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Fastness Properties of Dyed Silk Fabric with Eco-Friendly Natural Dyes Obtained from *Achras Sapota and Cordia Sebestena - A Comparison*

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Abstract

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

Keywords: *Achras sapota, Cordia sebestena Fastness, Mordants, Natural dye, Silk.*

1. INTRODUCTION

Environmental pollution due to the discharge of dyeing industry effluents is the matter of major concern now-a-days. Upto the end of 19th century natural dyes were the main colourants for textiles. Recently, 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). Until about 150 years ago all dyes were natural substances, derived mainly from plants and animals. The natural dyes present in plants and animals are pigmentary molecules (Sandeep Bains *et al.* 2003) which impart colour to the materials. With the world becoming more conscious towards ecology and environment, there is greater need today to revive the tradition of natural dye and dyeing techniques as an alternative of hazardous synthetic dyes is an extremely crude.

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There are several plants/plant parts that provide natural dyes which are used in the textile industry. However, the common drawbacks of natural dyes are their non-reproducible and non-uniform shades, poor to moderate colour fastness and lack of scientific information on the chemistry of dyeing and standardised dyeing methods (Samanta *et al.* 2003 and Gulrajani *et al.* 1992) . Many reports are available on application of natural dyes on silk (Mahale *et al.* 2003 and Kumaresan *et al.* 2011) and cotton (Senthilkumar *et al.* 2002).

The aim of present work has been carried out to prepare eco-friendly natural dyes from the stem of *Achras Sapota* and flower of *Cordia sebestena* and apply them on silk fabrics. In the present work an attempt has been made to study the effect of mordanting and dyeing properties (Anderson, 1971) of silk fabrics such as, washing, rubbing, light fastness and perspiration (Ashis Kumar Samanta *et al.* 2007) and also to visualize the effect of myrobolan and metallic mordants have been undertaken.

2. MATERIALS & METHODS

2.1 Materials

Loom state silk (430 ends/ dm,212 picks/dm, 50g/m^2) fabric 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 was used for the study. Depending upon the mordant used, the colour obtained on textiles from the stem of *Achras Sapota* and flower of *Cordia sebestena extract* may give different shades. The myrobolan (harda) powder was soaked in water (1:10 volume) for overnight (12h) at room temperature to obtain the swelled myrobolan gel. It was then mixed with a known volume of water and heated at 80 ^{0}C for 30 min. The resulting solution is cooled and filtered. The filtrate was used as final mordant solution for mordanting (Kumaresan *et al.* 2010).

2.2 Methods

2.2.1 Extraction 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.

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

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.

2.2.3 Pre-Mordanting of silk fabrics with myrobolan and metallic salts

Bleached silk 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.

2.2.4 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.

2.2.5 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.

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

The K/S value Kumaresan *et al.* (2011) 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

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

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 Fastness

Colour fastness 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 The test samples were graded for change in colour and staining using grey scales.

3. RESULTS & DISCUSSION

The colour strength values of silk 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, *Achras sapota* 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 silk, 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 silk 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 Table 4.

From the results, it was observed that among the two plant parts, *Achras sapota* showed better light fastness properties. Similar rub fastness and perspiration fastness values were obtained. *Achras sapota* showed better wash fastness when compared with *Cordia sebestena* dyed silk 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. For dyeing of silk, 1%, 2% and 3% mordant concentrations were used for the present study. Among these three

Table 1. Surface colour strength of *Achras sapota (AS)* and *Cordia sebestena (CS)* dyed silk fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration (K/S value without mordant : silk-2.34)

Mordant concentration:1%	K/S(λ =420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	2.27	2.17	2.63	2.59	2.39	2.32
Aluminium sulphate	2.45	2.38	2.71	2.66	2.51	2.49
Potassium dichromate	1.88	1.45	2.17	1.91	2.08	1.72
Ferrous sulphate	2.58	2.48	2.77	2.70	2.63	2.54
Stannous chloride	2.39	2.32	2.64	2.57	2.54	2.44
Myrobolan	1.66	1.33	2.08	2.12	2.02	2.00

Table 2. Surface colour strength of *Achras sapota (AS)* and *Cordia sebestena (CS)* dyed silk fabric after pre, simultaneous and post mordanting methods by using 2% mordant concentration (K/S value without mordant : silk-2.34)

Mordant concentration:2%	K/S(λ =420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	2.20	2.17	2.59	2.49	2.43	2.39
Aluminium sulphate	2.49	2.38	2.76	2.63	2.56	2.51
Potassium dichromate	1.91	1.39	2.24	2.09	2.12	1.88
Ferrous sulphate	2.65	2.59	2.82	2.71	2.65	2.57
Stannous chloride	2.43	2.41	2.67	2.59	2.54	2.43
Myrobolan	1.70	1.39	2.19	2.13	2.22	2.14

Table 3. Surface colour strength of *Achras sapota (AS) Cordia sebestena (CS)* dyed silk fabric after pre, simultaneous and post mordanting methods by using 3% mordant concentration (K/S value without mordant : silk-2.34)

Mordant concentration:3%	K/S(λ =420 nm)					
	Pre mordanting		Simultaneous mordanting		Post mordanting	
	AS	CS	AS	CS	AS	CS
Nickel sulphate	2.23	2.39	2.67	2.55	2.47	2.36
Aluminium sulphate	2.54	2.51	2.81	2.79	2.61	2.55
Potassium dichromate	1.95	1.33	2.28	1.98	2.18	1.73
Ferrous sulphate	2.66	2.58	2.86	2.81	2.69	2.59
Stannous chloride	2.47	2.41	2.70	2.66	2.61	2.51
Myrobolan	1.74	1.43	2.26	2.16	2.24	2.16

Table 4. Comparison of fastness properties of dyed silk 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	5	5	5	4	4	Present study
		PM	4	4	5	5	5	5	
	Aluminium sulphate (3%)	SM	4	4	5	5	4	4	
		PM	5	4	5	5	5	5	
Flower of *Cordia sebestena*	Ferrous sulphate (3%)	SM	5	5	5	4	4	4	
		PM	5	4	5	5	5	5	
	Aluminium sulphate (3%)	SM	4	5	5	4	4	4	
		PM	5	4	5	5	4	5	
Eclipta prostata	Ferrous sulphate (3%)	PM	5	8	5	5	5	5	Sharada devi *et al* (2002)
Rheum emodi	Aluminium sulphate (3%)	SM	4	3	-	-	-	-	Das *et al* (2008)
	Ferrous sulphate (3%)	SM	4	3	-	-	-	-	
Bixa orellana	Aluminium sulphate (3%)	PM	3-4	4	-	-	-	-	Das *et al* (2007)
	Ferrous sulphate (3%)	PM	2-3	3	-	-	-	-	

concentrations 3% mordant concentration gave better results.

Similar results were obtained in the previous study reported by Das *et al.* (2007).The present study shows excellent wash fastness (GS : 4) and light fastness (GS :4) when compared with Das *et al.* (2008) study (WF : 2-3 and LF : 3). A better light fastness (GS : 8) was reported by Sharada devi *et al.*(2002) in pre mordanting method.

4. CONCLUSION

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

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