



Application of Ecofriendly Natural Dye on Cotton Obtained from the Stem of *Achras sapota* Using Combination of Mordants

M. Kumaresan, P. N. Palanisamy* and **P. E. Kumar****

Department of Chemistry, M. P. Nachimuthu M. Jaganathan Engineering College, Chennimalai
Erode-638 112, T.N., India

*Department of Chemistry, Kongu Engineering College, Perundurai, Erode, T.N.

**Erode Arts and Science College (Autonomous), Erode, T.N.

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ABSTRACT

The colour fastness properties of the stem of *Achras sapota* dyed on cotton were studied using combination of mordants such as myrobalan :nickel sulphate, myrobalan : aluminium sulphate, myrobalan : potassium dichromate, myrobalan : ferrous sulphate, and myrobalan : stannous chloride in the ratio of 1:3, 1:1 and 3:1. The washing, rubbing, light and perspiration fastness of the dyed samples were evaluated giving fair to excellent fastness grades.

INTRODUCTION

Colour not only gives a pleasant look to the clothing, but also expresses emotions and ideas. Natural dyes have the ability to produce wide range of tints and shades with the same dye material. But with the invention of synthetic dyes in 1856, the prominence of natural dyes (Anderson 1971) slacked because the synthetic dyes had some advantages over natural dyes like colour fastness, good reproducibility of shades, brilliance of colour and easy to use.

These synthetic dye stuffs produce hazardous by-products some of which possess carcinogenic intermediates, and hence a ban has been imposed by Germany and some other European countries on the use of benzidine dyes in textile garments exported into their countries (Bains et al. 2003). Hence, due to the current ecoconsciousness, the attention of researchers has been shifted to the use of natural dyes for dyeing textile materials.

In the present work, the stem of *Achras sapota* dye was used to dye cotton at optimized dyeing conditions, using combination of mordants (Bains et al. 2005) and evaluate the resultant colour fastness of the dyed samples to washing, rubbing, perspiration and light.

MATERIALS AND METHODS

Materials: Bleached plain weave cotton fabric, obtained from Gandhigram Rural University, Dindigal, was used for the study. AR grade ferrous sulphate, aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, and commercial grade acetic acid, common salt and sodium carbonate were used. A natural mordant myrobalan (*Terminalia chebula*) powder (Bains et al. 2003) was used for the study. The ethanol extract of the stem of *Achras sapota* was used to get brown colour for dyeing fabrics. Depending upon the mordant used, the colour obtained on textiles from the stem of *Achras sapota* extract may give different shades.

A known quantity of stem of *Achras sapota* was dried, powdered and soaked in warm water overnight. The stem of *Achras sapota* extract was obtained by boiling it in the same water. The dye extract was allowed to cool, filtered and used for dyeing. The dyeing was carried out at optimized conditions namely dye extraction time 60 min, material to liquor ratio 1:20, and dyeing time 50 min.

The mordant combinations viz., myrobalan : nickel sulphate, myrobalan : aluminium sulphate, myrobalan : potassium dichromate, myrobalan : ferrous sulphate, and myrobalan : stannous chloride were used in the ratio of 1:3, 1:1 and 3:1. The total amount of two mordants used in each combination was 5% on the weight of the fabric i.e., 5 g of the mordant/100 g of the fabric. Each of the five mordant combinations in three different ratios mentioned above were used with all the three mordanting methods namely premordanting, simultaneous mordanting and postmordanting for dyeing (Gulrajani et al. 1992). After dyeing, the solution was allowed to cool, removed from dye bath, rinsed under running water to remove excess dye particles and shade dried.

Evaluation of colour fastness: Colour fastness to washing (Thomas Bechtold 2006) 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 (BS1006: BOI: 1978). The fading of each sample was observed against the fading of blue wool standards.

Colour fastness to perspiration (Gulrajani et al. 1992), assessed according to IS: 971-1983 composite specimen, was prepared by placing the test specimen between two adjacent pieces of fabrics of silk and 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 load of 4.5 kg. The apparatus was kept in the oven for four hours at $37\pm2^{\circ}\text{C}$. 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

Mordant Combination-Myrobalan : Nickel Sulphate

The evaluation of colour fastness to light, washing, rubbing and perspiration of stem of *Achras sapota* dyed cotton samples treated with myrobalan: nickel sulphate combination in aqueous medium is presented in Table 1. All the treated samples subjected to light showed fairly good (3-4) light fastness for all ratio mordant combinations. The washing fastness grades ranged between 4 and 5-4 for all the treated samples and there was no colour staining. The colour change to dry and wet rubbing for all the treated samples was excellent (5). There was no colour staining to negligible colour staining (5 to 4-5) in dry rubbing and slight to noticeable staining in wet rubbing. Most of the treated samples showed excellent fastness grade to colour change in both acidic and alkaline media. There

was no colour staining (5) for all the treated samples in both acidic and alkaline media are given in Table 1.

Mordant Combination-Myrobalan : Aluminium Sulphate

The evaluation of colour fastness to light, washing, rubbing and perspiration of stem of *Achras sapota* dyed cotton samples treated with myrobalan : aluminium sulphate combination in aqueous medium is presented in Table 2. All the treated samples subjected to light showed fairly good (3-4) light fastness for all ratios of mordant combinations. The treated samples for premordanting showed fair (3 to 2-3) washing fastness grades, but they ranged between excellent to good (4-5 to 4) for all the treated samples for simultaneous and post mordanting. There was no colour staining. The colour change to dry and wet rubbing for all the treated samples was excellent (5). There was no colour staining ranged between no staining to negligible staining (5 to 4-5) in dry rubbing. There was slight colour staining, except for simultaneous mordanting method where it was negligible staining (4-5) in wet rubbing. The perspiration fastness grades ranged between 4-5 and 4, except for 1:3 mordant proportion in pre-mordanting method, where it was fair (3) for all the samples in both acidic and alkaline media. There was no colour staining (5) for all the treated samples in both acidic and alkaline media as given in Table 2.

Mordant Combination-Myrobalan : Potassium dichromate

The evaluation of colour fastness to light, washing, rubbing and perspiration of stem of *Achras sapota* dyed cotton samples treated with potash dichromate : copper sulphate combination in aqueous medium is presented in Table 3. The treated samples subjected to light showed fairly good (3-4) light fastness for all ratio mordant combinations. The washing fastness grades showed fairly good (3-4) for all the treated samples. The colour change to dry and wet rubbing for all the treated samples was excellent (5). The colour staining ranged between no staining to negligible staining (5 to 4) in rubbing and they ranged between negligible to slight colours staining (4-5 to 4) in dry wet rubbing. Most of the treated samples showed excellent fastness grade to colour change, except for 1:3 mordant proportion in simultaneous mordanting methods, where it was good (4) for all samples in both acidic and alkaline media. There was no colour staining (5) for all treated samples in both acidic and alkaline media are given in Table 3.

Table 1: Fastness grades of stem of *Achras sapota* dye dyed on cotton at optimum dyeing conditions (wavelength 420 nm. dye extraction time 60min, material to liquor ratio 1:20, dyeing time 50 min.) using Mb:NS mordant combination.

Mordanting Method	Mordant Proportions	Light Fastness Grades	Washing Fastness		Rubbing Fastness		Perspiration Fastness			
			Grades		Grades		Grades		Acidic	
			CC	CS	CC	CS	CC	CC	CS	CC
Pre Mordanting	1:3	3-4	4-5	5	5	5	5	4-5	5	5
	1:1	3-4	4-5	5	5	5	5	4-5	5	5
	3:1	3-4	4-5	5	4-5	5	5	5	5	5
Simultaneous Mordanting	1:3	3-4	4-5	5	5	4-5	5	4	5	5
	1:1	3-4	4-5	5	5	5	5	4	5	5
	3:1	3-4	4-5	5	5	5	5	4	5	5
Post Mordanting	1:3	3-4	5	5	5	4-5	5	4	5	5
	1:1	3-4	4-5	5	5	4-5	5	4	5	5
	3:1	3-4	4/5	5	5	4-5	5	4	5	5

Mb:NS – Myrobalan : Nickel sulphate, CC – Colour change, CS – Colour staining

Table 2: Fastness grades of stem of *Achras sapota* dye dyed on cotton at optimum dyeing conditions (wavelength 420 nm, dye extraction time 60 min, material to liquor ratio 1:20, dyeing time 50 min) using Mb : AS mordant combination.

Mordanting Method	Mordant Proportions	Light Fastness Grades	Washing Fastness		Rubbing Fastness		Perspiration Fastness			
			Grades		Grades		Grades		Acidic	
			CC	CS	Dry		Wet		CS	CC
Pre Mordanting	1:3	3-4			5	4-5	5	3		
	1:1	3-4	4-5	5	5	4-5	5	4	4-5	5
	3:1	3-4	4-5	5	5	4-5	5	3	4-5	5
Simultaneous Mordanting	1:3	4	4-5	5	5	5	5	4	4	5
	1:1	4	5	5	5	5	5	4	4-5	5
	3:1	3-4	4-5	5	5	5	5	4	4-5	5
Post Mordanting	1:3	4	4	5	5	4-5	5	4	4-5	5
	1:1	4	4-5	5	5	4/5	5	4	4-5	5
	3:1	4	4-5	5	5	4-5	5	4	4-5	5

Mb:AS – Myrobalan: Aluminium sulphate, CC – Colour change, CS – Colour staining

Table 3: Fastness grades of stem of *Achras sapota* dye dyed on cotton at optimum dyeing conditions (wavelength 420 nm, dye extraction time 60 min, material to liquor ratio 1:20, dyeing time 50 min) using Mb:PD mordant combination.

Mordanting Method	Mordant Proportions	Light Fastness Grades	Washing Fastness		Rubbing Fastness		Perspiration Fastness			
			Grades		Grades		Grades		Acidic	
			CC	CS	Dry		Wet		CS	CC
Pre Mordanting	1:3	3-4			2-3	5	5	4-5	5	4
	1:1	3-4	3	5	5	4-5	5	5	4	5
	3:1	3-4	3	5	5	4-5	5	3-4	4	5
Simultaneous Mordanting	1:3	3-4	3	5	5	5	5	4-5	4	5
	1:1	3-4	3	5	5	5	5	4-5	4	5
	3:1	3-4	3	5	5	5	5	4-5	4-5	5
Post Mordanting	1:3	3-4	4-5	5	5	4-5	5	4	4-5	5
	1:1	3-4	4	5	5	4-5	5	3-4	4-5	5
	3:1	3-4	4-5	5	5	4-5	5	4	4-5	5

Mb:PD – Myrobalan: Potassium dichromate, CC – Colour change, CS – Colour staining

Mordant Combination-Myrobalan : Ferrous Sulphate

The evaluation of colour fastness to light, washing, rubbing and perspiration of stem of *Achras sapota* dyed cotton samples treated with myrobalan : ferrous sulphate combination in aqueous medium is presented in Table 4. The treated samples subjected to light showed fairly good (4-3-4) light fastness for all ratios of mordant combinations. The washing fastness grades ranged from excellent to good (5-4) for all the treated samples. The colour change to dry and wet rubbing for all the treated samples was excellent (5). The colour staining ranged from no staining to slight staining (5 to 3-4) in dry rubbing slight to noticeable colour staining (4-5 to 3) in wet rubbing. Most of the treated samples showed excellent fastness grade to colour change, except for 1:3 mordant proportion in simultaneous mordanting method., where it was good (4) for all samples in both acidic and alkaline media. There was no colour staining (5) for all the treated samples in both acidic and alkaline media as given in Table 4.

Table 4: Fastness grades of stem of *Achras sapota* dye dyed on cotton at optimum dyeing conditions (wavelength 420 nm, dye extraction time 60min, material to liquor ratio 1:20, dyeing time 50 min) using Mb:FS mordant combination.

Mordanting Method	Mordant Proportions	Light Fastness Grades	Washing Fastness		Rubbing Fastness			Perspiration Fastness				
			Grades		Grades		Grades		Acidic		Alkaline	
			CC	CS	CC	CS	CC	CS	CC	CC	CS	CC
Pre Mordanting	1:3	3-4	4-5	5	5	4-5	5	4-5	5	5	5	5
	1:1	3-4	5	5	5	4-5	5	4	5	5	5	5
	3:1	3-4	4-5	5	5	4-5	5	4-5	5	5	5	5
Simultaneous Mordanting	1:3	3-4	5	5	5	5	5	4-5	4-5	5	5	5
	1:1	4	4-5	5	5	5	5	4-5	4-5	5	5	4-5
	3:1	4	4	5	5	5	5	4-5	5	5	5	5
Post Mordanting	1:3	3-4	4	5	5	4-5	5	4-5	5	5	5	5
	1:1	3-4	5	5	5	4-5	5	4	4-5	5	5	5
	3:1	3-4	4-5	5	5	4-5	5	4	5	5	5	5

Mb:FS – Myrobalan: Ferrous Sulphate, CC – Colour change, CS – Colour staining

Table 5: Fastness grades of stem of *Achras sapota* dye dyed on cotton at optimum dyeing conditions (wavelength 420 nm, dye extraction time 60min, material to liquor ratio 1:20, dyeing time 50 min) using Mb:SC mordant combination.

Mordanting Method	Mordant Proportions	Light Fastness Grades	Washing Fastness		Rubbing Fastness			Perspiration Fastness				
			Grades		Grades		Grades		Acidic		Alkaline	
			CC	CS	CC	CS	CC	CS	CC	CC	CS	CC
Pre Mordanting	1:3	4	4-5	5	5	4-5	5	4	4-5	5	4-5	5
	1:1	4	4-5	5	5	3-4	5	3	4-5	5	4-5	5
	3:1	4	4-5	5	5	3-4	5	3	4-5	5	4-5	5
Simultaneous Mordanting	1:3	3-4	5	5	5	5	5	4-5	4	5	4	4
	1:1	3-4	4-5	5	5	5	5	4-5	5	5	5	5
	3:1	3-4	4	5	5	5	5	4-5	5	5	5	5
Post Mordanting	1:3	3-4	4	5	5	4-5	5	4-5	5	5	5	5
	1:1	3-4	5	5	5	4-5	5	4	4-5	5	5	5
	3:1	3-4	4-5	5	5	4-5	5	4	5	5	5	5

Mb:SC – Myrobalan: Stannous chloride, CC – Colour change, CS – Colour staining

Mordant Combination-Myrobalan : Stannous Chloride

The evaluation of colour fastness to light, washing, rubbing and perspiration of stem of *Achras sapota* dyed cotton samples treated with myrobalan : stannous chloride combination in aqueous medium is presented in Table 5. The treated samples subjected to light showed fairly good (4 to 3-4) light fastness for all the ratios of mordant combinations. The washing fastness grades ranged between excellent to good (4-5 to 3-4) for all the treated samples and there was no colour staining. The colour change to dry and wet rubbing for all the treated samples was excellent (5). The colour staining ranged from negligible to slight staining (4-5) in both dry and wet rubbing. The perspiration fastness grades ranged between 4 and 5 for all samples in both acidic and alkaline media. There was no colour staining (5) for all the treated samples in both acidic and alkaline media as given in Table 5.

CONCLUSION

It was found from the study that stem of *Achras sapota* dye can be successfully used for dyeing cotton to obtain a wide range of soft, pastel and light colours by using combination of mordants. With regards to colour fastness, test samples exhibited excellent fastness to washing (except for pre-mordanting using myrobalan : potassium dichromate combination); excellent fastness to rubbing (except for pre-mordanting using myrobalan : potassium dichromate combination); and good to excellent fastness to perspiration in both acidic and alkaline media and fairly good fastness to light.

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