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TITLE:

Photodegradation and Extraction study of natural dye from mango and papaya plants using methanol as solvent

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ABSTRACT

This study uses methanol as a solvent to explore the extraction and conductivity investigation for the photodegradation of natural colours made from plant waste, notably papaya (Carica papaya) and mango (Mangifera indica) leaves. This study's goals are to extract natural dyes from papaya and mango leaves, compare the photodegradation behaviour of the two leaves, and evaluate the conductivity value of the photodegradation process for each leaf. Natural dyes are extracted from both fresh and dry leaves over a period of 1, 3, and 5 days. The conductivity values of the extracted dyes are then measured. The findings show that the first day had the lowest conductivity level for fresh leave but for dry had shown that the fifth day was the lowest value, and the third day had the highest value for both fresh and dry. This pattern implies that additional pigments can be released over extended extraction, resulting in a darker extract and higher conductivity values. The results show that natural dyes may be successfully extracted from plant waste and show promise for additional uses. To improve the effectiveness of natural dye extraction, future studies can investigate stability, resistance to photodegradation, and substitute solvents.

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BACKGROUND

1.1 Introduction

In many industries, such as the manufacturing of food, cosmetics, and textiles, dyes are essential. However, because of their high production costs, hazardous consequences, and lack of biodegradability, the extensive use of synthetic dyes has caused serious environmental concerns (Santos et al., 2022). In order decrease these problems and promote environmentally friendly solutions, researchers are looking into sustainable alternatives, such as natural dyes made from plant waste (Kamel et al., 2020).

This work employs methanol as a solvent to extract and photodegrade natural colours from papaya (Carica papaya) and mango (Mangifera indica) leaves. An common and reasonably priced source of natural pigments is plant waste, which is frequently thrown away (Bechtold & Mussak, 2009). This study intends to investigate the viability of employing plant-based dyes as a substitute for their synthetic counterparts by recycling these resources.

To evaluate degradation behaviour, dyes are extracted from plant leaves over varying times (1, 3, and 5 days) and their conductivity is measured. By exposing the dye solutions to sunlight, the photodegradation process is carried out, and variations in ion concentration are measured using conductivity (Ali et al., 2021). The goal of this research is to improve knowledge of the unique properties of natural dyes, including their stability in the presence of light and their possible uses in environmentally friendly sectors.

1.2 Literature Review

Natural dyes have drawn a lot of interest because of their non-toxic qualities, biodegradability, and environmental friendliness. These dyes are sustainable substitutes for synthetic dyes since they are derived from plant materials like leaves, flowers, and roots. Among these, the leaves of papayas (Carica papaya) and mangos (Mangifera indica) contain bioactive substances called flavonoids, tannins, and polyphenols that enhance their dyeing capacity (Siva, 2007). Plant-based dyes have a wide range of uses, such as food colouring, textile dyeing, and dye-sensitized solar cells. Their photostability and extraction method, however, continue to be crucial elements in defining their efficacy and long-term viability.

Several variables, including solvent selection, extraction time, and temperature, affect the extraction of natural dyes. Because of its strong polarity, which facilitates the effective dissolving of plant pigments such as anthocyanins, carotenoids, and chlorophylls, methanol is frequently utilised as a solvent (Samanta & Agarwal, 2009). According to studies, mango leaves are good for extracting dyes because they contain high levels of flavonoids and phenolic compounds (Abou El-Reash et al., 2019). Similar to this, papaya leaves have a high content of polyphenols, alkaloids, and saponins, which increases their potential as a dye source (Saxena & Raja, 2014). Methanol is a recommended solvent for effective dye extraction as prior research has shown that it yields more extracted pigments than both water and ethanol (Pereira et al., 2021). However, while methanol enhances the extraction yield, it also influences the photodegradation behavior of these natural dyes.

Since dye molecules can break down after extended exposure to light, photodegradation is an essential component of natural dye stability. Light intensity, wavelength, and the presence of catalysts like ZnO and TiO_2 all affect the rate of deterioration (Gao et al., 2014). According to research on the photodegradation of papaya and mango leaf extracts, anthocyanins and flavonoids break down when exposed to UV radiation, gradually decreasing the dye's potency (Sharma et al., 2018). Because of their greater sensitivity to light, methanol-extracted dyes are frequently more prone to photodegradation even though they produce a higher concentration of pigments (Bechtold & Mussak, 2009). Thus, researchers have investigated a number of stabilisation methods, including pH changes, encapsulation, and the inclusion of UV stabilisers, to improve the photostability of these dyes (Kumar et al., 2020). In