Dyeing of silk fabric with eco-friendly natural dye obtained from *Nyctanthes arbor-tristis* using single mordants

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Abstract *-*

The silk fabric was dyed with natural dyes obtained from the flower of Nyctanthes arbor-tristis. The fastness properties and colour strength of dyed silk fabric was determined, compared and tabulated. From the comparative study of fastness properties and colour strength of the dyed silk samples, Nyctanthes arbor-tristis.in simultaneous mordanting method with 3% mordant combination gives better results.

Keywords *- Fastness, Mordant, Natural dye,* ***Nyctanthes arbor-tristis****, silk*

Introduction

In our earth natural dyes were the main colourant for the textiles during the 19th century for painting on pots and decorative purposes. Recently, interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards was given by many countries in response to toxic and allergic reactions associated with synthetic dyes. In practical, environmental pollution is due to the discharge of dyeing industry effluents which results many pollution problems. About 150 years ago all dyes were natural substances, derived mainly from minerals, plants and animals. The natural dyes obtained from the parts of plants and animals are colour giving molecules[1] which impart colour to the textile materials.

Fig. 1 ***Nyctanthes arbor-tristis***

The present investigation deals with the extraction of natural dyes from the flower of *Nyctanthes arbor-tristis*, also known as the Night-flowering jasmine and Parijat(Parvati chi phula) is a species of *Nyctanthes* native to South Asia and Southeast Asia.
Nyctanthes arbor-tristis is a shrub or a small tree growing to 10 m (33 ft) tall, with flaky grey bark. The leaves are opposite, simple, 6–12 cm (2.4–4.7 in) long and 2–6.5 cm (0.79–2.56 in) broad, with an entire margin. The flowers are fragrant,

with a five- to eight-lobed white corolla with an orange-red centre; they are produced in clusters of two to seven together, with individual flowers opening at dusk and finishing at dawn. The fruit is a bilobed, flat brown heart-shaped to round capsule 2 cm (0.79 in) diameter, each lobe containing a single seed.

Materials and methods

Materials

Conventionally desized, scoured and H_2O_2 (1%) silk fabric obtained from Gandhi Trust, Dindugal**,** was used for the study. Analytical reagents (AR) grade ferrous sulphate, aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, commercial grade acetic acid, common salt, sodium carbonate were used. A natural mordant myrobolan (*Terminalia chebula*) powder was used for the study. Depending upon the mordant used, the *flower of Nyctanthes arbor-tristis extract* gave different shades.

Methods

Extraction[2-4] of colour component

For optimizing the extraction method the ethanol extraction of dye liquor was carried out under varying conditions, such as time of extraction, temperature of extraction bath and material-to-liquor ratio. In each case, the optical density or absorbance value at a particular maximum absorbance wavelength (λ_{420nm}) for the ethanol extract of plant parts were estimated by using Hitachi-U-2000 UV-VIS absorbance spectrometer.

Dyeing of silk fabrics with the extract of flower of *Nyctanthes arbor-tristis*

The wetted out silk samples were entered into dye baths containing required amount of dye extract and water. After 10 minutes, required amount of sodium carbonate and sodium chloride were added. The dyeing was carried out for one hour at 60°C. The dyed samples were dried in air without washing to make them ready for pre, simultaneous and post-mordanting using myrobolan and metallic salts.

Pre-Mordanting of silk fabric with myrobolan and metallic salts

Silk fabric with or without pre-mordanting were further mordanted prior to dyeing using 1-3% of any one of the chemical mordants, such as aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, copper sulphate and the myrobolan, at 60°C for 30 min with material-to-liquor ratio of 1:20. The samples treated with metal salts were dyed with the dye extract.

Simultaneous mordanting of silk fabrics with myrobolan and metallic salts.

Bleached silk fabrics were treated with both dye extract and metal salts simultaneously, using 1-3% of any one of the chemical mordants, such as aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, copper sulphate and the myrobolan, at 60°C for 30 min with material-to-liquor ratio of 1:20.

Post-Mordanting of silk fabrics with myrobolan and metallic salts

Bleached silk fabrics were dyed with dye extract. The wetted out silk samples were entered into different dye baths containing required amount of dye extract and water. After 10 minutes required amount of sodium sulphate was added. After 20 minutes required amount of sodium chloride was added. The dyeing was carried out for one hour at 50°C. The dyed samples were taken out, squeezed and used for treatment with metal salts process without washing. The dyed silk samples were treated with different metal salts using 1-3% of any one of the chemical mordants, such as aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, copper sulphate and the myrobolan, at 60°C for 30 min with material-to-liquor ratio of 1:20.

In all the above three methods, after the dyeing is over, the dyed samples were repeatedly washed with water and then dried in air. Finally, the dyed samples were subjected to soaping with 2gpl soap solution at 50°C for 10 min, followed by repeated water wash and drying under sun.

Determination of surface colour strength[5-7] (K/S value)

The K/S value of the undyed and dyed silk fabrics was determined by measuring surface reflectance of the samples using a computer-aided Macbeth 2020 plus reflectance spectrophotometer, using the following Kubelka Munk equation with the help of relevant software:

$$K/S = \frac{(1- R_{\lambda\, max})^2}{2R_{\lambda max}} = \alpha C$$

Where, K is the coefficient of absorption; S the coefficient of scattering; C_d, the concentration of the due and $R\lambda_{max}$ the surface reflectance value of the sample at a particular wavelength, where maximum absorption occurs for a particular dye/colour component.

Evaluation of Colour Fastness:

Colour fastness[8-10] to washing of the dyed fabric samples was determined as per IS: 764 – 1984 method using a Sasmira launder-O-meter following Is-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (extent of staining) and the same was cross-checked by measuring the loss of depth of colour and staining using Macbeth 2020 plus computer-aided colour measurement system attached with relevant software. Colour fastness to rubbing (dry and wet) was assessed as per IS: 766-1984 method using a manually operated crock meter and grey scale as per ISO-105-AO3 (extent of staining).

Colour fastness to exposure to light was determined as per IS: 2454-1984 method. The sample was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (having 500 watt

Philips mercury bulb tungsten filament lamp simulating day light) along with the eight blue wool standards (BS 1006: BOI: 1978). The fading of each sample was observed against the fading of blue wool standards (1-8).

Colour fastness to perspiration assessed according to IS 971-1983 composite specimen was prepared by placing the test specimen between two adjacent pieces of fabrics of silk and stitched all among four sides. The sample was soaked in the test solution (acidic /alkaline) separately with MLR 1:50 for 30 minutes at room temperature. The sample was then placed between two glass plates of perspirometer under load of 4.5kgs (10 lbs). The apparatus was kept in the oven for four hours at 37±2˚C. At the end of this period the specimen was removed and dried in air at a temperature not exceeding 60˚C. The test samples were graded for change in colour and staining using grey scales.

Results and discussion

The colour strength values of silk fabrics dyed with the flower of *Nyctanthes arbor-tristis* obtained in this study by using single mordanting method are presented and compared in Tables 1, 2 and 3.

From the results, it was observed that *Nyctanthes arbor-tristis* showed better colour strength values. In all the three dyeing methods, simultaneous method gave excellent results. In all the three methods of dyeing, the mordants ferrous sulphate and aluminium suphate show excellent colour strength values. For dyeing of silk, 1%, 2% and 3% mordant concentrations were used for the present study. Among these three concentrations 3% mordant concentration gave better results.

Conclusion

In all the three dyeing methods, simultaneous method gave excellent results. In all the three methods of dyeing, using two plant parts, the mordants ferrous sulphate and aluminium suphate show excellent results. From the study of fastness properties and colour strength of the dyed silk samples, *Nyctanthes arbor-tristis* in simultaneous mordanting method with 3% mordant combination gives better results

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Table 1 Surface colour strength of *Nyctanthes arbor-tristis* dyed silk **fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration. K/S value without mordant:** silk **-1.47**

Mordant concentration:1%	**K/S(λ =420 nm)**		
	Pre mordanting	**Simultaneous mordanting**	**Post mordanting**
Nickel sulphate	1.37	2.43	2.11
Aluminium sulphate	1.57	2.73	2.58
Potassium dichromate	1.30	1.32	1.31
Ferrous sulphate	1.72	2.83	2.67
Stannous chloride	1.65	2.48	2.41
Myrobolan	1.23	1.18	1.36

Table 2 Surface colour strength of *Nyctanthes arbor-tristis* dyed silk **fabric after pre, simultaneous and post mordanting methods by using 2% mordant concentration. K/S value without mordant: silk -1.47**

Mordant concentration:2%	**K/S(λ =420 nm)**		
	Pre mordanting	**Simultaneous mordanting**	**Post mordanting**
Nickel sulphate	1.43	2.48	2.18
Aluminium sulphate	1.74	2.82	2.63
Potassium dichromate	1.29	1.31	1.41
Ferrous sulphate	1.81	3.01	2.87
Stannous chloride	1.67	2.74	2.44
Myrobolan	1.22	1.27	1.29

Table 3 Surface colour strength of *Nyctanthes arbor-tristis* dyed silk fabric after pre, simultaneous and post mordanting methods by using 3% mordant concentration. K/S value without mordant: silk-1.47

Mordant concentration:3%	**K/S(λ =420 nm)**		
	Pre mordanting	**Simultaneous mordanting**	**Post mordanting**
Nickel sulphate	1.45	2.49	2.19
Aluminium sulphate	1.81	2.88	2.69
Potassium dichromate	1.31	1.28	1.46
Ferrous sulphate	1.89	3.11	2.81
Stannous chloride	1.75	2.87	2.38
Myrobolan	1.26	1.37	1.41