

Design and Development of Eco-Friendly Macrame Garments Dyed with *Rubia tinctorum* and *Indigofera tinctoria* with Natural Fragrance Finish

Abitha M.¹; Dr. R. Divya^{2*}; Shivshree T.³; Shruthika A. S.⁴; Subhasree S.⁵

^{1,3,4,5}M.Sc Research Student, Department of Fashion and Apparel Design, PSGR Krishnammal College for Women, Coimbatore, TN, India.

²Head of Department, Department of Costume and Apparel Design, PSGR Krishnammal College for Women, Coimbatore, TN, India.

Corresponding Author: Dr. R. Divya^{2*}

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Abstract: The increasing environmental concerns associated with synthetic dyes have led to the exploration of sustainable alternatives in textile processing. The present study focuses on the development of macramé garments using cotton yarn dyed with natural colourants obtained from *Rubia tinctorum* (madder) and *Indigofera tinctoria* (indigo). The dyeing process was carried out using alum as a mordant at different concentrations to examine its influence on colour depth and fastness properties. The dyed yarns were then utilized in macramé construction to create garments using traditional knotting techniques. A natural fragrance finish derived from *Michelia champaca* was applied to enhance the sensory and functional characteristics of the developed products. The performance of the dyed yarns was evaluated through pH analysis, colour fastness tests, antimicrobial assessment, biodegradability study, and skin irritation test. The results indicated satisfactory fastness properties along with improved functional performance and skin compatibility. The fragrance finish also demonstrated acceptable retention over time. The study concludes that the combination of natural dyeing and functional finishing can be effectively used to produce eco-friendly and value-added macramé garments suitable for sustainable textile applications.

Keywords: Cotton Macramé yarn, *Rubia tinctorum*, *Indigofera tinctoria*, *Michelia Champaca*, Sustainable Textiles.

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I. INTRODUCTION

The rapid expansion of the textile industry has resulted in the extensive use of synthetic dyes, which contribute significantly to environmental pollution and health hazards due to their toxic and non-biodegradable nature. The discharge of coloured effluents into water bodies has raised serious ecological concerns. According to M. L. Gulrajani (2001), natural dyes provide a sustainable alternative as they are biodegradable, non-toxic, and derived from renewable sources.

India has a long tradition of natural dyeing using plant-based materials. Among them, *Rubia tinctorum* (madder) and *Indigofera tinctoria* (indigo) are widely recognized for

producing red and blue shades, respectively. These dyes exhibit good affinity towards cellulosic fibres and can achieve satisfactory fastness properties when used with appropriate mordants. As reported by A. K. Samanta and Agarwal (2009), the use of mordants such as alum enhances dye fixation and improves colour durability. Studies by T. Kanimozhi and Divya (2023) further indicate that dye concentration and mordanting conditions play a key role in determining colour strength and uniformity.

In addition to aesthetic appeal, natural dyes can impart functional properties such as antimicrobial activity, improving the overall performance of textiles. Mohammad Yusuf et al. (2017) reported that plant-based dyes contain bioactive compounds that inhibit microbial growth.

Furthermore, the application of natural fragrance finishes, such as *Michelia champaca*, enhances the sensory quality and value of textile products. Therefore, this study focuses on the development of macramé garments using naturally dyed yarns combined with fragrance finishing to promote sustainable and value-added textile applications.

II. MATERIALS AND METHODS

➤ Materials



Fig 1 Cotton Macrame Yarn

Cotton macramé yarn was selected as the base material for this study due to its high absorbency and suitability for knot-based textile construction. Natural dyes were obtained from *Rubia tinctorum* (madder root) and *Indigofera tinctoria* (indigo leaves), which are widely known for producing red and blue shades, respectively. Alum was used as a mordanting agent at an appropriate concentration to enhance dye fixation and improve colour fastness properties. For functional finishing, *Michelia champaca* flowers were utilized to impart a natural fragrance to the dyed yarns.

➤ Extraction of Natural Dyes:

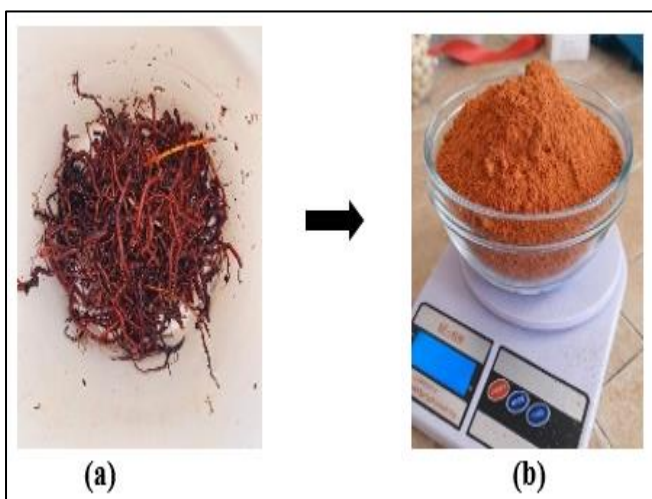


Fig 2 *Rubia tinctorum* (a) Root and (b) Powder



Fig 3 *Indigofera tinctoria* (a) Dried Leaves and (b) Powder

➤ Pre-treatment

Prior to dyeing, the cotton macramé yarns were subjected to a pre-treatment process to remove impurities such as natural waxes, oils, dust, and other surface contaminants. The yarns were scoured using a mild detergent solution at an elevated temperature for a specific duration to ensure effective cleaning.

After scouring, the yarns were thoroughly rinsed with clean water to eliminate any residual chemicals and then dried under ambient conditions. This process improved the absorbency and wettability of the yarns, thereby facilitating better penetration and uniform uptake of natural dyes during the dyeing process.

➤ Dye Extraction

Natural dyes were extracted from *Rubia tinctorum* and *Indigofera tinctoria*. Madder dye was obtained by boiling finely powdered roots in water at a controlled temperature, followed by filtration to obtain a clear dye solution. Indigo dye was prepared through a fermentation and reduction process, converting the dye into its soluble form suitable for dyeing.

➤ Dyeing Process

The dyeing of cotton macramé yarns was carried out using dye concentrations of 20% and 40% (on the weight of fibre) with a material-to-liquor ratio of 1:10. Prior to dyeing, the yarns were mordanted with alum at 10% (owf) to enhance dye fixation. The mordanted yarns were immersed in the dye bath and dyed under controlled temperature and time conditions with continuous movement to ensure uniform colouration.

➤ Drying and Finishing

After dyeing, the yarns were thoroughly rinsed to remove unfixed dye particles and then shade dried under ambient conditions. The dried yarns were subsequently treated with a natural fragrance finish using *Michelia champaca* through the wicking method, followed by drying to ensure proper absorption and retention of fragrance.

III. TESTING METHODS

➤ pH Test

The pH of the dyed macramé yarns was determined by preparing an aqueous extract of the sample and measuring it using a digital pH meter to evaluate its suitability for skin contact.

- Standard: ISO 3071:2005

➤ Colour Fastness to Washing

The resistance of the dyed yarns to colour change and staining during washing was assessed using a standard detergent solution under controlled temperature and agitation conditions. The results were evaluated using grey scale ratings.

- Standard: ISO 105-C06:2010

➤ Colour Fastness to Rubbing

Rubbing fastness was evaluated to determine the resistance of dyed yarns to colour transfer due to friction. Both dry and wet rubbing tests were carried out and assessed using grey scale ratings.

- Standard: ISO 105-X12:2016

➤ Colour Fastness to Light

Light fastness was determined by exposing the dyed yarns to artificial light under controlled conditions and assessing the degree of colour fading.

- Standard: ISO 105-B02:2014

➤ Fragrance Retention Test

The durability of the fragrance finish was evaluated by observing the retention of aroma over a period of time through sensory analysis.

- Standard: Subjective evaluation method

IV. PRODUCT DEVELOPMENT

The dyed macramé yarns prepared using *Rubia tinctorum* and *Indigofera tinctoria* were utilized for the development of macramé garments. The construction of the garments was carried out using basic knotting techniques such as square knots and half hitch knots to achieve the desired structure and design.

Garments were developed using yarns dyed at 20% and 40% concentrations, allowing comparison of shade depth and visual appearance. The finished products exhibited distinct colour variations ranging from lighter to deeper shades based on dye concentration. The application of *Michelia champaca* fragrance finish enhanced the sensory appeal of the garments.

The developed macramé garments were evaluated for their aesthetic appearance, structural stability, and overall suitability for sustainable textile applications. The results

indicated that naturally dyed yarns are suitable for macramé garment construction with added functional and aesthetic value.

V. CONCLUSION

This study successfully demonstrated the design and development of macramé garments using naturally dyed yarns from *Rubia tinctorum* and *Indigofera tinctoria*. The use of alum as a mordant improved dye fixation and enhanced colour fastness. Dyeing at two concentrations (20% and 40%) produced noticeable differences in shade depth, contributing to the visual and aesthetic appeal of the garments.

Application of the Chenbagam fragrance finish further improved the functional and sensory properties of the textiles. Performance testing confirmed satisfactory results in terms of pH, colour fastness, antimicrobial activity, biodegradability, and skin compatibility. Overall, the combination of natural dyeing, traditional macramé techniques, and fragrance finishing proved effective in creating sustainable, eco-friendly, and value-added textile products.

REFERENCES

- [1]. T. Kanimozhi, & Divya, R. (2023). Analysis of colour fastness of natural dyes on different natural fabrics. *International Journal for Multidisciplinary Research*, 6, 1–6.
- [2]. T. Kanimozhi, Divya, R., Suba, J. A., & Senthil Kumar, B. (2025). Investigation of pH influence on madder-dyed cotton blends. *Indian Journal of Fibre & Textile Research*.
- [3]. T. Kanimozhi, & Divya, R. (2025). Impact of natural dyes on cellulosic fabrics and their antimicrobial properties. *Advances in Bamboo Science*.
- [4]. Gulrajani, M. L. (2001). Present status of natural dyes. *Indian Journal of Fibre & Textile Research*.
- [5]. Samanta, A. K., & Agarwal, P. (2009). Application of natural dyes on textiles. *Indian Journal of Fibre & Textile Research*.
- [6]. Yusuf, M., Shabbir, M., & Mohammad, F. (2017). Natural dyes: Sources and applications. *Renewable and Sustainable Energy Reviews*.
- [7]. Chauhan, J., Parekh, S., & Solanki, H. A. (2023). Natural textile dyeing.