ISSN: 2278-5213

RESEARCH ARTICLE

Value addition of Eri silk yarns with *Datura stramonium*–A natural colourant

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Abstract

Dye obtained from leaves of *Datura stramonium* applied on bleached eri silk yarns has been subjected to pre, post and simultaneous mordanting with selected mordants namely alum, copper sulphate, ferrous sulphate and stannous chloride. Various optimized conditions were recorded such as wavelength (545 nm), 75 min extraction time, alkali concentration of 2.5%/100 g of yarn, 45 min dyeing time, 5% dye material concentration, mordant concentration of 6% alum, 3% copper sulphate, 2% ferrous sulphate and 2% stannous chloride and 30 min mordanting time for all mordants. Colourfastness to washing, sunlight, perspiration, pressing was also studied on four different colour shades. Physical properties of raw as well as dyed yarns were also evaluated in this study.

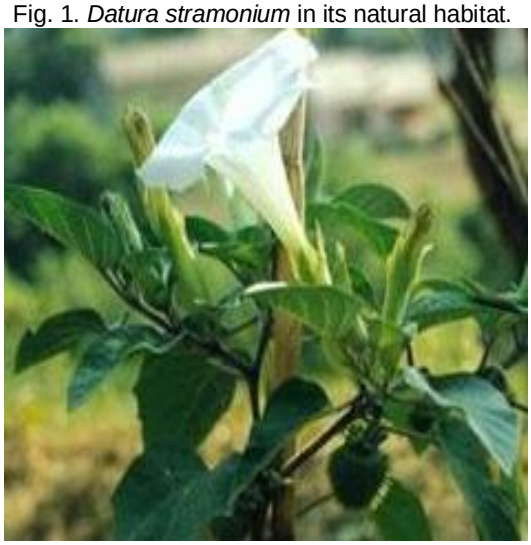
Keywords: Dye, *Datura stramonium*, mordants, extraction time, dyeing time, colourfastness.

Introduction

Tradition of dyeing and printing with natural dyes in India dated back to prehistoric ages. Its early origin and development through ages can be traced through various literary sources like Vedas, Upanishad, Ramayana, Mahabharata and Kautilya's Arthashastra. On the basis of archaeological evidences i.e., fragment of cotton dyed with madder found in Mohenjadaro and Harappa (Indus valley civilization). Till 18th century, India was the largest exporter of textiles, obviously hand woven and processing with natural dyes in the world (Paul, 2011). Due to the health hazards and environmental problems associated with the use of synthetic dyes, people have realized the utility of natural dyes and moved toward it with scientific background. Thus, the interest in natural dyes has been revived (Khan *et al.*, 2004).

Dyeing of silk with natural dyestuffs is a traditional craft of India. In early days, silk was dyed with vegetables dyes which were extracted from roots, stems, stalks, foliage, barks and seeds of different plants (Das, 1992; Choudhury, 1992). Equisetic qualities like natural sheen, inherent affinity for dyes and vibrant colour, high absorbency made silk an important fibre for dyeing. In the dyeing of silk fibre, the most essential requirement is the fastness of the dyes, as these fabrics are not laundered or ironed as frequently as other fabrics. The selection of dye is therefore very important as dyeing increase the value of silk (Choudhury, 1984). Dyeing of fabrics takes place in three stages. The first is the attachment of the dye to the surface of the fibre; the second is the penetration of the dye to the fibre and last is the fixation of the dye. In order to achieve these three phases the fibre must swell to allow the dye to be absorbed and thus is carried out by the water in the dye bath and by raising the temperature. The dye penetration in the fibre is then fixed by the addition of salts and acids.

Fig. 1. *Datura stramonium* in its natural habitat.



Absorption is then depends upon the role of water, action of electrolyte, effect of temperature and pH value. Datura is considered to have various medicinal properties and the atropine extracted from datura is used for ayurvedic medicines (Gohain, 2012). Colouring of eri silk with datura dye enhances the quality of fabric as well as its aesthetic value. It can act as herbal fabrics to cure pain, skin problems etc. Colouring also makes the natural grey or beige colour eri silk more attractive. Eri silk does not create any environmental problem at the stage of production or use and maintain ecological balance. Combination of datura dye with eri silk will produce product which are better biodegradable and generally high compatible over the environment. Dyeing adds a natural value to the eri silk by making it attractive and more scope for making diversified products so as to, popularizing its demand in the society.

Considering the importance of marketability, eco-friendly dyeing and vast potentiality of eri silk, it was decided to carry out an investigation with the following objectives.

1. To optimize the dyeing condition of selected dye on eri silk yarns.
2. To evaluate the colourfastness properties of dyed yarns.
3. To study the physical properties of dyed yarns.

Materials and methods

Collection of leaves and dye extraction: Datura stramonium leaves were collected from Assam Agricultural University campus and were washed with running tap water and grinned well to extract the dye (Fig. 1). Eri silk yarns collected from Lakhimpur district were degummed and bleached before dyeing. The dye liquor was scanned using spectrophotometer between 500-570 nm as it is the wavelength for green colour (Gohl and Vilensky, 1983).

Optimization of parameters: Various dyeing conditions were optimized such as alkali concentration, extraction medium, dye extraction time, dye material concentration, mordanting concentration and time and mordanting methods by calculating the dye absorption percentage by using the formulae.

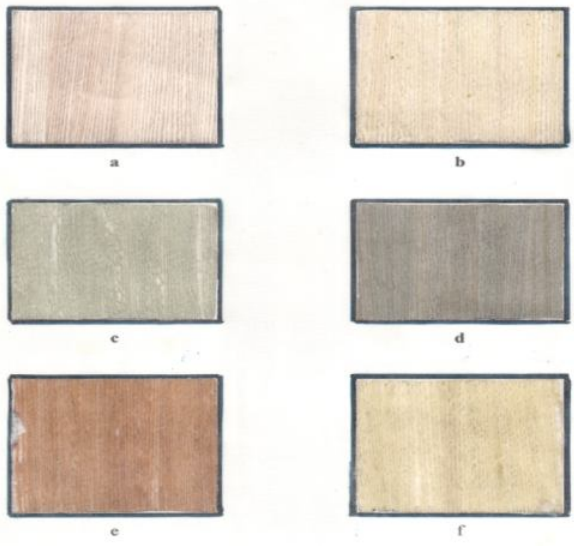
$$\% \text{ of dye absorption} = \frac{\text{OD of the liquor before dyeing} - \text{OD of the liquor after dyeing}}{\text{OD of the liquor before dyeing}} \times 100$$

Evaluation of colour fastness and physical properties: Colourfastnesss properties like colour fastness to washing of dyed eri silk yarns were tested by using sasmira launder-o-mete. The wash fastness rating was rated by using grey scale rating from 1-6. Colourfastness to pressing (dry and wet) was done by subjecting the yarns to hot iron in both wet and dry condition and compared with the grey scale to see the both colour change and colour stain. Colourfastness to sunlight was seen by exposing the yarns to the direct effect of sunlight simultaneously from 9 am to 5 pm. Colourfastness to perspiration (acidic and alkali) was assessed by using, American Society for Testing Materials (1968) method. The test specimen of coloured textiles were wet out in alkali and acidic perspiration solution with fixed mechanical pressure and allowed to dry slowly at a slightly elevated temperature. Physical properties such as count with the help of Bessley balance, tenacity and elongation using Instron strength tester, density, Wicking height and moisture content by using hot air oven. Tenacity and strenght were evaluated by subjecting to analysis of variance through completely randomised design by using` F' test.

Results and discussion

The wavelength of the dye was found to be 545 nm. Alkaline medium was selected as the best medium for dye extraction. Bansal *etal* (2006) also found alkali medium as best medium on dyeing of silken yarns with berberry dye.

Fig. 2. Yarns dyed with *Datura stramonium* dye.



a. Original; b. Without mordant (Light yellow green colour); c. Alum mordanted (Light green colour); d. Copper sulphate mordanted (Camouflage green colour); e. Ferrous sulphate mordanted (Brownish green colour); f. Stannous chloride mordanted (Lime colour).

Alkali concentration 2.5%/100 g of yarn showed highest absorption value. The optimum dye concentration was found to be 5% similar to the findings of Phukan (2005) on dyeing silk yarns with heartwood of jackfruit. The dyeing time was optimized as 45 min similar to the results shown by Bordoloi (2008) on dyeing eri silk yarns with bark of carambola. The mordant concentration was found to be 6%/100 g of yarns for alum, 4%/100 g for copper sulphate, 2%/100 g for both ferrous sulphate and stannous chloride. Dyeing time was found to be for 30 min for all mordants, the optical density value decreased as the yarns were unable to absorb dye after reaching the maximum absorption point. Simultaneous mordanting method was considered as the best method for alum, copper sulphate and ferrous sulphate while post mordanting method was best for stannous chloride mordanted samples. The colour obtained from datura dye on eri silk yarns were found to be light yellow green without mordant, light green mordanted with alum, camouflage green when mordanted with copper sulphate, ferrous sulphate mordanted produce brown colour and lime colour obtained when mordanted with stannous chloride (Fig. 2).

Copper sulphate mordanted sample showed good colour fastness and no colour staining. The alum mordanted sample showed good fastness to crocking, perspiration (alkali) and pressing (dry and wet) and very fair fastness to washing and acidic perspiration while fair fastness to sunlight and slightly stained on acidic perspiration. Ferrous sulphate mordanted sample showed good fastness to sunlight, dry crocking, acidic perspiration and dry pressing while very fair fastness to wet crocking, wet pressing and alkaline perspiration and slightly stained in wet pressing and wet crocking.

Table 1. Ratings for colourfastness properties of dyed samples.

Mordant used	Sunlight	Washing		Crocking				Perspiration				Pressing			
				Dry		Wet		Acidic		Alkaline		Dry		Wet	
		CC	CS	CC	CS	CC	CS	CC	CS	CC	CS	CC	CS	CC	CS
Without mordant	3	4	5	5	5	4	4	4	4	5	5	5	5	5	5
Alum	3	4	5	5	5	5	5	4	4	5	5	5	5	5	5
Copper sulphate	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Ferrous sulphate	5	4	5	5	5	4	4	5	5	4	4	5	5	4	4
Stannous chloride	3	4	5	5	5	5	5	4	4	5	5	5	5	5	5

CC: Colour change; CS : Colour staining; CC Ratings: 1 = very poor, 2 = poor, 3 = fair, 4 = very fair, 5 = good, 6 = very good;
CS Ratings: 1= heavily stained, 2= considerably stained, 3= noticeable stained, 4=slightly stained, 5= negligible or no staining.

Stannous chloride mordanted sample showed good fastness to dry and wet crocking, dry and wet pressing alkaline perspiration, very fair fastness to acidic perspiration and washing and fair fastness to sunlight while without mordanted sample showed good fastness dry and wet pressing, alkali perspiration and dry crocking while very fair fastness to washing, wet crocking and acidic perspiration while fair fastness to sunlight and it showed slightly stained in wet crocking and acidic perspiration (Table 1). The count and twist of raw eri silk yarns were found to be 14 and 11 TPI. The raw yarns showed a density of 1.98 g/cm^2 while decreased to 1.54 g/cm^2, 1.44, 1.34, 1.28 and 1.20 g/cm^2 for mordanted samples with alum, copper sulphate, ferrous sulphate, stannous chloride and without mordanted samples. The wicking height and moisture regain of dyed yarns increased than the raw yarns due to various pre-treatment such as degumming, bleaching prior to dyeing. Tenacity and elongation decreased in dyed yarns than undyed ones. Among the dyed yarns, alum mordanted sample showed highest tenacity (1.92 g/tex) and elongation (21.9%), while copper sulphate mordanted samples showed lowest tenacity (1.66g/tex) and elongation (8.33%) (Table 2). The decrease in tenacity might be due to break down of interfibre bonds and interfibre forces of attraction during dyeing and processing (Troatman, 1975).

Conclusion

Dyeing of eri silk yarns with datura dye produces various soft and subtle natural shades. Sample mordanted with coper sulphate showed good fastness to sunlight, perspiration, pressing, washing and crocking. On the other hand, *Datura stramonium* plant has various medicinal properties. It is used to cure pains, boils, pimples, asthma, dandruff, piles etc (Agharkar, 1991). So, eri fabrics woven from dyed eri silk yarns with datura may relieve body pains. Thus, dyeing eri silk yarns as well as fabrics with *D. stramonium*) dye give a new look to this poor man's friend, will boost in preparing diversified products. Such efforts are required to improve the quality and aesthetic value of eri silk to match with new trends in national and international market.

Table 2. Effect of dyeing on physical properties of dyed eri silk yarn.

Dyed yarn sample	Tenacity (g/tex)	Elongation (%)
Raw yarn	1.99	22.23
Without mordant	1.71	19.87
Alum mordanted	1.92	21.91
Copper sulphate mordanted	1.66	18.33
Ferrous sulphate mordanted	1.69	20.51
Stannous chloride mordanted	1.79	20.93
S.Ed.	0.008	0.010
CD-5%	0.018	0.022

Interaction between all the variables was statistically significant at 5%.

Acknowledgments

We are thankful to the Head, department of clothing and textiles, College of Home Science, Jorhat for providing all kinds of support and encouragement.

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