

Periodic Research

Sustainable Dyeing of Cotton Fabric with Eucalyptus Erythrocorys Leaves Extract and Natural Mordants

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Abstract

Eucalyptus is one of the fastest growing and abundantly grown plants across the globe for wood and fuel requirements. In present investigation natural dye was extracted from leaves of Eucalyptus erythrocorys by aqueous extraction method. Further dyeing of cotton was performed using natural mordants such as pomegranate peel, harda and amla powder as well as chemical mordants such as alum, copper sulphate and ferrous sulphate. Cotton fabrics were dyed by pre, post and simultaneous mordanting methods with aforesaid mordants in exhaust method on open water shaker bath.

The colour fastness properties were evaluated for all the dyed fabrics. It was observed that dye have moderate to good wash and rubbing fastness along with poor to moderate light fastness properties for all the mordants and mordanting techniques. L*, a*, b* values and K/S values were estimated using CIE system using Premier Color Scan. The extracted dye showed very good shades of brown on cotton dyed fabric in yellow and red colour coordinates. The results of the study shows that extract of eucalyptus erythrocorys leaves waste can be used successfully for dyeing of cotton as substitute to chemical dyes in a sustainable way.

Keywords: Natural Dyes, Eucalyptus Leaves, Extraction, Mordant, Cotton Sustainable.

Introduction:

Textile processing industries are one of the major environment polluters. In 21th century people are more conscious about their health and sustainability. Thus there is dire need to replace the chemical dyes with suitable natural dyes as they are safe, biodegradable, eco-friendly and not harmful to the human health¹.

Review of Literature

Natural dyes have been used since ancient time as a food colourant and for dyeing of textiles & leather. Natural dyes are obtained from animal, plant and vegetable resources¹. There is need to emphasise on various suitable natural dyes which can be obtained from abundantly available natural resources. Therefore, in present study natural dye was extracted from leaves of Eucalyptus erythrocorys^{2,3}. Eucalyptus is one of the fastest growing and abundantly grown plant across the globe for wood and fuel requirements. Eucalyptus erythrocorys belongs to the family Myrtaceae with about 300 species of the genus^{2,3}. Eucalyptus is popularly known as Gum tree, red iron tree, nilgiri and safeda. It is a native of Australia and Tasmania and brought in India by British in 1843. Its bark has numerous applications in wood, timber, plywood, etc industries but leaves have no applications as such. Its leaves are waste product and need to utilise for some purpose².

Numerous attempts have been found showing extraction of natural dye from eucalyptus erythrocorys. Eucalyptus has ample natural tannins and polyphenols ranging from 10% to 12%. The leaves contain 10% of the major component of tannic gallic acid and ellegic acid with flavoniods (quercetin,rutin etc) as miner substance. It is found in literature review that natural dye based on eucalyptus was used for dyeing various textile substrates^{4,5}.

In present investigation leave of Eucalyptus erythrocorys-Red Cap Gum was collected and natural dyes was extracted and applied to cotton textile material^{6,7}. Natural dyes need mordants for improving their substantivity and colour fastness properties. Thus various mordants were

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applied via pre, post and meta mordanting methods. Initially dyeing was performed using three chemical mordants such as ferrous sulphate, copper sulphate and alum. Chemical mordants may harm the environment thus some renewable natural mordants were also used in the study to evaluate their performance in comparison to chemical mordants. Pomegranate peel, Harda and Amla powder extracts are known for their medicinal values and successfully applied as natural mordants by certain researchers and in our previous studies. Thus these three natural mordants were also used in dyeing of cotton⁸⁻¹⁰.

Further, colour fastness properties such as light, rubbing and washing fastness of all dyed fabrics were evaluated. Colour staining and change in colour were assessed by using standard grey scale.

Materials and Methods

Plain Cotton Fabric

Bleached plain woven cotton fabric of GSM-100, EPI 90 and PPI 84 was procured from local market and used in present study after finishing by mild soaping treatment.

Natural Dye

Leaves of Eucalyptus erythrocorys-Red Cap Gum was collected from campus BPSMV, Sonapat, Haryana. Further collected leaves were dried and ground for extraction of dye in aqueous solution.

Natural Mordants

Pomegranate peel, Amla powder and Harda powder were procured from local market and used as such for mordanting purpose.

Chemical Mordants

Alum, copper sulphate and ferrous sulphate were used of LR grade.

Extraction of dye

Dye powder was extracted using 15 gm of eucalyptus leaves in 450 ml of distilled water for 90 minute at 100 °C. Extract was filtered and dried to obtain the natural dye in powder form.

Mordanting Techniques

In present study chemical and natural mordants were used to dye a cotton fabric by three different technics as follows:

Pre-Mordanting

In pre-mordanting the material is first impregnated directly with the mordants (Pomegranate peel, Harda, Amla powder, Alum, Copper sulphate and ferrous sulphate) and then dyed with eucalyptus extract in the separate bath.

Simultaneous Mordanting/ Meta Mordanting

In this method the fabrics were mordanted and dyed in same bath.

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Post-mordanting

In case of post-mordanting, mordanting is carried out after dyeing step.

Mordanting Recipe

Natural as well as chemical mordants were used with following recipe-

Mordant Concentration: - 20% owf

MLR: - 1:30

Temperature: - 100° C

Time: - 90 minutes

Mordanting was carried out by pre-mordanting, simultaneous mordanting and post-mordanting methods. Mordanted fabric was then rinsed, squeezed and dried at room temperature.

Dyeing Recipe

Dyeing was performed using following recipe

Dye concentration:-20%

MLR:-1:30

Temperature:-100° C

Time: - 90 minutes.

pH: 7

Dyeing was performed on open water bath by the conventional exhaust dyeing method. After the completion of the dyeing process, the dyed material was washed with cold water and dried at room temperature.

Colour Strength

The colour difference dE colour value (L*a*b*) of difference sample were determined using Premier Color Scan spectrophotometer and software interfaced. The instrument was standardized with white tile.

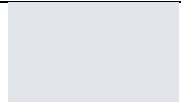

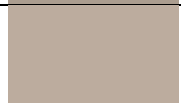

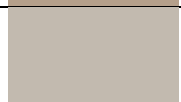






Colour Fastness

The various properties such as wash, rubbing and light fastness were checked using IS: 3361-1979 IS: 766-1988 and IS: 2485-19 methods, respectively.

Result and Discussion

Eucalyptus erythrocorys extraction was found in brown shades of yellow-red region. Mordant plays very important role in imparting colour to the fabric. The results indicate that there were many shades of yellow-brown colour obtained after dyeing the cotton fabric with eucalyptus erythrocorys using different mordanting techniques. Initially dyeing was performed using chemical mordants. The L*a*b* values, k/s and shade of samples are tabulated in Table 1. It can be observed that dyed sample with eucalyptus leaves extract without any mordant was in yellow red colour coordinates. Colour variations were observed when mordants such as alum, copper sulphate and ferrous sulphate were applied to cotton fabric although all the dyed samples were laying in brown shades of yellow red colour coordinates.

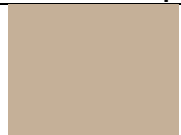
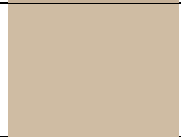





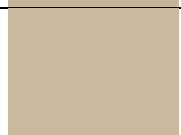
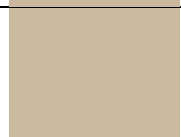
Table 1: Dyeing of Cotton Fabric with Eucalyptus Leaves Extract (20% Shade) Using Different Chemical Mordants and Mordanting Techniques

| Mordant | Process | k/s | L* | a* | b* | Shade of Sample |
|--|-----------------|-------|--------|-------|--------|---|
| Undyed | | 0.096 | 90.513 | 0.615 | -4.132 |  |
| Dyed sample with eucalyptus leaves extract (20% shade) without mordant | | 1.112 | 65.616 | 3.159 | 8.375 |  |
| Alum, 20 % | Pre-mordanting | 0.707 | 71.322 | 3.538 | 8.504 |  |
| | Meta-Mordanting | 1.263 | 67.068 | 4.544 | 13.227 |  |
| | Post-mordanting | 0.435 | 75.805 | 1.3 | 5.648 |  |
| Copper Sulphate, 20 % | Pre-mordanting | 1.312 | 62.924 | 3.349 | 9.261 |  |
| | Meta-Mordanting | 2.018 | 63.007 | 4.897 | 17.18 |  |
| | Post-mordanting | 0.819 | 71.616 | 0.712 | 10.02 |  |
| Ferrous Sulphate, 20 % | Pre-mordanting | 1.315 | 62.888 | 3.396 | 9.222 |  |
| | Meta-Mordanting | 1.119 | 63.523 | 0.81 | 4.891 |  |
| | Post-mordanting | 1.057 | 66.293 | 1.153 | 8.229 |  |

Dyeing of cotton fabric with eucalyptus leaves extract were also performed using natural mordants. The obtained L, a, b values, k/s and shade of dyed samples are tabulated in Table 2. It can be

observed that similar to chemical mordants varied brown shades in yellow red coordinates were obtained for all the natural mordants too.

Table 2: Dyeing of Cotton Fabric with Eucalyptus Leaves Extract (20% Shade) Using Different Natural Mordants and Mordanting Techniques

| Mordant | Process | k/s | L* | a* | b* | Shade of Sample |
|------------------------|-----------------|--------|--------|-------|--------|---|
| Pomegranate Rind, 20 % | Pre-mordanting | 0.95 | 72.95 | 3.991 | 14.386 |  |
| | Meta-Mordanting | 0.715 | 77.212 | 3.082 | 14.183 |  |
| | Post-mordanting | 0.752 | 76.795 | 2.214 | 14.227 |  |
| Aamla, 20 % | Pre-mordanting | 0.905 | 69.709 | 2.837 | 10.475 |  |
| | Meta-Mordanting | 0.467 | 78.973 | 3.118 | 10.486 |  |
| | Post-mordanting | 0.449 | 77.141 | 1.476 | 7.002 |  |
| Harda 20 % | Pre-mordanting | 0.8113 | 74.256 | 4.044 | 13.475 |  |
| | Meta-Mordanting | 0.826 | 75.847 | 2.943 | 14.754 |  |
| | Post-mordanting | 0.841 | 76.363 | 1.599 | 14.951 |  |

Colour Fastness of Eucalyptus Dyed Cotton Fabric

Colour fastness testing such as washing, light and rubbing was performed and their fastness

rating were assigned as per the standards. The obtained fastness ratings with all the dyed samples are tabulated in Table 3.

Table 3
Colour Fastness of Dyed Cotton Fabric with Eucalyptus Leaves Extract (20% Shade) Using Different Natural Mordants and Mordanting Techniques

| Mordant | Process | Washing Fastness | | | Light Fastness | Rubbing Fastness | |
|---------------------------------|-----------------|------------------|--------------------|------------------|----------------|------------------|-----|
| | | Staining on wool | Staining on cotton | Change in colour | | Wet | Dry |
| Without mordant with eucalyptus | | 4 | 4-5 | 4-5 | 4 | 3-4 | 4 |
| Alum | Pre-mordanting | 4 | 4-5 | 4 | 3-4 | 4.5 | 4 |
| | Meta-Mordanting | 4 | 4-5 | 4-5 | 4 | 4 | 4 |
| | Post-mordanting | 4 | 4-5 | 4-5 | 3-4 | 4 | 4 |
| Copper sulphate | Pre-mordanting | 4-5 | 4-5 | 4-5 | 3 | 4 | 4 |
| | Meta-Mordanting | 4 | 4 | 4-5 | 3-4 | 4 | 4 |
| | Post-mordanting | 4 | 4 | 4-5 | 4 | 3-4 | 4 |
| Ferrous sulphate | Pre-mordanting | 4 | 4-5 | 4-5 | 3-4 | 4 | 4 |
| | Meta-Mordanting | 4-5 | 4-5 | 4-5 | 4 | 3-4 | 4 |
| | Post-mordanting | 4-5 | 4-5 | 4-5 | 3-4 | 3-4 | 4 |
| Pomegranate | Pre-mordanting | 4 | 4 | 4-5 | 3-4 | 4 | 4 |
| | Meta-Mordanting | 4-5 | 4-5 | 4 | 4 | 3-4 | 4 |
| | Post-mordanting | 4-5 | 4-5 | 4 | 4 | 3-4 | 3-4 |
| Amla | Pre-mordanting | 4 | 4-5 | 4-5 | 3-4 | 4 | 4 |
| | Meta-Mordanting | 4 | 4 | 4-5 | 3-4 | 4 | 4 |
| | Post-mordanting | 4 | 4 | 4 | 3-4 | 3-4 | 4 |
| Harda | Pre-mordanting | 4 | 4-5 | 4 | 3-4 | 4 | 4 |
| | Meta-Mordanting | 4-5 | 4-5 | 4 | 3 | 4 | 4 |
| | Post-mordanting | 4-5 | 4-5 | 4-5 | 3 | 4 | 4 |

It can be observed that dyed cotton fabric samples with eucalyptus leaves extract have good wash fastness and moderated rubbing fastness properties. The dyed samples have poor to moderate light fastness properties. It can be analysed that natural mordants also gives comparable colour fastness properties to chemical mordants. Most of the chemical mordants are toxic being heavy metals and causing severe pollution. Thus natural dyeing can be performed sustainably without using any chemicals by the use of natural mordants.

Conclusion

It can be concluded from the above study that eucalyptus leaves which are a huge waste can be better attributes for sustainable textile dyeing. All dyed samples have a wide range of brown shades in yellow-red colour coordinates with moderate to good wash and rubbing fastness along with poor to moderate light fastness properties.

It can be also concluded that Natural mordants such as pomegranate peel, harda and amla powder can be also used alternative to chemical mordants. The renewable natural dyes with natural mordants do not require any chemicals as such thus have great potential for sustainable ecofriendly dyeing of cotton.

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