SUSTAINABLE DEVELOPMENT OF TABLE LINENS USING NATURAL DYE EXTRACTED FROM MELASTOMA MALABATHRICUM

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ABSTRACT

Growing environmental concerns have accelerated the shift toward sustainable textile solutions, including natural dyes and eco-friendly fibers. This study investigates the application of Melastoma malabathricum dye on bamboo–cotton blended fabric using alum as a mordant to develop eco-conscious table linen products. The dye was extracted from fresh flowers and applied using the tie-dye technique. Phytochemical screening confirmed the presence of phenols, flavonoids, alkaloids, terpenoids, and tannins, supporting its potential as a natural colorant. Test results indicated acceptable colour fastness and favourable visual evaluation of the dyed samples. The developed table napkin, runner, and placement mat were well received for colour, design, and utility. The study concludes that Melastoma malabathricum is a promising natural dye source with potential application in sustainable home furnishing textiles.

Keywords: Natural dye, Melastoma Malabathricum, bamboo–cotton, sustainability, eco-textiles, home furnishing.

1. INTRODUCTION

The global textile industry, one of the oldest and most influential manufacturing sectors, faces increasing scrutiny due to its significant environmental footprint. Conventional textile production is associated with high water consumption, toxic chemical discharge, and non-biodegradable waste generation [1]. In response, the industry is transitioning toward sustainable materials and environmentally conscious processing methods. Among these, the adoption of eco-fibers and natural dyes has gained considerable interest as viable alternatives to synthetic counterparts.

Eco-fibers derived from renewable plant or animal sources offer substantial environmental benefits, including biodegradability, lower toxicity, and reduced ecological impact during cultivation and processing [2]. These fibers help minimize greenhouse gas emissions and water pollution while providing functional advantages such as breathability, thermal regulation, and moisture management. Similarly, eco-dyes—particularly plant-based dyes—have emerged as sustainable substitutes for synthetic dyes, which are major contributors to water contamination and aquatic toxicity [3]. Botanical dyes extracted from roots, leaves, bark, and flowers offer biodegradable, non-toxic, and aesthetically rich coloration, while also supporting traditional dye practices and biodiversity conservation [4].

Melastoma malabathricum, a plant traditionally used in herbal remedies and artisanal crafts, has recently gained scientific attention as a natural dye source. Its leaves contain anthocyanins, natural pigments capable of producing a spectrum of hues from soft pastels to deep purples [5]. These pigments are biodegradable, non-toxic, and exhibit excellent fastness properties, making *Melastoma* a promising candidate for sustainable textile coloration. However, the effective application of many natural dyes requires mordants to improve dye–fiber bonding and enhance color retention, especially with cellulose fibers such as cotton or bamboo–cotton blends [6].

Sustainability in the textile sector extends beyond environmental considerations to include ethical production, waste minimization, reduced chemical use, and long-term ecological balance [7]. Home furnishing products, especially table linens, provide an effective medium through which sustainable textile practices can be integrated into everyday living. Using eco-fibers and natural dyes in home textiles promotes environmentally responsible

consumption while adding cultural and aesthetic value to interior spaces. The present study aims to explore the potential of plant-based dyes in sustainable home furnishing development.

2. METHODOLOGY

2.1 Selection and Treatment of Fabric

Bamboo cotton blend fabric was selected for the study. The selected fabric was washed thoroughly and dried under shade. To add an ornamentation technique to the product, tie and dye method was adopted. The fabric was tied in different areas and kept ready for dyeing.

2.2 Extraction of the Dye and Dyeing the Selected Fabric

The dye was extracted by crushing the fresh Melastoma flowers (Fig-1), boiled in water at 100°C for 1 hour. The mixture yielded a purplish-red coloured liquid extract. The liquid was then strained and collected for further use (Fig-2). The filtered extract was then subjected to UV spectrometry test and phytochemical screening test. The results of the tests are given in Results and Discussion**.**

Alum (aluminium sulphate) was selected as the mordant for dyeing on bamboo-cotton blend fabric due to its effectiveness in forming strong complexes with dye molecules, which enhances colour intensity and improves colour fastness. This mordant is commonly used in natural dyeing because of its ability to work well with plant-based dyes and its compatibility with both cotton and bamboo fibres. The mordant solution was made by dissolving 50g of alum (aluminium sulphate) in luke -warm water. To allow the alum to connect with the fibers and guarantee adequate fixing for the dye, the fabric was immersed in this solution for 30to 60 minutes. After pre-mordanting, the tied fabric was then immersed in the prepared dyebath for 30 to minutes for getting a vivid colour shade (Fig 3). After an hour the tie-dyed fabric was taken out, and spread out in shade for drying. The tie-dyed bamboo cotton blend fabric was tested for its fastness properties and was also visually evaluated. The developed fabric was then used to create ecofriendly sustainable and utility products like Table napkin (Fig 4), Table Runner (Fig 5), Placement mat with cutlery pouch (Fig 6).

Fig- 1 Melastoma Malabathricum

Fig- 2 Extracted Dye

Fig- 3 Dyeing the Fabric

Fig 4 Table Napkin

Fig-5 Table Runner

Fig- 6 Placement mat with Cutlery Pouch

3. RESULTS AND DISCUSSION

3.1 UV Spectroscopy of the Extracted Dye

The extracted dye was tested using UV-Visible spectroscopy to see how it absorbs light. The results are shown in a Chart- 3, highlights the wavelength where the dye absorbs the most.

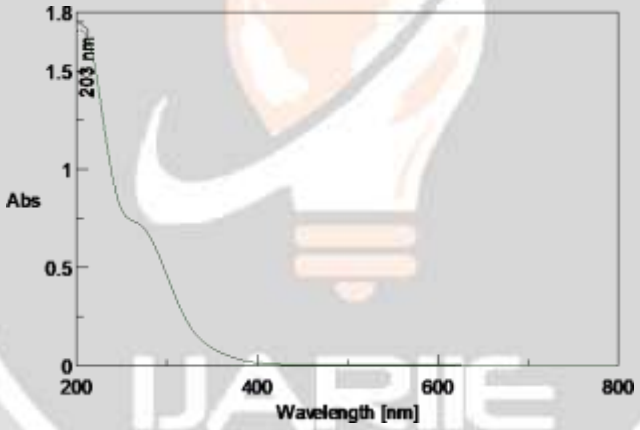

Chart 1- UV Visible Spectroscopy of the Extracted Dye

From the figure it is noted that there is no high peak of absorbance for the extracted dye. However, there is a slight absorption between 200nm and 300nm.

3.2 Phytochemical Analysis of Extracted Dye

Phytochemical analysis was carried out on the extracted dye to identify the presence of various bioactive compounds, and the results are given below in Table- 1.

Table 1- Phytochemical Screening Test

Phytochemical category	Test Name	Results
Phenols	Ferric chloride Test	+
Flavonoids	Shinoda Test	+

Alkaloids	Dragendorff's	+
	Mayer's Test	-
Terpenoids	Terpenoids Test	+
Tannins	Braymer's Test	+
Saponins	Frothing/Foam Test	-

The results of the phytochemical screening test showed that the sample included a variety of bioactive substances. A positive ferric chloride test indicated the presence of phenols. In Mayer's test, alkaloids were not present, but in Dragendorff's test, they produced a positive result. According to the Terpenoid test, terpenoids were found. The presence of tannins was verified by a positive Braymer's test. The Frothing/Foam test, however, yielded a negative result for saponins.

3.3 Visual Evaluation of Dyed Fabrics

Visual evaluation was conducted based on the responses of 100 people through a survey. The dyed samples were evaluated for color, texture, and appearance. The results given in Table 2 and Chart 2.

Table – 2 Visual Evaluation of Melastoma Malabathricum Dyed Fabric

FABRIC	ATTRIBUTE	CATEGORY	PERCENTAGE (%)
Dyed Fabric	Colour	Good	85%
		Fair	13%
		Average	2%
Dyed Fabric	Texture	Fine	60%
		Medium	39%
		Coarse	1%
Dyed Fabric	Appearance	Even	89%
		Partially Even	11%
		Uneven	0%

Based on the data presented in Table 2, 85% of respondents rated the colour quality as good. With respect to texture, 60% of the respondents described it as fine, whereas 40% categorized it as medium. In terms of appearance, 89% reported that the fabric exhibited an even colour distribution, while 11% perceived it as partially even.

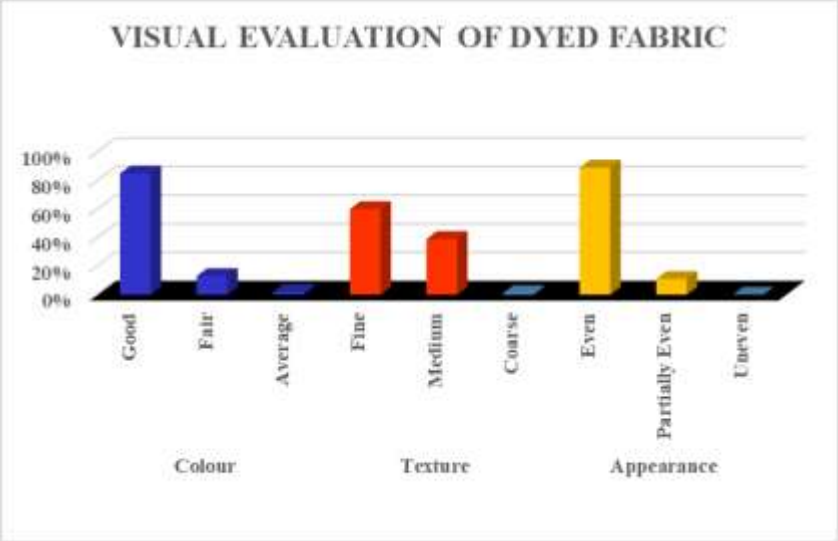

Chart 2- Visual Evaluation of Dyed Fabric

3.4 Colour Fastness Test of the Dyed Fabrics

Color fastness test such as color fastness to sunlight (CS), color fastness to hot iron (CHI), color fastness to washing (CW) were done for dyed bamboo-cotton blended fabric. The result of the color fastness test in dyed fabrics is given in Table 3 and Chart 3.

Table 3 -Colour Fastness of the Dyed Fabric

TESTS	GRADE	RATING
CS	B	4
CHI	B	4
CW	C	3

From the table, it was observed that Melastoma malabathricum dye shows good color retention under sunlight and ironing, while the washing test result was comparatively fair.

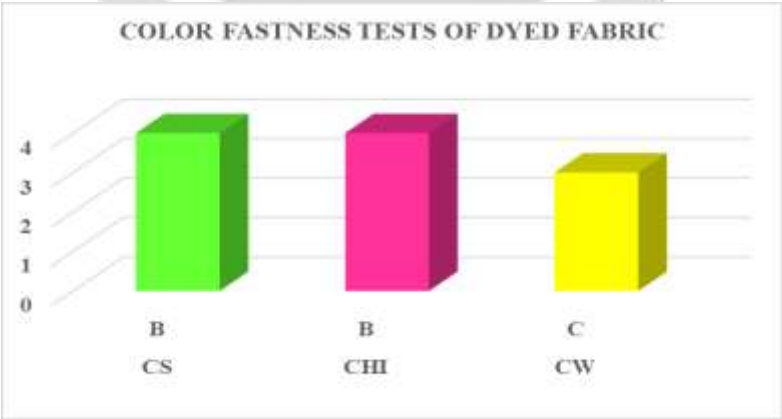

Chart 3- Color Fastness of the Dyed Fabric

3.5 Evaluation of the Developed Products

The results of the evaluation done for the developed products – Table Napkin, Table Runner and Placement Mat with Cutlery Puch is given in Table 4, Chart 4.

Table 4- Evaluation of the Developed Products

Developed Products	Design	Colour	Utility	Overall Appearance
Table Napkin	97%	97%	100%	98%
Table Runner	98%	98%	100%	100%
Placement mat with cutlery pouch	100%	100%	100%	100%

From the evaluation done on the products developed from tie dyed bamboo cotton blend fabric dyed with Melastoma Malabathricum, it was noted that, all the products received a good to high rating in design, colour, utility, and overall appearance of the products.

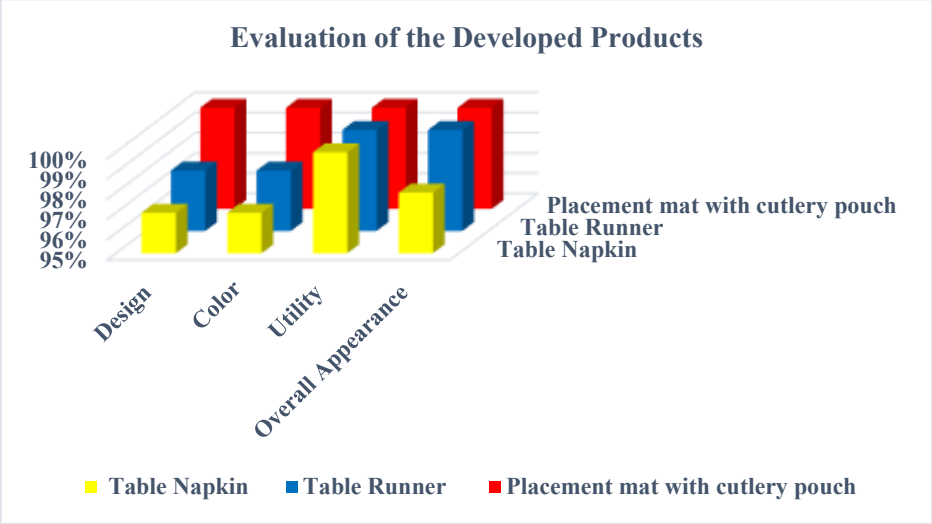

Chart 4- Evaluation of the Developed Products

4. Conclusions

Natural dyes and pigments have long contributed to enhancing the aesthetic value of textiles, food, paper, and artifacts, and continue to gain attention due to growing environmental and health considerations. Their advantages, including biodegradability, non-toxicity, visual softness, and origin from renewable sources, have driven increased research into alternative colorants, particularly in regions such as India, where over 500 dye-yielding plant species have been identified. The present study demonstrates the successful application of *Melastoma malabathricum* extract as a natural dye for bamboo–cotton blended fabric, using alum as a mordant. Phytochemical screening confirmed the presence of bioactive compounds relevant to dye adherence, and subsequent fastness assessments revealed satisfactory performance against washing, light, and ironing. Additional evaluation of UV protection further highlighted the functional potential of the dyed fabric. Consumer feedback on the developed home furnishing prototypes indicated favourable acceptance in terms of colour, appearance, and usability. Overall, the findings favors the potential of *Melastoma malabathricum* as a viable natural dye source for sustainable textile applications, particularly in eco-friendly home furnishing products.

5. REFERENCES

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