Application of Natural Dyes on Jute-Cotton Union Fabric

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Abstract: Due to increased awareness of the polluting nature of textile effluents, social pressure is increasing on the textile processing industry. Though air, water and noise pollution are created at every stage of textile production, the most problematic is textile wet processing. The natural dyes on textiles have been just one of the consequences of increased environmental awareness and now a day, there is a worldwide interest for dyeing textiles with flora and fauna. Because of drawbacks of using synthetic fibers people are looking forward to use natural fibers specially cotton. To overcome the shortage of cotton it is blended or mixed with other fibers. One of the possible blends is jute and cotton. In the present study the researcher has tried to extract natural dyes from selected plant materials and applied on Jute-cotton union fabric with eco-friendly mordants. Because both the fibers are natural, eco-friendly and biodegradable with certain similar and inherent characteristics, varied and multi tonal effects with good colour fastness could be produced.

Key words: Natural Dyes, mordants, jute-cotton union fabrics

1. Introduction

Environmental awareness has been increasing all over the globe and has become a great challenge. Hence environmental considerations are now becoming additional important factors during the selection of consumer goods including textiles all over the world. Textile industry is one of the most pollution creating industries in terms of high solid and BOD/COD content in waste water due to use of hazardous chemicals and dyes.

The acute ecological crisis has caused the environmentalists to raise the call: “Go back to the nature, if the world is to be saved from poisoning.” Interest in natural product is growing throughout the world and people are becoming aware of the need for eco-friendly materials to come up and dominate the scene. Hence a consideration of natural dyes is not an innovation; it is a revival with revised technique and scientific technology.

Synthetic fibers, like synthetic dyes are also harmful to environment, even though they have many easy care properties. Because of drawbacks of using synthetic fibers people would like to revert back to natural fibers specially cotton. At the same time cotton is becoming a scarce fiber due to its less production and high demand. To overcome the shortage of cotton it can be blended or mixed with other fibers. One of the possible blends is jute and cotton. Both the fibers are natural, eco-friendly and biodegradable with certain similar and inherent characteristics.

Although dyeing properties of various natural dyes from vegetable, animal and mineral sources on natural and synthetic fibers have been studied by various researchers, the knowledge of the same on jute-cotton union fabric is scanty. Hence this study was undertaken to obtain the following objectives:

- To optimize the parameters for dyeing of Jute-Cotton union fabric.
- To assess the suitable proportion of mordants used for dyeing of Jute-Cotton union fabric.
- To assess the effect of mordanting techniques in dyeing of Jute-Cotton union fabric.
- To evaluate the dyed samples for selected performance qualities.

2. Experimental Procedure

The experimental procedure comprised of the following aspects:

2.1 Selection of raw materials for extraction of dyes: Natural dyes are pigments derived from mineral, animal or plant sources, (Needles 1981). According to Jain and Kannan(1996), “Natural dyes are those dyes which are available in nature in the form of plant bark, roots, flowers, leaves, fruit cover or from insects and produce colour on cotton, wool, silk and other fabrics without any chemical processing of dyes.”

Chavan (1995) classified natural colouring matter into three broad categories, namely:
vegetable, mineral and animal origin. According to Gulrajani (1993), “Natural dyes can be classified on the basis of chemical classes such as Indigoid dyes, Anthraquinone dyes, Alpha-naphthaquinone dyes, Flavanoid dyes, carotenoids etc.”

Wicken (1982), classified natural dyes as: Substantive dyes (require no pretreatments to the fabric) and adjective dyes (needs mordants). Hummel (1993), classified the colouring matter into monogenetic and polygenetic. Monogenetic dyes produce only one colour irrespective of the mordants. Polygenetic colours produce different colours with different mordants. Following raw materials were selected for the extraction of natural dyes.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Part Used</th>
<th>Colour Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango</td>
<td>Mangifera indica Linn</td>
<td>Anacardiaceae</td>
<td>Bark</td>
<td>Yellow</td>
</tr>
<tr>
<td>2.</td>
<td>Babul</td>
<td>Acacia Arabica</td>
<td>Leguminasae</td>
<td>Bark</td>
<td>Brown</td>
</tr>
<tr>
<td>3.</td>
<td>Madder</td>
<td>Rubia cordifolia</td>
<td>Rubiaceae</td>
<td>Bark</td>
<td>Red</td>
</tr>
</tbody>
</table>

2.2 Extraction of dyes:

The raw materials were dried, powdered, soaked in to water and then boiled at 100°C for 60 minutes. The solution is then filtered and dried using spray dryer. The powdered dye was used for the optimization of dyeing parameters.

2.3 Selection of mordants and Mordanting Techniques:

According to Bhattachharya (1989), although natural dyes are derived from nature, the metallic mordants used for improved fastness and better fixation on textiles are not always ecofriendly. Reddiya (1989), stated that mordant is the life for the vegetable colours except Indigo. Without a mordant no colour can be obtained in natural dyes.

According to Gulrajani (1993), “The majority of natural dyes need a chemical in the form of a metal salt to create an affinity between the fiber and the pigment.” He further adds that there are three types of mordants namely:

- Metal salts or metallic mordants
- Tannins and tannic acid
- Oil and oil mordants

According to Chavan (1995), there are several mordants but the five most effective ones are: potassium aluminum sulphate (alum), copper sulphate (copper), potassium dichromate(chrome), ferrous sulphate (iron) and stannous chloride(tin). Out of these copper, chrome and tin are red listed. Hence alum, iron, tartaric acid and myrobalan (Terminalia chebula) a natural mordant were selected for the study.

2.4 Selection of fabric:

Jute-cotton union fabric was selected for the experiments. Both jute and cotton fibers are natural cellulosic fibers with some similar and some inherent characteristics. Union fabrics are the fabrics where in the fiber content of warp is different from that of weft. Union fabrics are the materials consisting of mixtures of two or more different fibers either spun, woven, knitted or felted together. (Horsfall and Lawrie). Cheetham (1996), state that “union fabrics are usually made from two or more yarns each manufactured from different fibers.”

The major objectives of blending or mixing of jute with other fibers natural as well as synthetics are to improve the functional properties of yarns as well as fabrics i.e. to overcome certain inherent deficiencies of jute fiber and to impart additional favourable technical properties and to improve the process performance of jute fabric. Chaudhary et.al (1999).

Shukla (1997), state that, through the colouration of union fabrics, many colour effects can be obtained depending upon the fibers and their pattern used in union fabrics i.e.by one dyeing of fabric multitional effect can be gained. Jute cotton union fabric is best combination in order to get pleasing shadow effect.

Grey Jute-cotton union fabric was prepared by scouring and bleaching in order to improve absorbency, even dyeing and brightness of colour.

2.5 Mordanting and dyeing of the fabric samples:

Mordanting was carried out in three stages such as: pre mordanting, simultaneous mordanting and post mordanting. Five concentrations (4,8,12,16 & 20% alum,1,2,3,4 & 5% FeSO4 and 2,3,4,5 & 6% myrobalan) of each selected mordants were taken in beakers and water was added keeping the M:L ratio 1:30 and jute-cotton union fabric was
then mordanted at 90°C for 45 minutes. Alum and FeSO₄ mordants were also used in combination with Tartaric Acid. Fabric samples were soaked in water for 15 minutes in order to get even mordanting.

Dyeing of the sample fabrics was carried out keeping the dye concentration constant (i.e. 5% owf) and M:L ratio 1:30. Dye powder was dissolved in water in different beakers and the temperature was raised to 100°C. Dyeing was carried out for 45 minutes in three stages such as: before mordanting, after mordanting and simultaneously.

2.6 Evaluation of dyed samples:

2.6.1 Visual Evaluation: Dyed samples were visually evaluated by a panel of 25 judges, studying in postgraduate classes (Textiles & Clothing). The opinion of the judges regarding general appearance, evenness in dyeing, depth of shade, brightness of colour and lustre were consolidated and analyzed.

2.6.2 Colour Measurement: Colour depends on the spectral reflectance character of the object and this reflectance depends on the chemical composition of the dye and texture of the surface. Colour is measured by two types of instruments:

- **Tristimulus colorimeter** – uses filters and measure colour in tristimulus values X, Y, Z or L,a,b values.
- **Spectrophotometer** - generates wavelength by wavelength analysis of light reflecting properties of the object. It measures the reflectance or transmission values of dyed samples and passes the information to the computer for further processing.

2.7 Selection of optimized parameters for mordanting and dyeing:

The optimized parameters were selected on the basis of the results of visual evaluation and colour measurement (table 2).

2.8 Dyeing of fabric with optimized parameters:

One meter of jute-cotton union fabric was mordanted with each dye by using the optimized parameters. The parameters for dyeing was kept constant which includes dye concentration (5%), M:L ratio (1:30), dyeing time (45 minutes) and temperature (90°C).

2.9 Colour fastness test:

Colour fastness of fabrics dyed with optimized parameters was tested for sunlight, washing, crocking, pressing and artificial perspiration, following the test procedures given by AATCC.

3. Results and Discussion

The findings of the study are as follows:

- The optimum mordant concentration and appropriate mordanting techniques are as follows:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Dyes</th>
<th>Mordants</th>
<th>Mordant Concentration (in % owf)</th>
<th>Mordanting Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango</td>
<td>Alum</td>
<td>16</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alum + Tartaric acid</td>
<td>16+1</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄</td>
<td>1</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄ + Tartaric acid</td>
<td>5+2</td>
<td>POM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Myrobalan</td>
<td>4</td>
<td>PRM</td>
</tr>
<tr>
<td>2.</td>
<td>Babul</td>
<td>Alum</td>
<td>4</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alum + Tartaric acid</td>
<td>4+1</td>
<td>POM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄</td>
<td>4</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄ + Tartaric acid</td>
<td>5+2</td>
<td>POM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Myrobalan</td>
<td>5</td>
<td>POM</td>
</tr>
<tr>
<td>3.</td>
<td>Madder</td>
<td>Alum</td>
<td>16</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alum + Tartaric acid</td>
<td>16+1</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄</td>
<td>3</td>
<td>PRM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FeSO₄ + Tartaric acid</td>
<td>4+2</td>
<td>POM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Myrobalan</td>
<td>3</td>
<td>POM</td>
</tr>
</tbody>
</table>

PRM=Pre mordanting,  POM=Post mordanting

- **Evaluation of K/S values:** The K/S value was evaluated by computer colour matching system on Spectrophotometer using the following equation:

\[ K/S = \frac{(1-R)^2}{2R} \]

Where K is the coefficient of absorption, S is the coefficient of scattering and R is the reflectance. The L*a*b* values and Reflectance Values of the dyed samples were also measured on Spectrophotometer.
• An addition of tartaric acid to the alum and \( \text{FeSO}_4 \) enhanced the brightness and luster of the samples but reduced the depth of shade.

• The samples dyed with optimized parameters showed good results regarding general appearance, evenness in dyeing, depth of shades, brightness of colours and luster, irrespective of the dyes.

• \( L^*a^*b^* \) values (tristimulus values) of the colour measurement showed that the samples dyed with optimized parameters produced interesting shades irrespective of the dyes. It was also noticed that addition of tartaric acid gave brighter and lighter shades.

• The reflectance values of colour measurement indicated different shade effects with respect to the type of mordants. The samples mordanted with alum gave lighter shades, samples mordanted with \( \text{FeSO}_4 \) gave darker shades whereas the sample mordanted with myrobalan produced medium depth of shades.

• Almost all the samples showed very good colour fastness to sunlight irrespective of the dyes, mordants, mordant concentration and mordanting techniques. A few very samples showed moderate colour fastness to sunlight.

• The result of colour fastness to washing was fair. The colour change was darker than the original; it may be because of lignin present in jute yarns. Addition of tartaric acid showed good colour fastness in comparison to the samples mordanted with only alum and \( \text{FeSO}_4 \).

• All the samples showed moderate to very good colour fastness to dry and wet crocking irrespective of the dyes, mordants and mordanting techniques.

• Colour fastness to dry and wet pressing also showed moderate to excellent results with respect to colour change and staining.

• All the samples showed good colour fastness to acidic and alkaline artificial perspiration with regard to colour change and staining.

4. Conclusion:
It can be concluded from the above study that optimized parameters for dyeing and mordanting was proved to be optimum as it produced even, darker, brighter and faster colour on jute-cotton union fabric. These parameters can also be used for producing multi tonal effect on blend and union fabrics.

5. References: