

Comparison between the Properties of Edible and Non Edible Natural Dye for the Fabrication of Dye Sensitized Solar Cell

*Ezeh M.I, ¹Osuji R.U, ²Okujagu C. U and ³Ezema, F.I

*Department of Physics, Delta State University, Abraka,

¹Department of Physics and Astronomy, University of Nigeria, Nsukka.

²Department of Physics, University of Porthacourt, Rivers.

³Department of Physics and Astronomy, University of Nigeria, Nsukka.

Abstract

The fabrication of dye sensitized solar cell as alternative to the conventional silicon cell, have employed different materials as sensitizer. In this study natural dyes from plants available was employed- Laali from Laali stem bark as non-edible dye and tomato fruit from tomato plant as edible dye in the fabrication of dye sensitized solar cell. Laali zero% transmittance up to 330nm and then increase to 100% transmittance throughout the Uv-visible region while for tomato zero % transmittance up to 340nm and increase to 100% transmittance throughout the uv-visible region. Laali emerged a good transmittance material for the fabrication of DSSCs.

Key words: Sensitizer, Fabrication, dye, transmittance

Introduction

The fabrication of dye sensitized solar cell has become an alternative to the conventional silicon cells for electricity generation.

Natural dyes have become the most promising sensitizers required in the fabrication of these dye sensitized solar cells. These natural dyes are sourced from plants, and are extracted from pigments of such plants. The natural dyes used in this work are of two types; edible – Tomato and non edible- Laali stem bark.

Tomatoes (Lycopene)

Tomato is the fruit on a tomato plant and the physiochemical name is lycopene, whose structural formula is shown in Figure 1, is a fat soluble carotenoid with 11 conjugated double bonds in the molecule, and it is a precursor of the b-carotene with a well known antioxidant activity, reported as at least twice that of the b-carotene (Sies and Stahl, 1998). Lycopene can be easily tainted by atmospheric oxygen and by light and rehabilitated from the *all trans* to the *cis* forms, that show a decrease biologic activity (Lee and Chen, 2002 ., Wang and Chen, 2006.). For these reasons it must be stored at a very low temperature (-70°C) away from the light and from the atmospheric oxygen. Lycopene content is in the range between 5.40-1500 mg/kg in tomato paste (wet weight) and the chemical structure is shown in figure 3.

Laali stem bark: natural dye can be extracted from Laali Stem Bark (*Lawsonia inermis*). *Lawsonia inermis* (Family: Lythraceae) is a shrub that is semi cultivated in the savannah region of West Africa (Adenike *et al.* 2012). It is abundant in Nigeria, locally called “laali or lali” in Yoruba "laale" in Hausa and "Uhie" in Igbo. The Bark and the leaf is grayish red, when soaked for some time or placed on the foot (Adenike *et al.* 2012). The stem bark is non edible shown in figure 2 and used in traditional medicine to treat a variety of ailments, such as jaundice, enlargement of the spleen, calculus, as an alternative in leprosy and obstinate skin affections, rheumatoid arthritis, headache, ulcers, diarrhoea, fever, leucorrhoea, diabetes, gonorrhoea and herpes infection cardiac disease, hepato protective



The properties of these natural dyes will be compared in this study.

Materials and Methods

Extraction of Lawsonia inermis “Laali”

10.30g of Laali stem bark was soaked in 100 ml of ethanol over night. It was further filtered into a beaker; the solution was seen to be greenish in colour. If soaked in a powdered form or applied on the skin turns brownish red.

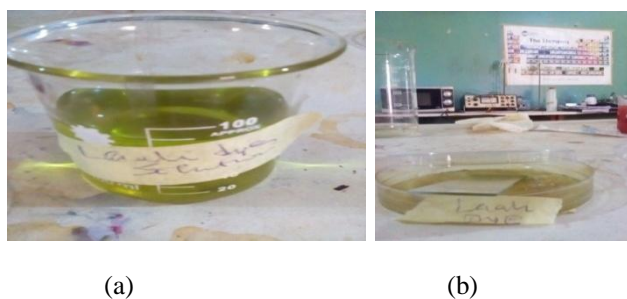


Figure 5: Laali solution in a beaker

Figures 5 (a) shows the laali dye solution in a beaker and (b) shows the solution in a petri dish with the insertion of a glass slide for thin film growth. After three days there was a uniform deposition and the slides cut to a portable sizes and prepared for absorbance, transmittance, structural and cryptographic analysis.

Extraction of Tomato seed

23.80g of Tomatoes seed was crushed and soaked in 20ml of ethanol over night. A reddish solution was filtered into a beaker



Figure 6: Tomato seed dye solution

Figures 6 (a) shows the blending process of the seed tomatoes and (b) shows the filtering process taking place after blending, (c) and (d) shows the solution in a beaker and slide respectively where the glass side was inserted into the solution to grow the thin film. After three days the deposited film was visibly seen on the slide. These slides are further in portable sizes and prepared for the absorption, transmittance, structural and cryptographic analysis.

Results and Discussion

Figure 7 and 8 shows the SEM result of Laali and Tomato while figures 9 and 10 the Transmittance and then figure 11 shows the XRD of tomato

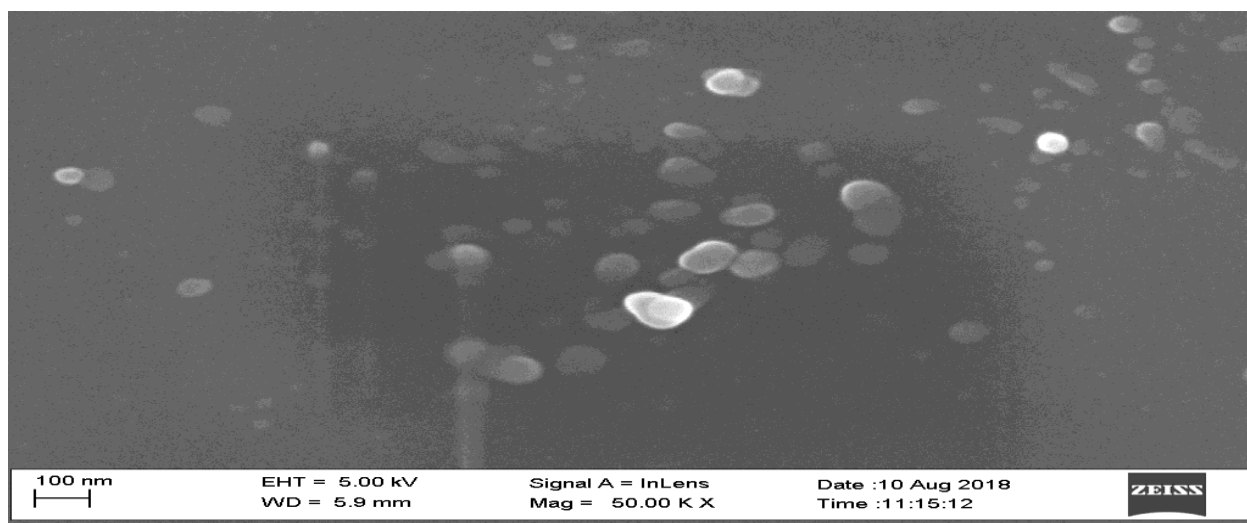


Figure 7: SEM of Laali dye at magnification of 50kx for wavelength 100nm

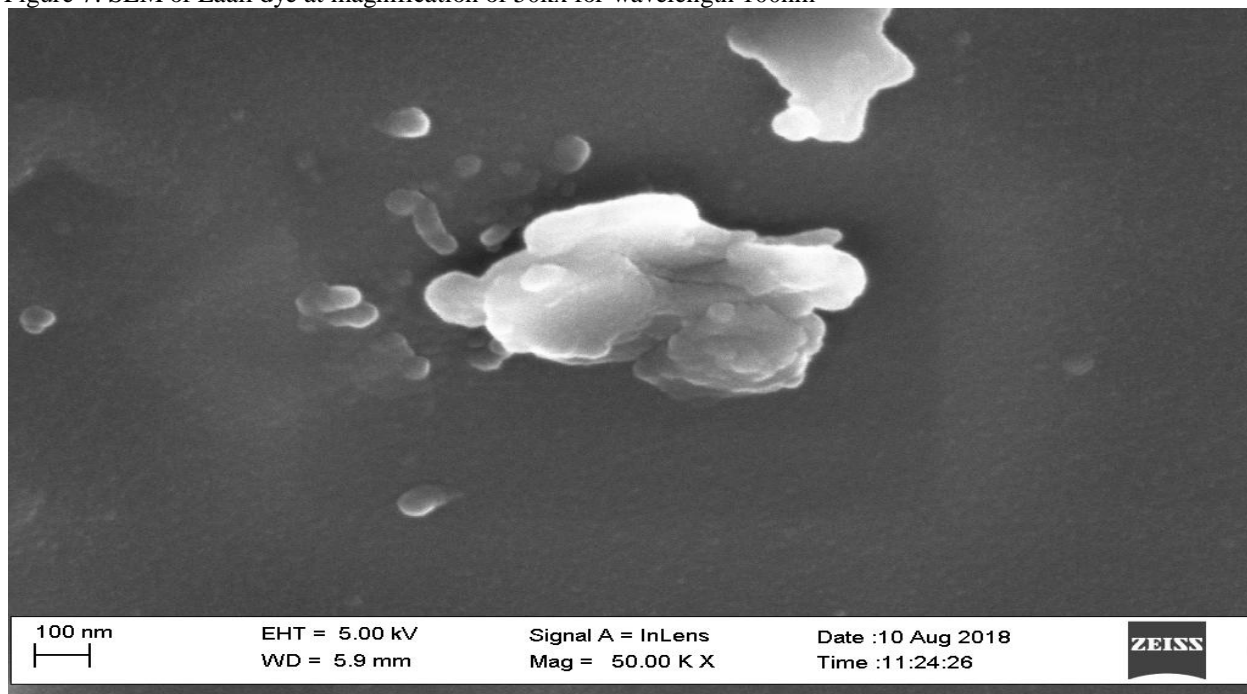


Figure 8: SEM of Tomato dye at magnification 50kx for 100nm wavelength

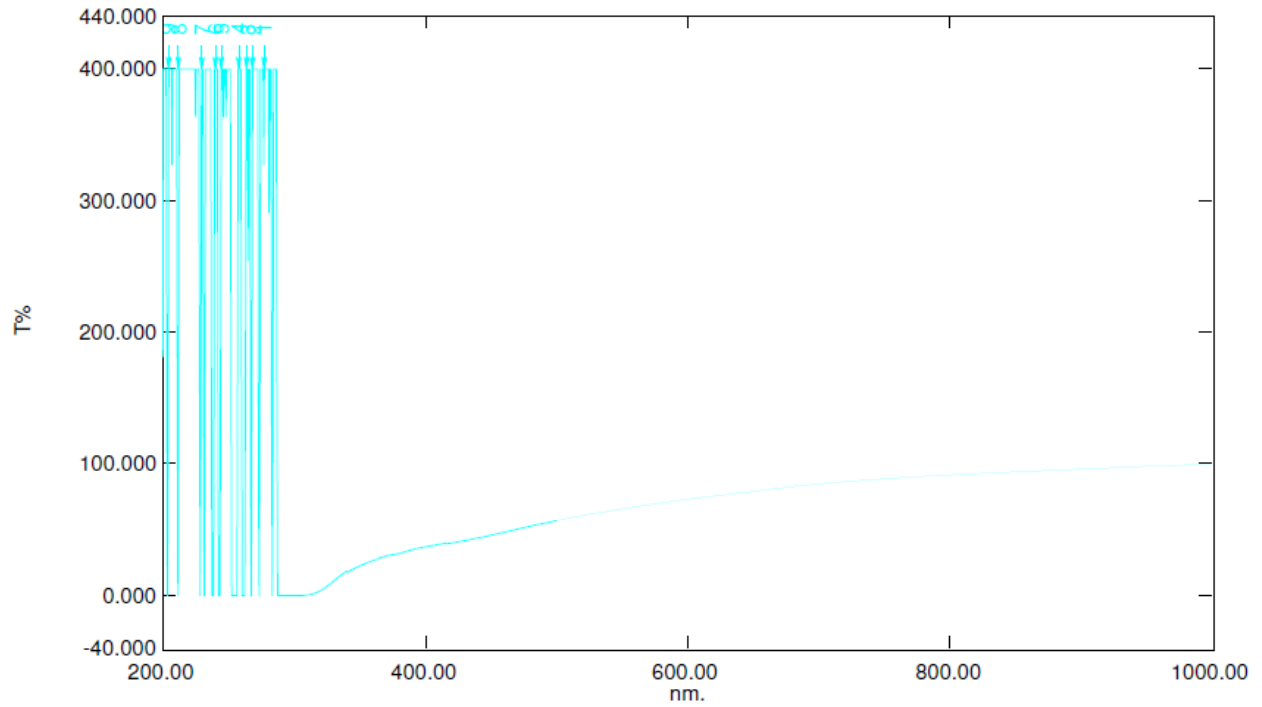


Figure 9: Transmittance of Laali dye

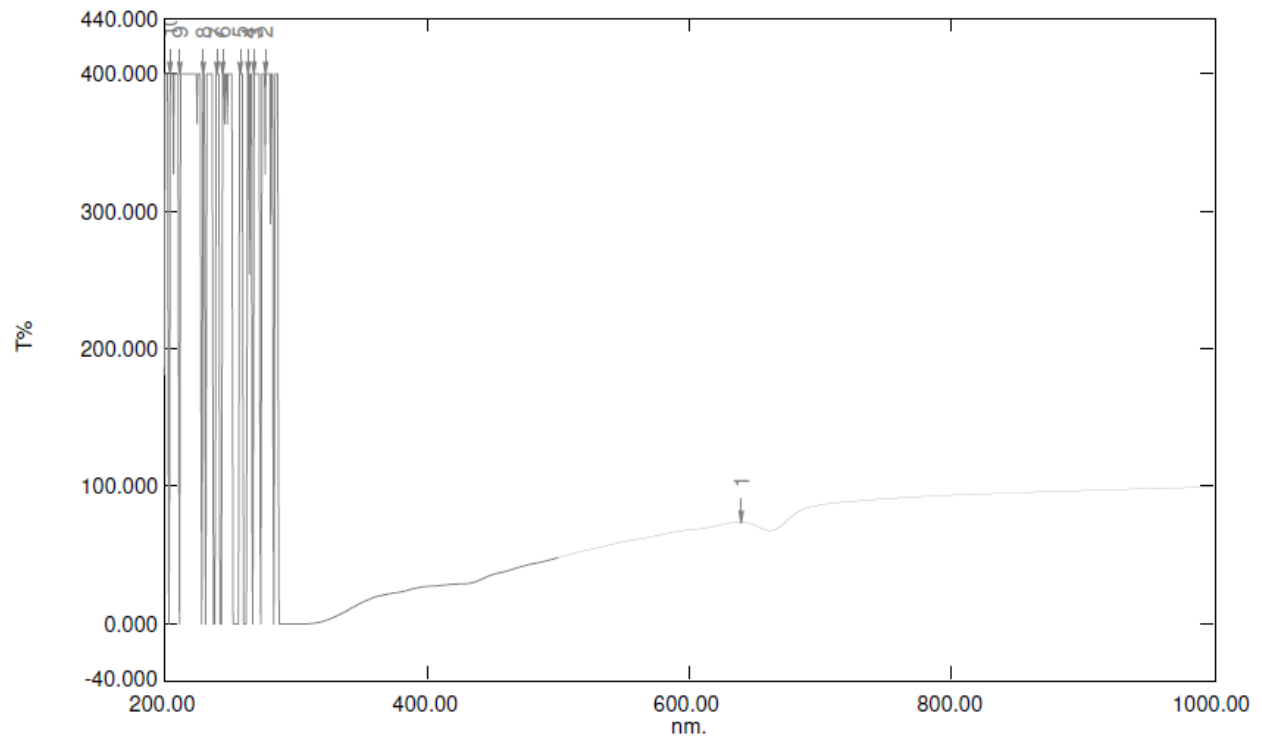


Figure 10: Transmittance of Tomato dye

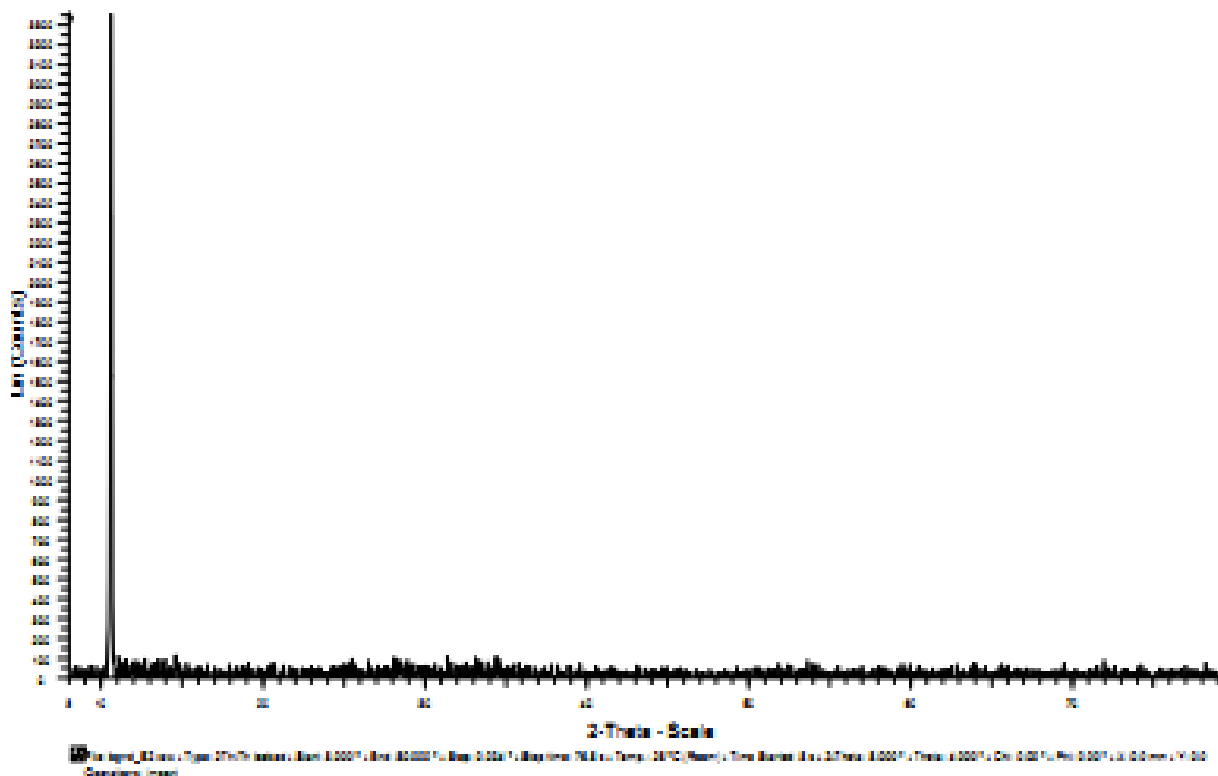


Figure 11: XRD of Tomato dye

Discussion

Analysis	Edible(Tomato seed dye)	Non-edible(Laali stem bark dye)
SEM	At 50 k X and 100nm the image size shows a cloudlike shape as shown in figure 8.	At 50k X and 100 nm the grain size shows a dotted shape as shown in figure 7.
XRD	Showed one peak prominent peak as shown in figure 11.	Not captured
Transmittance	Zero % transmittance up to 340nm then increase to 100% transmittance within the uv-visible region as shown in figure 10.	Zero % transmittance up to 330nm then increase to 100% within the uv-visible region as shown in figure 9.
Absorbance	No Absorbance	No Absorbance

Laali non edible dye showed a dotted shape image while SEM for tomato edible dye showed two large cloudlike image at 50kx magnification and 100nm wavelength. Laali dye cryptographic nature was not captured

Zero % Transmittance up to 330 nm then increase to 100% within uv-visible region for Laali dye while zero% Transmittance up to 340 nm as shown in figure 10. The XRD of tomato dye showed one prominent peak.

Conclusion

Laali non edible dye is a good transmittance material than Tomato dye, while the grain size of tomato is more visible than that of laali dye. XRD of tomato dye showed one prominent peak but Laali dye was not captured.

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