sciendo

DOI: 10.2478/9788367405386-021

October 12-13 2023 Online
TEX TEH XI
INTERNATIONAL CONFERENCE ON TEXTILES AND AFFILIATED R&D AREAS
Bucharest, Romania, 12-13 October 2023

NATURAL DYEING OF DIFFERENT FABRIC TYPES WITH *RUBIA CORDIFOLIA* EXTRACT

E.D. Koçak[1], P. Altay[2*], T. Ofluoğlu[3], Ö. Tektaş Çelikkanat[3]

[1]Marmara University, Faculty of Technology, Textile Engineering Department, Küçükyalı Maltepe, İstanbul/Türkiye, 34854
(E-mail: pelinaltay@itu.edu.tr)
[2]Textile Engineering Department, Faculty of Textile Technologies and Design, Istanbul Technical University, Istanbul, Türkiye, 34437
[3]İpekyol Tekstil ve Konfeksiyon A.Ş. Tasarım Merkezi, Şişli, İstanbul/Türkiye

Abstract: *Natural dyes derived from plants, insects/animals and minerals have attracted increasing attention due to growing environmental consciousness in order to avoid hazardous synthetic dyes. Madder, a source of a natural dye producing a variety of anthraquinone pigments in its roots and also in rhizomes, has traditionally been an important natural source of red color for textiles.* Rubia cordifolia*, also known as Indian Madder, is an ethnic plant containing more than 100 compounds and is one of the most widely used dyes in ancient Europe to dye wool, silk, linen, cotton fabrics. This study focuses on dyeing of different fabric types (100% viscose, 100% cotton and 85% modal-15% polyester) with* Rubia cordifolia *root extract as a natural dye due to the growing attention to the sustainability and environmental consciousness. All dyed samples were evaluated in terms of CIE values (L*, a*, b*, C*, h^0), color strength (K/S) and color fastness properties against to washing, rubbing and artificial light.*

Keywords: *Madder, Natural dyeing,* Rubia cordifolia

1. INTRODUCTION

Natural dyeing is currently of great interest due to growing attention to the sustainability and environmental consciousness. Natural dyes derived from plants, insects/animals and minerals are renewable and sustainable bioresource products with minimal environmental impact. The use of natural dyes has tremendous potential to reduce greenhouse gas emission by reducing the consumption of fossil fuel-based synthetic dyes. However, dyeing of fabrics with natural dyes causes some problems such as narrow shade range, and lower color fastness. Mordants are used to produce different colors from natural dyes and to help natural dyes adhere to fibers, thereby improving color fastness. Fabric dyed with natural dye will be more prone to fading if mordant is not used. Most commonly used mordants are metallic salts such as alum, iron (II) sulfate, copper (II) sulfate, tin (II) chloride, etc. [1-3].

Madder has traditionally been an important natural source of red color for textiles. *Rubia cordifolia* (Indian Madder) is an ethnic plant that grows near streams and rivers along the upper Ghats in evergreen forests. *R. cordifolia* is rich in more than 100 compounds, mainly including anthraquinones, naphthoquinones, anthraquinone glycosides, naphthoquinone glycosides, bicyclic hexapeptides, triterpenoids and polysaccharides. In ancient Europe, *R. cordifolia* is one of the most widely used dyes for dyeing wool, silk, linen, cotton fabric [4-7].

This study presents the dyeing of different fabric types with *R. cordifolia* root extract as a natural dye and the evaluation of their effect on color in terms of CIE values (L*, a*, b*, C*,

https://doi.org/10.2478/9788367405386-021

h^0), color strength (K/S) and color fastness properties against to washing, rubbing and artificial light.

2. EXPERIMENTAL

2.1 Materials and Method

Different fabrics, 100% viscose, 100% cotton and 85% modal-15% polyester, were dyed with madder (*Rubia Cordifolia*) in the presence of natural textile auxiliaries at 80 °C for 1 hour according to the recipe given in Table 1. Alum (VegeSmart DS) was chosen for use as eco-friendly mordant compared to other commonly used metal salt mordants. After dyeing, all dyed samples were washed with a soap solution (3.3 % VegeSuper).

Table 1. Natural dyeing recipe used in this study

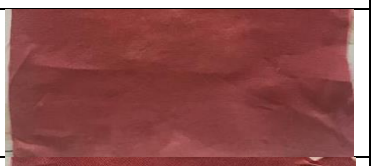
5%	Rubia Cordifolia (Indian madder)
8.3%	VegeSet (catalyst)
8.3%	VegePlus (cationic agent)
16.6%	VegeSmart DS (alum)
5%	VegeDisperse (dispersing agent)
1%	Sodium carbonate

All dyed fabrics were evaluated in terms of CIE L*a*b, C*, h^0 using Datacolor spectrophotometer.

3. RESULTS AND DISCUSSION

Dyed fabric samples and color measurement results are given in Table 2. It can be seen that dyeing with *R. cordifolia* gives different reddish shades from light to medium, with different depth of color (K/S) depending on the material used.

Table 2. Color measurement results of dyed fabric samples

	CIE L*	**CIE a***	**CIE b***	**CIE C***	**CIE h^0**	**K/S**	**Image of dyed samples**
Fabric samples							
100% cotton	50.04	34.03	8.49	35.08	14.00	1.9224	
100% viscose	44.84	34.53	9.58	35.84	15.51	2.5538	
85% modal-15% polyester	55.48	31.53	5.03	31.92	9.07	1.0983	

As can be seen from Table 2, lightness value (L*) ranged from 44.84 to 55.48. The dyed viscose fabric sample had the lowest L* value (44.84), indicating that it has the darkest color among the other samples. K/S value was found to be in the range of 1.09 - 2.55. The higher the K/S values, the lower the reflectance of the fabric and therefore the fabric is deeper dyed. The dyed viscose sample had the highest color strength (K/S=2.55) resulting in deeper shades. The fact that the values of a*>b* and both positive in all dyed fabrics, and the hue angle is in the

range of 9.07-15.51 indicates that the appearance colors are closer to red than yellow. The color saturation values ($C*$) of all dyed samples were almost the same. Tables 3 and 4 show the color fastness results of dyed samples with *R. cordifolia* extract. All dyed samples showed good washing, rubbing and light fastness ratings ranged from 4 to 4/5.

Table 3. Color fastness to washing of dyed samples

	Color change	**Color staining**					
Color fastness to washing		**acetate**	**cotton**	**nylon**	**polyester**	**acrylic**	**wool**
100% cotton	4/5	4	4/5	4	4/5	4/5	4/5
100% viscose	4/5	4	4/5	4	4/5	4	4/5
85% modal- 15% polyester	4/5	4	4/5	4	4	4	4/5

Table 4. Color fastness to rubbing and artificial light of dyed samples

	Color fastness to rubbing		**Color fastness to artificial light**
	Dry	**Wet**	
100% cotton	4/5	4	4/5
100% viscose	4/5	4	4/5
85% modal- 15% polyester	4/5	4	4/5

4. CONCLUSION

In this study, fabric samples made of three different fiber types (100% cotton, %100 viscose and 85% modal- 15% polyester) were dyed with *R. cordifolia* extract (Indian madder) in the presence of alum-based mordant. All dyed samples were evaluated in terms of CIE values (L*, a*, b*, C*, h^0), color strength (K/S) and color fastness properties against to washing, rubbing and artificial light. Results indicated that cotton, viscose and modal/polyester blended fabrics were successfully dyed with *R. cordifolia* extract, giving different reddish shades from light to medium, with different color depths and good color fastness properties.

REFERENCES

[1] Shahid, M., Shahid-ul-Islam, Mohammad, F., *Recent Advancements in Natural Dye Applications: A Review*, In: J. Clean. Prod., 2013, 53, 310-331, https://doi.org/10.1016/j.jclepro.2013.03.031
[2] Dutta, P., Mahjebin, S., Sufian, M.A., Rabbi, Md. R., Chowdhury, S., Imran, I. H., *Impacts of Natural and Synthetic Mordants on Cotton Knit Fabric Dyed with Natural Dye from Onion Skin in Perspective of Eco-Friendly Textile Process*, In: Mater. Today: Proc., 2021, 47, Part 10, 2633-2640, https://doi.org/10.1016/j.matpr.2021.05.229
[3] Mahangade, R.R., Varadarajan, P.V., Verma, J.K., Bosco, H., *New Dyeing Techniques for Enhancing Color Strength and Fastness Properties of Cotton Fabric Dyed with Natural Dyes*, In: Indian J. Fibre Text. Res., 2009, 34, 03, 279-282
[4] Wen, M., Chen, Q., Chen, W., Yang, J., Zhou, X., Zhang, C., Wu, A., Lai, J., Chen, J., Mei, Q., Yang, S., Lan, C., Wu, J., Huang, F., Wang, L., *A Comprehensive Review of Rubia cordifolia L.: Traditional Uses, Phytochemistry, Pharmacological Activities, and Clinical Applications*, In: Front. Pharmacol., 2022, 13, 965390, https://doi.org/10.3389/fphar.2022.965390
[5] Yusuf, M., Mohammad, F., Shabbir, M., Khan, M.Al., *Eco-dyeing of Wool with Rubia cordifolia Root Extract: Assessment of the Effect of Acacia catechu as Biomordant on Color and Fastness Properties*, In: Text. Cloth. Sustain., 2017, 2, 10, https://doi.org/10.1186/s40689-016-0021-6

[6] Gupta, D., Kumari, S., Gulrajani, M., *Dyeing Studies with Hydroxyanthraquinones Extracted from Indian Madder. Part 2: Dyeing of Nylon and Polyester with Nordamncanthal*, In: Color. Technol., 2001, 117, 333–336, https://doi.org/10.1111/j.1478-4408.2001.tb00085.x
[7] Siva, R., *Status of Natural Dyes and Dye-Yielding Plants in India*, In: Curr. Sci., 2007, 92, 7, 916–25, available at: http://www.jstor.org/stable/24097672