An Eco-Friendly Dyeing of Woollen Fabric by using medicinal herbs kalanchoe pinnata Natural Dye

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ABSTRACT

The Present research is an attempt to explore colouring behavior of kalanchoe pinnata herbs on wool textile substrate. This herb show good affinity for the wool fabric. Mordanting of the fabric was carried out using three mordanting technique i.e. Pre, Meta and Post-mordanting using natural as well as chemical mordants i.e. Dry goose berry powder, harda powder, orange peel powder, alum, ferrous and copper sulfate. Dyed samples were further analyzed for colour strength and fastness properties. This herb gives a wide colour spectrum in yellow-green region with excellent fastness properties. The overall results show that kalanchoe pinnata dye can be successfully used and explored further for dyeing of wool with medicinal properties.

Keywords: kalanchoe pinnata, Natural Dye, Wool, Natural and Synthetic Mordant.

1. INTRODUCTION

Natural dyes are non-substantive colouring compound. It contains chromophore as well as auxochrome groups. Chromophore group has capacity to absorb certain portion of visible light and attributes colour to dye molecule. Auxochrome groups provide solubility, intensity and affinity to the dye molecule and responsible in dye fibre interaction or reaction .Natural dyes are renewable, eco-friendly and sustainable in nature. Derived from the natural source like plants, animals, minerals etc.

Kalanchoe pinnata is such an herb found in abundant in nature, known as patherchatt in Hindi and it’s have brilliant medicinal properties and no literature have been found on its applications in textiles. Therefore, present study is an attempt to explore dyeing behavior of kalanchoe piñata using different mordanting methods i.e. pre-mordanting, meta-mordanting and post-mordanting. Dyes were extracted from leaves part via aqueous and ethanol extraction method. Herb was treated with both chemical as well as natural mordants on woollen fabric by exhaust method on water shaker bath for a comparative study of their colouring behavior and fastness properties. Colour strength was evaluated using computer colour matching instrument and different fastness properties were evaluated as per the AATCC standards. [3]

2. LITERATURE REVIEW

Herb Description

- Botanical Name: - Bryophyllum pinnatum
- Family Name:- Crussulaceae
- Sanskrit Name: - Pashanabhedha, parn beej, hemsagar.
- Hindi Name:- Patharchur.
- Bengali:- koppat, patharkuchi.
- Telugu:- Ranapala
- Tamil:- Runa kalli
Common Names: Cathedral Bells, Air Plant, Life Plant, Miracle Leaf, Goethe Plant and Katakataka. Also called “Wonder of the World” in the English speaking Caribbean. ‘Oliwa Ka Kahakai (Hawaii), Mother Of Thousands, Herbe Mal Tete (Dominica) Never Dead, Parvu, Hoja Del Aire (Bolivia)[1,2]

Medicinal Activities Of Herb

- Neuro-pharmacological activities.
- Antihypertensive activity.
- Analgesic.
- Anti-inflammatory.
- Insecticidal.
- Wound Healing activity.
- Anti microbial.
- Uterine Contractility.
- Neurosedative/muscle relaxant.
- Fungi toxic.
- Anti carcinogenic.
- Anti ulcer.
- Anti depressant.
- Anti oxidant.
- Anti diabetic. [2,3]

Chemical Structure of Herb

![Chemical Structure]

Colouring behavior

No literature found regarding to colouring properties on woollen and other textiles.

3. MATERIAL AND METHOD

Dye

The dye powder was extracted from the dry leaves of kalanchoe pinnata herb, collected from Bhagat Phool Singh Mahila Vishvadyalya Campus, Khanpur Kalan, Sonipat, Haryana, India. The picture of the herb is at Figure1.

Textile Material Used for Dyeing

Twill weaved woollen fabric was used for dyeing having EPI and PPI of 58, 62 respectively and weight of fabric was 295 gsm.
Mordants

In this research three chemical and three natural mordants were used.

1. Natural mordants

<table>
<thead>
<tr>
<th>Natural mordants</th>
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</thead>
<tbody>
<tr>
<td>Orange peel powder</td>
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<tr>
<td>Harda powder</td>
</tr>
<tr>
<td>Dry goose berry powder</td>
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</tbody>
</table>

2. Chemical mordants

<table>
<thead>
<tr>
<th>Chemical mordants</th>
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</thead>
<tbody>
<tr>
<td>Aluminium sulfate</td>
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<tr>
<td>Ferrous sulphate</td>
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<tr>
<td>Copper sulphate</td>
</tr>
</tbody>
</table>

Mordanting method

In this research these three mordanting methods were followed.

a) **Pre - mordanting:** - In this method the wool was first treated with mordant and then dyed under optimized conditions.

b) **Simultaneous –mordanting:** - In this method the wool was dyed with mordant at a same time under optimized conditions.

c) **Post - mordanting:** - In case of postmordanting the fabric was first dyed under optimized conditions and then treated with mordant.

Dye Extraction Method

Dye extraction via aqueous and ethanol extraction method

1. Aqueous extraction method
Ethanol extraction method

In case of ethanol extraction method slightly dry leaves of herbs grind and left in ethanol solution for 24 hour in closed container, than evaporate ethanol and remaining colouring substrate are ready for use as colouring agent.[4,5,6]

Optimized extraction condition

1. Aqueous extraction method
   - Fresh leaves – 200 gpl
   - Boiling time – 50 min
   - Boiling temp. – 90°C
   - M: L: R – 1:5

2. Ethanol extraction method
   - Dry leaves – 25 gpl
   - M: L: R – 1:40

Optimized Dyeing recipe for k.p

1). Aqueous extraction method.
   - Kalanchoe-pinnata:-20% owf
   - Mordant
     (in case of any synthetic mordant such as Alum, Copper Sulphate or Ferrous Sulphate) :20% owf
     (in case of any natural mordant such as Dry Goose Berry, Harda or Orange Peel powders) : 25% owf
   - Mordanting Procedure : Pre, Meta, Post
   - MLR: 1:30
   - pH of the dye bath: 5 - 6.5
   - Temperature of dying: 90 °C
   - Time of dying : 1 hr
     After dyeing , dyed samples washed by using non-ionic soaping at 70 °C for 30minutes.

2) Ethanol extraction method.
   - Kalanchoe-pinnata:-15 % owf
   - Mordant
42%

(in case of any synthetic mordant such as Alum, Copper Sulphate or Ferrous Sulphate) : 15% owf
(in case of any natural mordant such as Dry Goose Berry, Harda or Orange Peel powders) : 20% owf

- **Mordanting Procedure**: Pre, Meta, Post
- **MLR**: 1:30
- **pH of the dye bath**: 6 - 6.5
- **Temperature of dyeing**: 90 °C
- **Time of dyeing**: 45 min

After dyeing, dyed samples washed by using non-ionic soaping at 70 °C for 30 minutes[7,8,9]

**Dye applied method**

- Dyeing was performed on water shaker bath machine as shown in Figure at 65 rpm speed in borosil conical flask.

**Testing methods**

a) **Light fastness**

- This method is intended for determining the resistance of the colour of material to the action of a standard artificial light source. The xenon lamp has an emission wavelength profile close to daylight as per AATCC 16 test standard. [6]
- Exposure time 40 hrs as per AATCC 16 standard.

b) **Wash fastness**:-

The resistance of a material to change in any of its colour characteristics, when subjected to washing is called colour fastness to washing.
After soaping treatment, specimen, rinse twice in cold water and then in running cold water under a tap. Squeeze it and air dry at temperature not exceeding 60°C. The change in colour and staining is evaluated with the help of grey scales as per AATCC 61 test standard.[5]

c) Rubbing fastness

This method is intended for determining the transfer of colour and the behaviour of the surface of a fabric on rubbing with an undyed wool felt using crockmeter tester as shown in .

![Rubbing fastness machine](image)

d) Computer colour matching system (CCM)

Computer colour matching (CCM) is the instrument which measures the colour attributes and predicts the dyeing recipes using the spectrophotometer.

![Computer colour matching system](image)

- AATCC test method 110, this procedure measures the “whiteness of textiles,” by instrumentally measuring and calculating whiteness and tint of fabrics.
- AATCC test method 173, “CMC: calculation of small colour differences for acceptability,” describes how to calculate and use the de cmc colour difference scale.
- AATCC test method 182, “relative colour strength of dyes in solution,” describes determination of colour strength of a dye spectrophotometrically by comparing its transmission measurements to those of a reference dye. [7]

4. RESULT AND DISCUSSION

Result

Dyed wool fabrics with k.pinnata from aqueous extraction via pre, meta and post-mordanting methods.

Dyed wool fabric samples with k.pinnata extracted from aqueous extraction method via pre, meta and post mordanting method as shown in Table.
Table 1: Dyed wool fabrics with k.pinnata via pre, meta and post-mordanting methods.

<table>
<thead>
<tr>
<th>K. Pinnata dye</th>
<th>Pre-mordanting</th>
<th>Meta-mordanting</th>
<th>Post- mordanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without mordant k.p (20%)</td>
<td></td>
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</tr>
<tr>
<td>Dry goose berry powder (25%)</td>
<td></td>
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<tr>
<td>Harda powder (25%)</td>
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<tr>
<td>Orange peel powder (25%)</td>
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<tr>
<td>Copper sulphate (20%)</td>
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<tr>
<td>Aluminium sulphate (20%)</td>
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<tr>
<td>Ferrous sulphate (20%)</td>
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</tbody>
</table>

Dyed wool fabrics with k.pinnata from ethanol extraction via pre, meta and post-mordanting methods[9-14]. Dyed wool fabric samples with k.pinnata extracted from ethanol extraction method via pre, meta and post mordanting method as shown in Table.

<table>
<thead>
<tr>
<th>k.pinnata (extracted via ethanol)</th>
<th>Pre-mordanting</th>
<th>Meta-mordanting</th>
<th>Post- mordanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without mordant (20%)</td>
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<tr>
<td>Dry g.berry powder (20%)</td>
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<tr>
<td>Harda powder (20%)</td>
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</table>
Results of dyed samples in terms of L* a* b* , K/S , wash fastness, light fastness, and rubbing fastness.

<table>
<thead>
<tr>
<th>Mordanting method</th>
<th>Mordant used in Dyeing of woollen samples with kalanchoe-pinnata</th>
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<tbody>
<tr>
<td></td>
<td>Colour coordinates and fastness properties</td>
</tr>
<tr>
<td>Pre</td>
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<td>a</td>
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<td>R F</td>
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</tbody>
</table>

K/S values of dyed woollen fabric by with k.pinnata by various mordants
K/S values of dyed woollen fabric with k.pinnata by various mordants are shown in Figure.

![Figure: k/s values of dyed woollen fabric by with k.pinnata by various mordants](image)

Discussion

1) Very good to excellent wash fastness with pre –mordanting, excellent wash fastness with meta and post –mordanting.

2) Excellent stain washes fastness with wool in pre and post, very good to excellent in meta mordanting method.

3) Very good to excellent stain washes fastness with cotton in pre, meta and post mordanting method.

4) Fair to good light fastness with pre, meta , and post mordanting.
5) Excellent rubbing fastness in dry state with pre and post, Very good to excellent with meta - mordanting method.
6) Good to very good rubbing fastness in wet state with pre, Good to excellent with meta, Very good to excellent with post-mordanting.

7) Pre mordanting: Chemical mordant ferrous sulphate gives maximum K/S values.

8) Meta-mordanting: Natural mordants (harda powder) give maximum K/S values.

9) Post-mordanting: Chemical mordant copper sulphate gives maximum K/S values.

CONCLUSION

- This herb act as good natural dyeing agents for woollen textiles, in term of colour strength and depth, it was determined by mean of colour strength.
- Colour spectrum of dye lies in yellow green region.
- It possesses excellent fastness properties. But natural mordants are also good as well as to chemical mordants with excellent fastness ratings.
- Dry goose berry and harda powder can be used as alternative to synthetic mordant's with good K/S values.
- Good potential for eco-friendly dyeing of woollen textiles with renewable resources.
Treated fabrics were analyses in terms of possess antibacterial activity and obtained very good antimicrobial activity.

And ethanol extracted dye were provided better dyeing results in term of depth, colour strength and fastness properties that’s lies moderate to very good.[24]

FUTURE SCOPE

In this research medicinal herb k pinnata was used for dyeing and provided many different shade of colour with moderate to excellent fastness properties. Its consisting antimicrobial activity in their powder form, therefore in further study their dyed samples may be analyses in terms of possess antibacterial activity in them. [23-25] beside these their antioxidant properties can be also explored for medical textiles.

Further, possible applications of these dyed fabrics are to make bandages, sutures and anti-acne fabric due to its wound healing and anti acne property for medical textile. Ultimately this medicinal herbs can be play lead role in medical textile due to much kind of useful and effective medicinal properties.

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