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Comparison of Fastness Properties of Dyed Cotton Fabric with Eco-Friendly Natural Dyes Obtained from *Achras sapota and Cordia Sebestena*

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Abstract

Cotton fabric was dyed with natural dyes obtained from the stem of Achras sapota and flower of Cordia sebestena. The colour fastness properties and colour strength of dyed cotton fabric were determined and compared. From the comparative study of fastness properties and colour strength of the dyed samples, Cordia sebestena dyed samples in simultaneous mordanting method with 3% mordant combination gives better results as compared to the natural dye obtained from the stem of Achras Sapota

Keywords: *Achras sapota; Cordia sebestena; Cotton; Fastness; Mordants; Natural dye.*

1. INTRODUCTION

Recently the interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries in response to toxic and allergic reactions associated with synthetic dyes (Anitha *et al.* 2007). Natural dyes are obtained from three main sources which are mineral, vegetable and animal sources. The introduction of synthetic dyes led to an almost complete replacement of natural dyes, due to favorable application properties of synthetic dyes. Besides, a wide range of available colours, higher reproducibility and improved quality of dyeing could be achieved at lower specific cost.

Hence, due to the current eco-consciousness, the researcher's attention has been shifted to the use of natural dyes for dyeing textile materials (Ashis kumar samanta *et al.* 2007). The present investigation deals with the extraction of natural dye from the stem of *Achras Sapota* and flower of *Cordia sebestena*.

Sapota belongs to the Sapotaceae family. Sapota (*Achras sapota*) commonly known as chiku is mainly cultivated in India for its fruit value. Sapota, being a tropical crop can be grown from sea level upto a height of 1200 m. It needs warm (10-38 ^{0}C) and humid climate (70% relative humidity) for growth and can be cultivated throughout the year. Coastal climate is best suited for its cultivation.

Cordia sebestena is a species of flowering plant in the Boraginaceae family. It is commonly known as Geiger tree. *Cordia sebestena* is widely planted throughout the tropics and subtropics as an ornamental plant in gardens because of its flowers.

The stem of *Achras Sapota* and flower of *Cordia sebestena* dye were used for dyeing cotton at optimized dyeing conditions, using single mordants and then the colour fastness of the dyed samples to washing, rubbing, perspiration and light evaluated.

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2. MATERIALS & METHODS

2.1 Materials

Cottn fabrics obtained from Gandhi Trust, Dindugal**,** was used for this 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 (Bains *et al.* 2003) was used for the study. Depending upon the mordant used, the colour obtained on textiles from dye extracts may give different shades.

2.2 Methods

2.2.1 Extraction of colour component

For optimizing (Gulrajani *et al.* 1992) 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.

2.2.2 Dyeing of cotton fabrics with the extract of stem of Achras Sapota and flower of Cordia sebestena

The wetted out cotton 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 (Kumar *et al.* 2004; Kumaresan *et al.* 2010).

2.2.3 Pre-Mordanting of cotton fabrics with myrobolan and metallic salt

Bleached cotton fabrics 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 (Kumaresan *et al.* 2011).

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2.2.4 Simultaneous -Mordanting of cotton fabrics with myrobolan and metallic salts.

Bleached cotton 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.

2.2.5 Post-Mordanting of cotton fabrics with myrobolan and metallic salts.

Bleached cotton fabrics were dyed with dye extract. The wetted out cotton 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 cotton 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 2 gpl soap solution at 50°C for 10 min, followed by repeated water wash and drying under sun.

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

The K/S value (Kumaresan *et al* . 2012) of the undyed and dyed cotton 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.

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

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.

2.2.7 Evaluation of Colour Fastnes

Colour fastness to washing (Kumaresan *et al.* 2011,2012) of 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 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).

Table 1. Surface colour strength of *Achras sapota (AS)* and *Cordia sebestena (CS)* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration (K/S value without mordant : cotton-1.31)

Mordant concentration:1%	K/S(λ=420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	1.41	1.62	2.34	2.44	2.07	2.32
Aluminium sulphate	1.71	1.80	2.57	2.58	2.48	2.59
Potassium dichromate	1.14	1.15	1.19	1.21	1.15	1.18
Ferrous sulphate	1.77	1.87	2.61	2.92	2.72	2.84
Stannous chloride	1.62	1.70	2.53	2.62	2.38	2.51
Myrobolan	0.92	1.10	1.22	1.32	1.26	1.29

Table 2. Surface colour strength of *Achras sapota (AS)* and *Cordia sebestena (CS)* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 2% mordant concentration (K/S value without mordant : cotton-1.31)

Mordant concentration:2%	K/S(λ =420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	1.46	1.53	2.37	2.56	2.12	2.51
Aluminium sulphate	1.75	2.54	2.59	2.81	2.53	2.62
Potassium dichromate	1.23	1.32	1.29	1.99	1.34	1.41
Ferrous sulphate	1.82	2.91	2.67	2.98	2.76	2.78
Stannous chloride	1.67	1.73	2.56	2.76	2.43	2.61
Myrobolan	0.98	1.83	1.27	2.35	1.31	2.31

Table 3. Surface colour strength of *Achras sapota (AS)* and *Cordia sebestena (CS)* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 3% mordant concentration (K/S value without mordant : cotton-1.31)

Mordant concentration:3%	K/S(λ =420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	1.51	1.60	2.41	2.52	2.16	2.26
Aluminium sulphate	1.79	1.91	2.64	2.75	2.58	2.69
Potassium dichromate	1.27	1.35	1.34	1.46	1.38	1.41
Ferrous sulphate	1.87	2.01	2.71	2.89	2.61	2.78
Stannous chloride	1.71	1.79	2.62	2.71	2.48	2.58
Myrobolan	1.03	1.17	1.31	1.39	1.35	1.47

Table 4. Comparison of fastness properties of dyed cotton using single mordants

Plant parts used for dyeing	Mordant used	Method	Properties						Reference
			WF	LF	RF		PF		
					Dry	Wet	Acidic	Alkaline	
Stem of *Achras sapota*	Ferrous sulphate (3%)	SM	5	4	5	5	5	5	Present study
		PM	5	4	5	5	5	5	
	Aluminium sulphate (3%)	SM	4-5	4	5	5	5	5	
		PM	5	4	5	5	4	4	
Flower of *Cordia sebestena*	Ferrous sulphate (3%)	SM	5	5	5	5	5	5	
		PM	5	5	5	5	5	5	
	Aluminium sulphate (3%)	SM	4	5	5	4	4	4	
		PM	5	4	5	5	5	5	
Onosma echioides	Ferrous sulphate (3%)	SM	5	2	5	5	4	5	Sandeep bains et al (2003)
	Aluminium sulphate (5%)	SM	5	2	4	3-4	5	5	
Fountain flower	Ferrous sulphate (3%)	SM	4-5	5	4-5	4	4-5	4-5	Shilpa mudgal and Geeta mahale (2002)
Mangifera indica	Ferrous sulphate (2.5%)	SM	5	4	4-5	4	5	5	Bains et al (2003)
	Aluminium sulphate (12.5%)	SM	5	4	4-5	4	5	5	
Colquhounia coccinea	Ferrous sulphate (2.5%)	PM	4-5	4-5	5	5	5	5	Vankar et al (2010)
	Aluminium sulphate (12.5%)	PM	4	4	4	4	4	4	
Pongamia pinnato	Ferrous sulphate (2.5%)	SM	-	5	4-5	4-5	-	-	Kumar et al (2004)
	Aluminium sulphate (12.5%)	SM	-	5	4-5	4-5	-	-	
Neem tree bark	Aluminium sulphate (12.5%)	PM	3	2-3	4-5	4-5	-	-	Boonroeng et al (2009)

Colour fastness (Kumaresan *et al.* 2011) 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.

3. RESULTS & DISCUSSION

The colour strength values of cotton fabrics dyed with stem of *Achras sapota* and flower of *Cordia sebestena* 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 among the two plant parts, flower of *Cordia sebestena* showed better colour strength values. 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. For dyeing of cotton, 1%, 2% and 3% mordant concentrations were used for the present study. Among these three concentrations 3% mordant concentration gave better results. The colour fastness values of cotton fabrics dyed with stem of *Achras sapot*a and flower of *Cordia sebestena* obtained in this study by using single mordanting method are presented and compared in Table 4.

From the results, it was observed that among the two plant parts, *Cordia sebestena* showed better light fastness properties than *Achras sapota*. Similar rub fastness and perspiration fastness values were obtained. *Cordia sebestena* showed better wash fastness when compared with *Achras sapota* dyed cotton fabrics. 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.

Similar results were obtained in the previous study reported by Boonroeng *et al* (2009). The present study shows excellent wash fastness (GS : 5) and light fastness (GS :4-5), similar results obtained when compared with Vankar *et al.* (2010) and Kumar *et al.* (2004) studies.

4. CONCLUSION

From the comparative study of fastness properties and colour strength of the dyed cotton samples, *Cordia sebestena* in simultaneous mordanting method with 3% mordant combination gives better results as compared to the *Achras sapota* dye.

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