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Studies on Natural dyes obtained from *Tecoma capensis* flower

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ABSTRACT

In this study, natural colors were produced from the flower of *Tecoma capensis*. The dyes were extracted from the petal part of the plant using the solvent extraction method of acidified methanol. The natural colors were then converted into a powder form in nano-size scale using a ball mill grinder. Cotton fabrics were used as substrate and were colored using several natural and synthetic mordants. The use of different solvents for extraction and mordants for dyeing resulted in different color shades on the cotton fabrics. The color fastness in washing tests revealed that fastness in washing ranges from 4 - 4/5 and the change in color ranges from 2/3 - 3/4. The findings will benefit and promote the dyeing and printing industries.

Keywords: Cotton; Nano; Natural dye; *Tecoma capensis*.

1. INTRODUCTION

Natural dyes or colorants have been used since ancient times. Recently, natural dyes imparted color for textiles, pots and decorative purposes. Recently, there has been an interest in the use of natural dyes due to stringent environmental norms imposed by many countries. Synthetic dyes are toxic and allergic to flora and fauna. Mostly the environmental pollution is due to the discharge of dyeing industry effluents which results in more pollution problems. In ancient days, all dyes were natural substances derived from minerals, plants and animals used for various applications. The natural dyes are obtained from the parts of various plants and animals having color-giving molecules (Boonroeng *et al.* 2009) that impart color to the textile materials.

Fig. 1: The flower of *Tecoma capensis*

The present investigation deals with the extraction of natural dyes from *the Tecoma capensis* flower. The plant grows to 2-3 m (7 – 10 ft) height and has a similar width. It may lose its leaves in colder climates, and it may scramble in certain habitats, meaning that it shoots out long growth tips that lean on the stems and branches of other plants in all warm and damp parts of India. The flowers are tubular and narrow, about 7.5 cm (3 in) long and are produced at different times throughout the year. They are grouped in 10–15 cm (4–6 in) long terminal clusters. The flower color ranges from orange-red to apricot.

Tecoma capensis has been in cultivation for many years and is often used for hedging as it is a scrambling shrub. It can be propagated from cuttings or by removing rooted suckers during the active growth phase. It can be planted in semi-shade to full sun. Tolerating temperatures down to 5 °C (41 °F), it can be grown in mild temperate areas with the protection of a warm wall. Otherwise, it can be grown in a container and taken indoors through the winter months.

2. MATERIALS AND METHODS

2.1 Materials

Conventionally de-sized, scoured and H_2O_2 (1%), a plain cotton fabric (220 ends/ dm, 180 picks/dm,120 g/m^2) fabric obtained from Gandhi Trust, Dindugal, Tamilnadu, India, was used for this study. Analytical reagents (AR) grade stannous chloride, potassium dichromate, aluminum sulfate, nickel sulfate, ferrous sulfate, acetic acid, sodium chloride and sodium carbonate were used. An excellent natural mordant myrobolan (*Terminalia chebula*) powder was used for

this study. Depending upon the mordant used, the flower of *Tecoma capensis* extract gave varieties of shades.

2.2 Methods

2.2.1 Extraction of color component

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

2.2.2 Dyeing of cotton with the extract of flower of Opuntia ficus-indica

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

2.2.3 Pre-mordanting of fabric with myrobolan and metallic salts

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

2.2.4 Simultaneous mordanting of cotton samples with myrobolan and metallic salts

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

2.2.5 Post-Mordanting of cotton samples with myrobolan and metallic salts

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

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

2.2.6 Determination of surface color strength (K/S value)

The K/S value of the undyed and dyed samples weres 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:

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

K is the coefficient of absorption; S is the coefficient of scattering; Cd is the concentration of the dye and $R_{\lambda max}$ is the surface reflectance value of the sample at a particular wavelength where maximum absorption occurs for a particular dye/color component.

2.2.7 Evaluation of Color Fastness

The colorfastness to washing the dyed 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 greyscale 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 color and staining using Macbeth 2020 plus computer-aided color measurement system attached with relevant software. Colorfastness to rubbing (dry and wet) was assessed as per IS: 766-1984 method using a manually operated crock meter and greyscale as per ISO-105-AO3 (extent of staining).

The colorfastness to exposure to light (Sun) 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 watts Philips mercury bulb tungsten filament lamp simulating daylight) along with the light blue wool standards (BS 1006: BOI: 1978). The fading of each sample was observed against the fading of blue wool standards (Bhuyan *et al.* 2005; Boonroeng *et*

al. 2009; Kumaresan, M., Palanisamy, P. N., Kumar *et al.* 2010; Mongkholrattanasit *et al.* 2010).

The colorfastness to perspiration assessed according to IS 971-1983 composite specimen was prepared by placing the test specimen between two adjacent pieces of fabrics of cotton 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 a load of 4.5 kg (10 lb). 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 cotton samples were graded for change in color and staining using grey scales.

3. RESULTS AND DISCUSSION

The color strength values of cotton samples with the flower of *Tecoma capensis* obtained in this study by using the single mordanting method were presented and compared in Tables 2, 3 and 4.

Table 1. Colorfastness to washing

Dyestuff	Mordant	Colorfastness to washing			
		Change in color		Staining on	
		Dyed Fabrics		Dyed Fabrics	
		Dyed	Nano dyed	Dyed	Nano dyed
Flower of Tecoma capensis	Nickel sulfate	3	4/5	3/4	4
	Aluminum sulfate	2/3	3/4	3/4	4
	Potassium dichromate	3/4	4	4	4
	Ferrous sulfate	3/4	4/5	4	5
	Stannous chloride	3/4	5	3/4	4
	Myrobolan	2	3/4	3/4	4

Table 2. Surface color strength of *Tecoma capensis* dyed cotton fabric after pre-mordanting, simultaneous and post-mordanting methods by using 1% mordant concentration. K/S value without mordant: cotton-1.52

Mordant concentration:1%	K/S(λ =420 nm)		
	Pre-mordanting	Simultaneous mordanting	Post-mordanting
Nickel sulfate	1.50	2.48	2.11
Aluminum sulfate	1.57	2.83	2.68
Potassium dichromate	1.30	1.36	1.40
Ferrous sulfate	1.82	2.93	2.79
Stannous chloride	1.73	2.60	2.44
Myrobolan	1.23	1.28	1.36

Table 3. Surface color strength of *Tecoma capensis* dyed cotton fabric after Pre-mordanting, simultaneous and post-mordanting methods by using 2% mordant concentration. K/S value without mordant: cotton-1.52

Mordant concentration: 2%	K/S(λ =420 nm)		
	Pre-mordanting	Simultaneous mordanting	Post-mordanting
Nickel sulfate	1.50	2.52	2.22
Aluminum sulfate	1.81	2.87	2.67
Potassium dichromate	1.30	1.31	1.42
Ferrous sulfate	1.85	3.03	2.89
Stannous chloride	1.71	2.74	2.44
Myrobolan	1.23	1.28	1.32

Table 4. Surface color strength of *Tecoma capensis* dyed cotton fabric after pre-mordanting, simultaneous and post-mordanting methods by using 3% mordant concentration. K/S value without mordant: cotton-1.52

Mordant concentration: 3%	K/S(λ =420 nm)		
	Pre-mordanting	Simultaneous mordanting	Post-mordanting
Nickel sulfate	1.47	2.51	2.21
Aluminum sulfate	1.82	2.90	2.73
Potassium dichromate	1.33	1.30	1.48
Ferrous sulfate	1.92	3.13	2.84
Stannous chloride	1.80	2.87	2.41
Myrobolan	1.27	1.38	1.43

The above results show that the color produced depends on the mordant used. The pattern of color reflectance of dyed fabrics is almost the same. However, the differences were in terms of shades obtained and among five different mordants, dyeing with ferrous sulfate produced the deepest color for both dye and nano-sized dye form. Table 1 shows that the color fastness was in the range of 2/3 to 4/5 for change in color and 3/4 to 5 for staining. Good staining on cotton can be observed in all dyes with raw dye and nano-sized dyes.

From the above results, it was observed that *Tecoma capensis* showed better color strength values. In all three dyeing methods, the simultaneous method gave excellent results. Comparing all the three dyeing methods, the mordants ferrous sulfate and aluminum sulfate show excellent color strength values. For dyeing of cotton, 1%, 2% and 3% mordant concentrations were used for the present study. Among the three concentrations, 3% mordant concentration gave better results. The binding is more when nano-sized particles of natural dye are used in this study.

4. CONCLUSION

Among the three dyeing methods, the simultaneous method gave excellent results. Similarly, the mordants ferrous sulfate and aluminum sulfate among the three dyeing methods show excellent results. From the study of fastness properties and the color strength of the dyed samples, *Tecoma capensis* in simultaneous mordanting method with 3% mordant combination gives better results.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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