Dyeing of Eri silk with natural dyes in presence of natural mordants

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Received 14 August 2017, revised 4 December 2017

Camellia sinensis (L.) Kuntze (tea leaves), Allium cepa L. (onion peel), Laccifer lacca Kerr (lac insect) and iron ore are used as natural dyes in presence of different natural mordanting agents for dyeing of Eri silk yarns. These natural mordanting agents are available in plenty at Meghalaya and use of these improves the colour fastness to washing and light considerably, which will motivate the handloom weavers to use these dyes and mordants for producing fabric with eco-friendly character.

Keywords: Eri silk, Mordant, Sohtung leaves, Sohkhu leaves.

IPC Int. Cl.8: D01B 7/04, D01B 7/02, D01B 7/06, C09B 65/00, D06P 1/36, C09B, C09B 61/00

The art of dyeing with natural sources is one of the oldest known to man and India has a prosperous heritage for decorating textiles through dyeing or printing using natural dyes. During 15th to 19th centuries, black printed resist dyed textiles from Gujarat and Deccan adored Europeans and their homes. The very earliest dyes were discovered by accident using berries and fruits, but with the experimentation and gradual scientific development the process of dyeing textiles with natural colours has resulted in a highly refined art ¹⁻⁹. During 19th century synthetic dye was discovered in the west but later it was found that some of those have hazardous effect on human skin and lungs. Therefore, environmentalist started searching the substitute of synthetic dyes and in recent days the inherent advantages of natural dyes resulted in the revival and use of those colourants on textile substrates.

Most of the natural dyes require mordant to create an affinity between the dye and fibre. Among the metal and its oxides, potassium dichromate, stannous chloride, stannic chloride, ferrous sulphate, cupric sulphate and aluminum sulphate are most commonly used as mordants. Metallic ions of mordants act as an electron acceptors to form co-ordinate bonds with the dye molecule, making them insoluble in water. But the mordants containing red listed transition metals such as copper, cobalt, chromium, lead are not considered as environment friendly. Envisaging this drawback, the present article depicts the use of widely available natural mordants, viz. Terminalia chebula Retz. (Sohtung leaves), Tsuga canadensis (L.) Carrière (Snep sohmylleng), Oroxylum indicum (L.) Kurz (Waitlam pyrthat) and Baccaurea ramiflora Lour. (Sohkhu leaves) in Meghalaya on eri silk yarn in order to achieve good fastness properties without damaging the environment¹⁰⁻¹³.

Eri is a multivoltine silk spun from open ended cocoons. As the Eri cocoons (Fig. 1) are open mouthed and not composed of continuous filaments, hence reeling is not possible. The word Eri is derived from Sanskrit nomenclature ‘Eranda’ and it is also popularly termed as Endi or Errandi. Eri silk is the product of the domesticated silk worm, Philosamia ricini and it is the only domesticated non-mulberry variety. Castor leaf is the main food of Eri worms. Eri culture is a house hold activity practiced mainly for protein rich pupae, a delicacy for the tribal people of North-eastern part of India.

Materials

Eri silk

2/40s Ne Eri silk yarn purchased from the local market of Guwahati, Assam was used in the present study.

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**Natural dyes**

Camellia sinensis (tea leaves), Allium cepa L. (onion peel), Laccifer lacca Kerr (lac) collected locally from the Khasi hills of Ri-Bhoi district of Meghalaya and were used as natural dyes for dyeing purpose.

**Chemicals**

Laboratory reagent (LR) grade sodium carbonate obtained from M/s Loba Chemie Pvt. Ltd., Mumbai, India, and anionic wetting agent (T R Oil, i.e., sulphonated castor oil), non-ionic detergent of commercial grade obtained from local market was used in this study.

**Methodology**

**Degumming of silk**

Degumming of silk yarn was performed in a solution containing sodium carbonate or soda ash (0.5 g/L) and non ionic detergent (2 g/L) at 50 °C for 30 min keeping the material to liquor ratio at 1:30. The degummed yarn was thoroughly washed with cold water and dried at room temperature prior to mordanting and dyeing.

**Extraction of natural dyes**

Aqueous solution of all the natural dyes was prepared by adding 200 g of each natural source to 1 L of water. The mixture was stirred, heated and kept at boiling point for 60 min in a thermostat controlled beaker dyeing machine, allowed to stand for 15 min and finally filtered. Such filtrate was used for dyeing purpose after diluting it to the specified level, if required.

**Mordanting and dyeing**

Hundred gram of Sohtung leaves was boiled in 1 L of water for 45 min and this extract was used as mordant. Mordanting was done at 80 °C for 30 min and left for another 30 min in the mordant solution. This mordanted material was then rinsed, squeezed and dried at room temperature followed by dyeing.

For achieving better colour fastness properties in black shade the silk yarn was first pre-mordanted with Sohtung leaves (Fig. 2) (10 % o.w.f) followed by application of iron ore (Fig. 3). This yarn was then further post-mordanted in presence of Snep sohmylleng (Fig. 4) (10 % o.w.f) and Waitlam pyrthat (Fig. 5) (5 % o.w.f). In order to achieve dark chocolate shade with very good fastness properties, only pre mordanting was carried out with Snep Sohmylleng, whereas in case of achieving magenta pink colour and olive green colour the Eri silk yarns were pre-mordanted with Sohku leaves (Fig. 6) (3 % o.w.f) followed by dyeing with lac and onion peel (Fig. 7), respectively.

The dyeing process was performed at 80-85 °C temperature for one hour, followed by soaping with non-ionic detergent and drying at room temperature.

For black and dark chocolate shade post treatment with ash water and for olive green shade post treatment with lemon water was carried out in order to achieve better fixation of color.

**Assessment of colour fastness to washing**

Colourfastness to wash of dyed cotton yarn was assessed in a launder-o-meter in accordance with a
Assessment of colour fastness to light
Colourfastness to light was assessed on a Mercury Bulb Tungsten Filament (MBTF) light fastness tester following a method prescribed in IS: 2454-1985.

Assessment of colour fastness to rubbing
This was determined employing a Crockmeter following the method as prescribed in IS: 766-1988.

Results and discussion
Suitability of natural dyes and natural mordants
Most of the colour used in Khasi Hills of Ri Bhoi district of Meghalaya is of natural origin, but it is a pity that very little attention has been given to the study of plants as a source of dyes and colorants. The most difficult task for the application of the dye is the non-availability of chemical substances as fixing agents. The locally available natural mordants are used to improve the fastness properties. During the study it was observed that for obtaining black shade and dark chocolate shade with iron ore and tea leaves the fixation can be achieved under alkaline condition with ash water and for olive green shade lemon water was used under acidic condition.

There has been a large demand for Eri silk within the society of Meghalaya that cannot be fulfilled by the local people so the raw material is purchased from the neighboring state of Assam and this bring about a deficit to the society as the price of the material is quite high.

This research was done to exploit the best possible combination of natural mordants, viz. Sohtung leaves and Sohkhlu leaves with natural dyes in order to achieve improved result in colour fastness, durability, eco-friendliness and ease of application.

Assessment of colorfastness properties
Data for colour fastness to light, wash and rubbing of Eri silk yarn dyed with natural dyes as specified in presence of different combination of natural mordants as described earlier are reported in Table 1. From the table it is observed that overall colour fastness of the natural dyes in presence of natural mordants found good to very good, except for black shade with iron ore; in which the light fastness was slightly less as compared to other dyes. It may be due to the fact that the iron ore is not forming metal-complex with the mordants and hence shows poor light fastness. All the natural mordants are having good complex forming ability that can hold two or more suitable dye molecules together to form insoluble large complex, which enhanced the light fastness of the dyed substrates. Such complexation of the coloured component within the fibre structure leads to the polymerization of the dye molecules and is responsible for improvement in light fastness of the dyed substrates. The chromophore in those cases may be protected from photochemical oxidation after dyeing in presence of natural mordants.

The rating of colour fastness to washing of Eri yarn dyed with specified natural dye in presence of natural mordants commonly produces good colour fastness to washing properties. Improvement in such colour fastness to washing may be the consequence of formation of insoluble large complex formed by the colouring component present in the dyes and the natural mordants.

A common good rubbing fastness rating of the specified natural dyes when applied on Eri silk yarns indicates very little deposition of the colourants on the surface of the yarns at the end of the dyeing process.

Traditional significance and recommendations
The plants from which vegetable dyes are extracted are largely wild growing species, although some can also be cultivated. Hence, there is need to study the plant species which can be commercially cultivated in order to ensure the constant supply of raw materials and ensure envisaging the natural biodiversity in North eastern part of India.

Dyeing with natural sources is practiced by very few elderly people and hence the process must be well

<table>
<thead>
<tr>
<th>S No.</th>
<th>Natural dye used</th>
<th>Mordants used</th>
<th>Colour fastness to washing</th>
<th>Colour fastness to rubbing</th>
<th>Colour fastness to light</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Change in Colour</td>
<td>Staining on adjacent fabric</td>
<td>Dry</td>
</tr>
<tr>
<td>1</td>
<td>Iron ore</td>
<td>Sohtung leaves and Waitlam pyrthat</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Tea leaves</td>
<td>Snep sohmylleng</td>
<td>4</td>
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<tr>
<td>3</td>
<td>Lac</td>
<td>Sohkhlu leaves</td>
<td>4</td>
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<td>4</td>
<td>Onion peel</td>
<td>Sohkhlu leaves</td>
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documented in order to preserve this traditional practice before it vanishes. So, it is a challenge to document the process sequence and to find out a standardize recipe with natural dyes in order to popularize it amongst the handloom weavers. A study on eco-friendly natural mordanting agents in order to improve colourfastness to light and washing is very much essential in order to increase the acceptability of natural dye in the market.

Hence, there is plenty of scope for rapid development in terms of agricultural production, processing and application technique of this colour on textile. If this technology is to be used for generating revenue, employment and for creating a strong base for renewable resources for the dye industry a comprehensive training programme is required on the traditional use of this heritage colour in a more scientific manner for creating exquisite handloom articles without compromising quality and aesthetic appeal.

A greater emphasis to promote the use and production of natural dyes could make a valuable contribution to environmental sustainability and for this purpose more young personnel should be trained in a scientific way and encourage them by providing some employment oriented scheme in rural areas.

Conclusion

In recent years eco-friendly natural dye has made a serious impact as fashion designers have rediscovered the beauty in natural dyes due to its known advantages as well as eco-friendly nature. But the use of natural dyes is restricted to few people. The handloom clusters in the North eastern regions are wide spread as well as popular. Handloom itself is an eco-friendly process of manufacturing fabrics and hence use of natural dyes in presence of different natural mordanting agents really completes sustainable textiles.

References