Colour fastness of walnut dye on cotton

Anshu Sharma* and Ekta Grover

1Department of Textiles and Apparel Designing, College of Home Science
Central Agricultural University, Sangsangre, West Garo Hills, Tura-794101, Meghalaya, India
2Department of Clothing and Textiles, College of Home Science, Allahabad Agricultural Institute
Naini-Allahabad-211 007, Uttar Pradesh, India

Received 26 March 2010; Accepted 7 February 2011

The term natural dye, cover all the dyes derived from natural resources such as plants, insects and animals. The colour fastness of a coloured textile is therefore defined as its resistance to changes when subjected to a particular set of conditions. Walnut (Juglans regia Linn.) is a large deciduous, monoecious tree, mostly grown in un-reclaimed and poor soil. In the present study an attempt has been made to dye cotton yarns with walnut bark dye and to test the colour fastness of dyed material against light, crocking, perspiration and washing. It has been found that walnut dye can be successfully used for dyeing of cotton. This dye may be useful in imparting number of fast shades on cotton using common mordants like Alum, FeSO₄, CuSO₄ and Chrome with good fastness properties. Thus, this dye may find its use in dyeing of cotton fabrics.

Keywords: Colour fastness, Cotton fabrics, Crocking, Juglans regia, Mordants, Natural dye, Walnut.

IPC code; Int. cl. (2011.01) — D06B 1/00

Introduction

The term natural dye, cover all the dyes derived from natural resources such as plants, insects and animals. Natural dyes are mostly indirect or non substantive but can be used with mordants. Natural dyes have been the men’s colouring material from the time immemorial.

It is a fundamental requirement that coloured textiles should withstand the conditions encountered during processing, coloration and their subsequent use in life. When a colour textile is subjected to particular conditions, e.g. during washing one or more of several things may happen. There may be alteration in hue, value or intensity. In certain cases, there may be alteration in all three. Further, under certain conditions, e.g. during washing adjacent white material may become coloured and coloured material may acquire new colour due to the transfer of dye from the original dyed material, which is generally known as staining.

The colour fastness of a coloured textile is defined as its resistance to changes when subjected to a particular set of conditions. The colour changes, which occur in dyed or printed textiles when subjected to a particular agency, can be due to two reasons. The first is that the dye itself is getting decomposed inside the fibre thereby getting converted into colourless or differently coloured compound(s); secondly it can detach from the substrate. Atmospheric humidity greatly affects the rate of fading of certain dyes; high humidity usually accelerates fading.

Natural dyes are excellent for their soft and lustrous pastel colours. They give harmonizing colours. Sometimes it is possible to obtain some brilliant colours from natural dyes using mordants. Dyes of natural origin are great for colour experimentation as any variation in the concentration of dye, mordant, types of water, soil and climate give variation in colours.

In recent years natural dyes are again getting importance due to harmful effect caused by synthetic dyes during their production and use. They are compatible with the nature due to their non-hazardous nature and produce colours that are gentle, soft, and subtle and create a restful effect. Thus, it is of immense importance to explore the sources of natural dyes.

Walnut (Juglans regia Linn.) is a large deciduous, monoecious tree, mostly grown in un-reclaimed and poor soil (Plate 1a). The trees are grown at the altitude of 900-3,300 m. The various parts of walnut tree are used for dyeing and tanning.

*Correspondent author:
E-mail: anshusharma_2002@rediffmail.com
In the present study an attempt has been made to dye cotton yarns with walnut bark dye and to test the colour fastness of dyed material against light, crocking, perspiration and washing.

**Materials and Methods**

**Selection of yarn and walnut bark**

Cotton yarns of 40s count were used for the study. Prior to dyeing, the cotton yarns were bleached to make the yarns whiter. The solution for bleaching was prepared by adding 3% H$_2$O$_2$ and 1-2% (owf) of sodium silicate in 100 ml of water, maintaining the material to liquor ratio 1:50. The cotton yarns were washed several times and then dried. Walnut bark were collected from wild walnut plant from Almora (a city in the Kumaon region of Uttarakhand) and used for dyeing of cotton (Plate 1b). Collected walnut bark were dried in shade and powdered by using the electric grinder (Plate 1c).

**Selection of mordants**

One natural mordant Myrobalan (Harad) and four synthetic mordants, viz. Potassium aluminum sulphate (Alum), Potassium dichromate (Chrome), Copper sulphate and Ferrous sulphate were selected for the study. For each synthetic mordant, three concentrations were taken. These were 5, 10 and 15% for alum; 2, 4 and 6% for copper sulphate; 1, 3 and 5% for ferrous sulphate; and 1, 1.5 and 2% for chrome mordant. The concentrations used for myrobalan were 10, 15, 20, 25 and 30%.

**Dyeing and mordanting**

Three methods of mordanting namely pre mordanting, simultaneous mordanting and post mordanting were adopted for the study.

The dyeing recipe used for dyeing of yarns was as follows: dye concentration, 5%; extraction medium, alkaline (conc.1%); extraction time, 90 min; and dyeing time, 45 min.

**Colour fastness tests**

Each dyed samples were tested for colour fastness to light, washing, crocking and perspiration.

**Colour fastness to light**

The dyed samples of 6 cm length and 1 cm width size were mounted on a cardboard frame. This cardboard frame was covered with black sheet in such a manner that all the samples were half exposed and half covered. The prepared specimens along with eight standard patterns of blue wool cloth of various

---

Plate 1—Walnut: a-tree, b-bark, c-bark powder
light fastness rating were placed inside the exposure rack. The specimens were exposed to sunlight for 6 h/day for 12 days. After 72 h of exposure, the samples were graded for colour fastness

**Colour fastness to washing**

Each dyed samples were placed between a piece of un-dyed wool and cotton fabric both measuring 10 cm length and 4 cm width. These three fabrics were stitched together to form composite specimens. The washing solution was prepared with 5 ml liquid soap/l of water. Laundrometer was used for the tests. The samples were washed in the laundrometer for 45 minutes and then colour change and staining on the adjacent fabrics were graded using grey scale

**Colour fastness to crocking**

Paramount Crockmeter was used for testing rubbing fastness. The test specimens of 25 x 5 cm size were prepared from dyed yarns and rubbed against standard crocking cloth provided with the equipment. Each sample was given ten strokes and the colour change and staining on the white cloth were graded.

**Colour fastness to perspiration**

Paramount perspirometer was used for testing colour fastness against perspiration. Samples were made into composite specimens by placing between two un-dyed cotton fabrics of 10 x 4 cm size. Alkaline solution was prepared by dissolving 3 g of NaCl/l and adjusting the pH to 7.2 with the addition of sodium carbonate. Acidic solution was prepared by dissolving 2.65 g of NaCl and 0.75 g of urea/l and adjusting the pH of the solution to 5.6 with the addition of acetic acid. The specimens were immersed in the acidic and alkaline solution for 30 minutes.

The treated samples were then pressed between the plates of the perspirometer and all the samples along with the perspirometer were kept in the oven at 37°C for 4 hours. Finally samples were graded by using grey scale for staining and colour change.

**Results and Discussion**

Colour fastness grades of cotton samples dyed with walnut dye and alum as a mordant

It is evident from Table 1 that after washing there was slightly to negligible change of colour in all samples. Best results were obtained in case of pre mordanting method. In this method no staining was observed after washing. Negligible to slightly staining was observed in all samples in all three methods of mordanting on both cotton and wool fibres after washing.

Very good to good light fastness rating was observed in all cotton samples dyed with walnut dye using alum as a mordant, and with three methods of mordanting i.e pre mordanting, simultaneous mordanting and post mordanting.

In both dry and wet crocking methods negligible to slight change of colour was observed in all three methods of mordanting using three concentrations of alum i.e. 5, 10 and 15%. Slightly to negligible staining was observed in all samples after crocking except in case of wet crocking of post mordanted samples with alum (15%). In this case noticeable staining was observed.

In both acidic and alkaline perspiration negligible to slight staining and colour change was observed in all samples, mordanted with three methods of mordanting i.e. pre, simultaneous and post mordanting and using three concentrations of mordant alum i.e. 5, 10 and 15%, except in case of pre and simultaneous

<table>
<thead>
<tr>
<th>Method of Mordanting</th>
<th>Conc. of mordant g/100g of material (%)</th>
<th>Washing fastness</th>
<th>Light fastness</th>
<th>Rubbing fastness</th>
<th>Perspiration fastness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Colour change</td>
<td>Wool</td>
<td>Cotton</td>
<td>CC</td>
</tr>
<tr>
<td>Pre mordanting</td>
<td>5</td>
<td>5</td>
<td>4/5</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>4/5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>4/5</td>
<td>6</td>
</tr>
<tr>
<td>Simultaneous mordanting</td>
<td>5</td>
<td>4/5</td>
<td>4/5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4/5</td>
<td>4/5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>4</td>
<td>4/5</td>
<td>4/5</td>
<td>7</td>
</tr>
<tr>
<td>Post mordanting</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>4/5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4</td>
<td>4/5</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

*Conc. of dye material-5 g/g of material, extraction time-90 min, dyeing time-45 min, myrobalan conc.-20%

CC-Colour change, CS-Colour staining
mordanting methods using 5% concentration of alum. In these cases samples showed noticeable colour change.

**Colour fastness grades of cotton samples dyed with walnut dye and copper sulphate as a mordant**

Using copper sulphate as a mordant and walnut as a dye, cotton samples showed slightly to negligible colour change after washing except 2 and 4% concentrations of copper sulphate in pre mordanting method. On cotton slightly to negligible staining was observed in all three methods of mordanting with 2, 4 and 6% concentration of copper sulphate, except in case of pre mordanting with 2 and 4% concentrations of copper sulphate (Table 2).

Excellent light fastness rating was observed in all cotton samples dyed with walnut dye using copper sulphate as a mordant, and with two methods of mordanting i.e. pre mordanting, and post mordanting. In case of simultaneous mordanting very good colour fastness against light was observed. Excellent to outstanding colour fastness after crocking was observed in all samples. No change of colour was observed in dry crocking method while slightly to negligible change of colour was in wet crocking method. In simultaneous and post mordanting methods, in all three concentrations i.e. 2, 4 and 6% concentrations slightly to negligible staining in dry crocking was observed. In pre mordanting method noticeable staining was observed in wet crocking method in all three concentration of copper sulphate i.e. 2, 4, and 6%. Slightly to negligible colour change and colour staining was observed in both acidic and alkaline perspiration in all methods of mordanting except in case of pre mordanting method using 2% concentration of copper sulphate.

**Colour fastness grades of cotton samples dyed with walnut dye and ferrous sulphate as a mordant**

As shown in Table 3 noticeable to negligible colour change was observed in all samples using ferrous sulphate as a mordant. All sample showed slightly to

<table>
<thead>
<tr>
<th>Method of Mordanting</th>
<th>Conc. of mordant g/100g of material (%)</th>
<th>Washing fastness</th>
<th>Light fastness</th>
<th>Rubbing fastness</th>
<th>Perspiration fastness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Colour change</td>
<td>Staining</td>
<td>Wool</td>
<td>Cotton</td>
</tr>
<tr>
<td>Pre mordanting</td>
<td></td>
<td>Colour change</td>
<td>Staining</td>
<td>Wool</td>
<td>Cotton</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3/4</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4/4</td>
<td>4</td>
<td>3</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>3/4</td>
<td>4</td>
<td>3/4</td>
<td>8</td>
<td>4/5</td>
</tr>
<tr>
<td>Simultaneous mordanting</td>
<td></td>
<td>4</td>
<td>4/5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>4/5</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>4/5</td>
<td>4/5</td>
<td>4</td>
<td>7</td>
<td>4/5</td>
</tr>
<tr>
<td>Post mordanting</td>
<td></td>
<td>4/5</td>
<td>4/5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>4/5</td>
<td>4/5</td>
<td>4/5</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4/5</td>
<td>4/5</td>
<td>4/5</td>
<td>8</td>
<td>4/5</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>4/5</td>
<td>4/5</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

*Conc. of dye material-5 g/g of material, extraction time-90 min, dyeing time-45 min, myrobalan conc.-20%
CC-Colour change, CS-Colour staining*
negligible staining on both wool and cotton fibres, except 3 and 5% concentrations of ferrous sulphate in
pre mordanting method. Excellent light fastness rating
was observed in pre and post mordanting methods and
very good light fastness was observed in simultaneous
mordanting method. In both dry and wet crocking
methods negligible to slight staining was observed in
all samples mordanted with ferrous sulphate using
three methods of mordanting. Slight staining was
observed in dry crocking method and noticeable to
slight staining was observed in wet crocking method.

Alkaline perspiration showed slight to noticeable
colour change. Maximum colour change was
observed in simultaneous mordanting method. Slight
colour change was observed in alkaline perspiration
of pre and post mordanting methods. In acidic
perspiration slightly to negligible colour change was
observed in pre and post mordanting methods and
noticeable colour change was observed in simultaneous
mordanting method. No to slight staining was observed in both acidic and alkaline
perspiration in pre and post mordanting methods and
noticeable staining was shown by samples dyed with simultaneous method of mordanting.

Colour fastness grades of cotton samples dyed with walnut
dye and chrome as a mordant

It has been observed (Table 4) that slightly to
negligible colour change occur in all samples dyed
with walnut dye using chrome using chrome as a
mordant after washing. Slight to negligible staining
was observed after washing on wool and cotton
fabrics. Excellent to outstanding lightfastness rating
was observed in all samples dyed with walnut dye and
mordanted with three methods of mordanting that is
pre, simultaneously and post mordanting with three
concentration of mordant i.e. 1, 1.5 and 2%.

In both dry and wet crocking method slightly to
negligible change of colour was observed in all
sample. Slight to negligible staining occur in both dry
and wet crocking methods, except in wet crocking of
1.5% in pre and simultaneous mordanting methods. In
these cases noticeable staining was observed. Acidic
perspiration showed noticeable to negligible colour
change, best result was obtained in case of post
mordanting. In post mordanting method slightly to
negligible colour change was observed in all samples.
In alkaline perspiration noticeable to negligible colour
change was observed. Post mordanting showed best
results in this case also. Noticeable to negligible
staining was observed in both acidic and alkaline
perspiration solutions. Best result was obtained in
post-mordanting method, in this case slightly to no
staining was observed.

Conclusion
Walnut dye obtained from bark, is not used for any
good purpose, though its processing involves no toxic
chemicals. Therefore, it can be successfully used for
dyeing of cotton to obtain number of fast shades using
common mordants like Alum, FeSO₄, CuSO₄ and
Chrome with good fastness properties.

References

