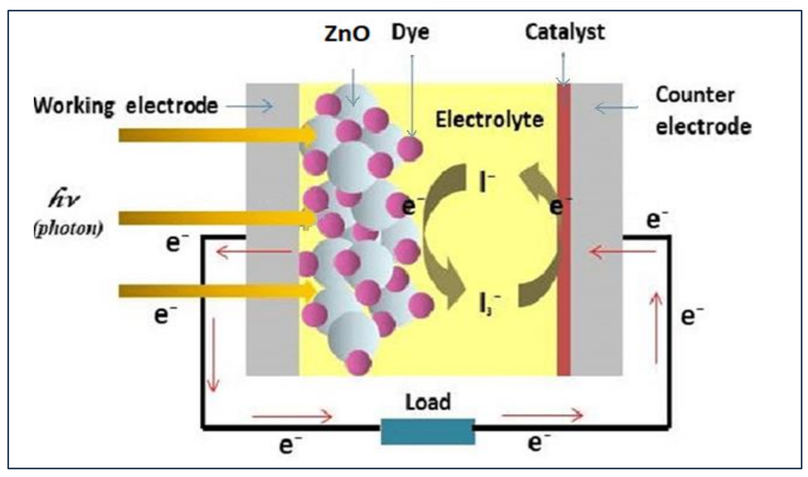

Figure 1: DSSC schematic: dye absorbs light, exciting electrons from HOMO to higher energy.

Current Work

Objectives

- Investigate how blending neem and baobab extracts affects optical properties.
- Determine optical bandgap of individual and blended dyes via UV-Vis.
- Assess dye blends' ability to enhance light absorption and spectral range.
- Identify blend ratios that balance J_{SC} and V_{OC} for improved efficiency.

Methodology

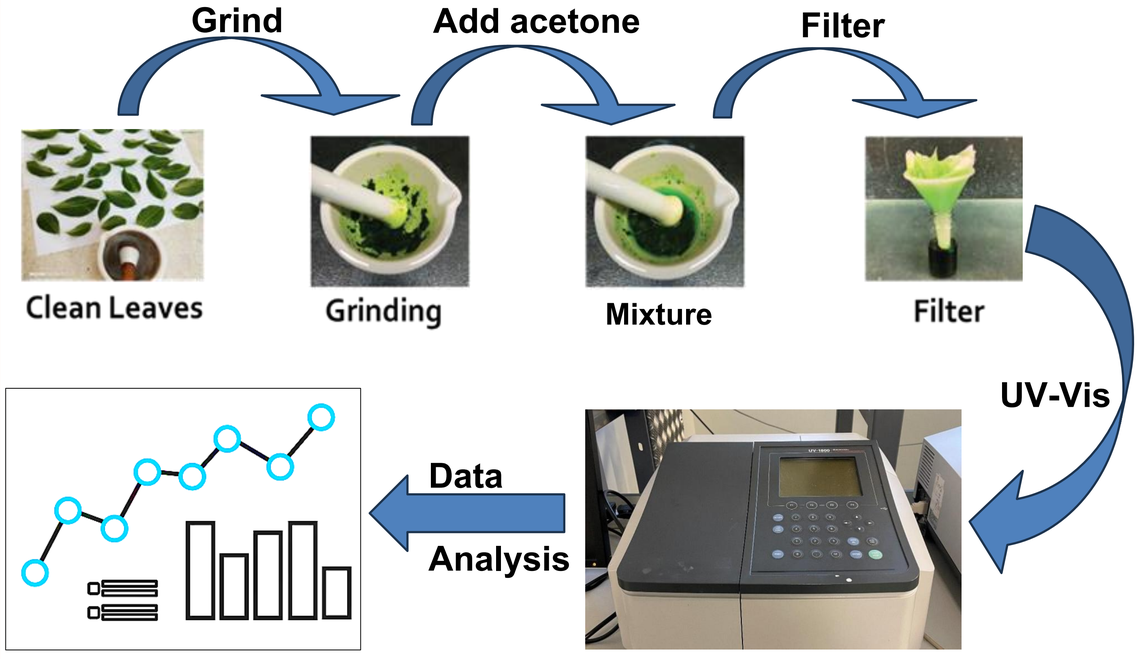

Figure 2: Flow chart on procedure followed. Blends prepared 1:1, 1:2, 2:1 baobab:neem. UV-Vis Spectroscopy (300-800 nm) done at 24 °C.

Results and Discussion

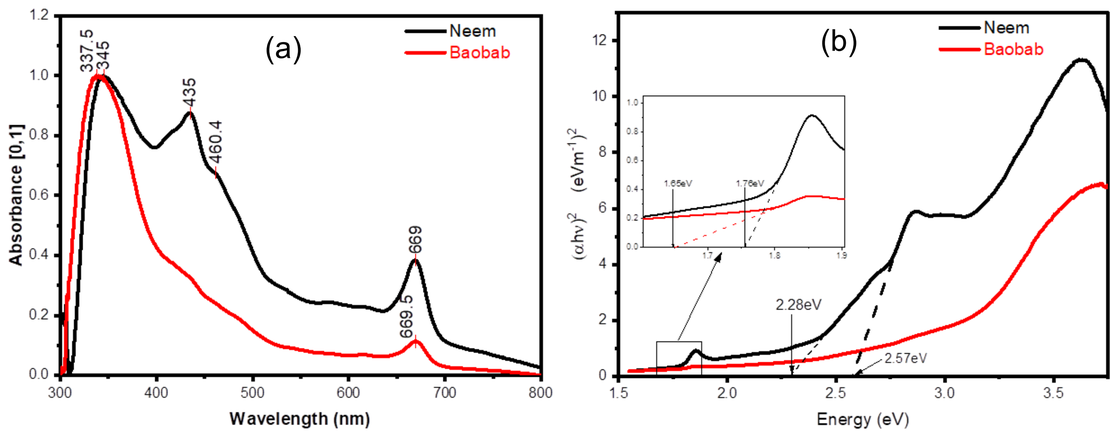

Figure 3: (a) Absorption spectra (300–700 nm) for baobab and neem extracts, (b) Tauc's plots of bandgap energies.

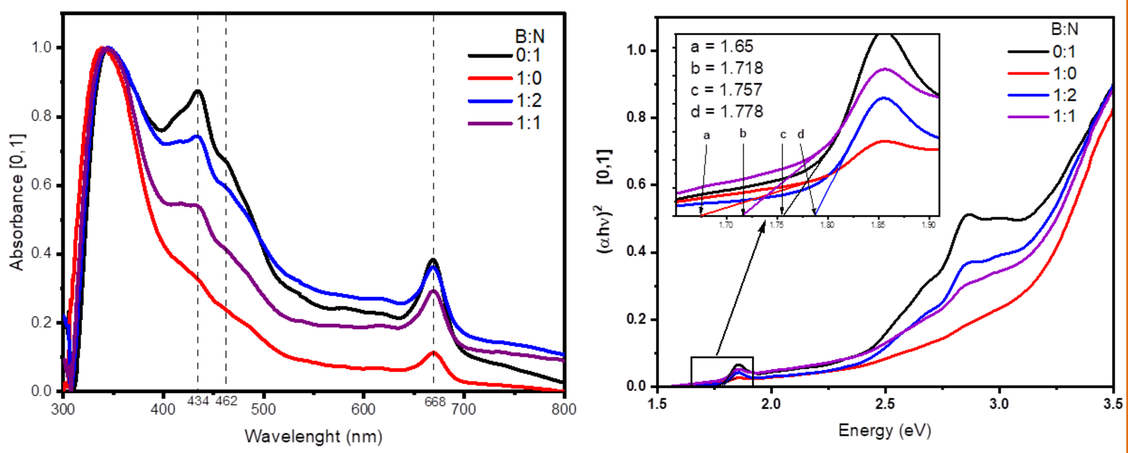

Figure 4: (Left) Comparative spectra of blends vs. pure dyes. (Right) Tauc's plots for bandgap energies.

Conclusions

- Neem shows peaks at 345, 435, and 669 nm; baobab at 337 and 669 nm with a lower bandgap (1.65 eV).
- Blending adds a 460 nm peak, broadening absorption.
- The 1:2 blend gives three peaks and a reduced bandgap (1.693 eV), making it ideal for DSSCs.

References

1. B. O'Regan and M. Gratzel, "A low-cost, high-efficiency solar cell based on dye-sensitive colloidal TiO2 films," *Nat.*, vol. 353, no. 6346, 1991. B. O'Regan and M. Gratzel, "A low-cost, high-efficiency solar cell based on dye-sensitive colloidal TiO2 films," *Nat.*, vol. 353, no. 6346, 1991, https://doi.org/10.1038/353737a0.
2. S. Sahare, N. Veldurthi, R. Singh, A. K. Swarnkar, M. Salunkhe, and T. Bhave, "Enhancing the efficiency of flexible dye-sensitized solar cells utilizing natural dye extracted from Azadirachta indica," *Mater. Res. Express*, vol. 2, no. 10, p. 105903, Oct. 2015, https://doi.org/10.1088/2053-1591/2/10/105903.

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