Research Article

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ECO-FRIENDLY DYEING OF COTTON FABRIC WITH A NATURAL DYE EXTRACTED FROM FLOWERS OF *LANTANA CAMARA* LINN.

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Abstract: The present study was carried out to revive the old art of dyeing with natural dye from flowers of *Lantana camara Linn*. It belongs to family Verbenaceae, commonly known as unnichedi. The dye has good scope in the commercial dyeing of cotton in textile industry. In the present investigation, bleached cotton fabrics were dyed with different chemical mordants. Dyeing was carried out by pre-mordanting, post mordanting and simultaneous mordanting. Fastness properties of the dyed samples were determined by standard IS methods. The dyed samples have shown good washing, light and rubbing fastness properties. The various colour changes were measured by computer colour matching software. The range of colour developed on dyed samples were evaluated in terms of (L*a*b*) CIELAB coordinates and the dye absorption on the cotton was studied by using K/S values. An ICPMS study was also performed for the dye extract. This study has proved that, heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye extract.

Keywords: Extraction, natural dye, flowers, *Lantana camara Linn*, cotton, textiles.

INTRODUCTION

Natural dyes are generally eco-friendly and have many advantages over synthetic dyes. Natural dyes are known for their use in colouring of food substrate, leather, wood as well as natural fibers like cotton, silk, wool and flax as major areas of application since ancient times. Natural dyes may have a wide range of shades and can be obtained from various parts of plants including leaves, seeds, roots, flowers, barks, fruit etc. Since the advent of widely available and cheaper synthetic dyes in 1856 having moderate to excellent colour fastness properties, the use of natural dyes having poor to moderate wash and light fastness has declined to a great extent. However, recently there has been revival of the growing interest on the application of natural dyes on natural fibers due to worldwide environmental consciousness [1]. The widely and commonly used synthetic dyes impart strong colour but causes carcinogenicity and inhibition of benthic photosynthesis [2]. In many of the world's developing countries, natural dyes can offer not only rich and varied source of dye stuff, but also the possibility of an income through sustainable harvest and sale of these plants [3].

The use of natural dyes for textile dyeing purposes, decreased to a large extent after the discovery of synthetic dyes in 1856. As a result, with a distinct lowering in synthetic dye stuff costs, the natural dyes were virtually unused at the beginning of 20thcentury [4]. Presently there is an excessive use of synthetic dyes, estimated at around 10x10^{6} tons per annum, the production and application of which release vast amount of waste and unfixed colorants causing serious health hazards and disturbing the eco-balance of nature. Nowadays, fortunately there is increasing awareness among people towards natural dyes. Natural dyes are preferred in developed countries, because they are non-allergic, non-carcinogenic and have lower toxicity and better biodegradability than the synthetic dyes [5].

Lantana camara Linn is a perennial flowering plant, native to tropical regions of the America and Africa. It is a some what hairy shrub that when bruised gives a spicy pungent odour. The aromatic flowers are borne in clusters and are a mixture of red, yellow, blue, lilac, white and orange florets. The leaves are pointed at the tip, rounded at the base and toothed in the margins. They grow as a bush and can reach up to 6 feet tall and wide. Deadheading spent flowers will encourage additional blooming and will prevent the growth of toxic berries. Lantanas are easy to care for and grow anywhere in well drained soils. Enjoy this attractive plant as butterflies enjoy the sweet nectar from the beautiful blooms. Flowers known to be haemostatic and the decoction of dried flowers are used for haemoptysis and pulmonary tuberculosis. Lantana leaves can be used for relief from headaches, fever, flu, coughs, colds toothaches and indigestion. It also relieves the symptoms of rheumatism and other joint

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pains. Use pounded fresh leaves applied as poultice for sprains, wounds and contusions. The dried lantana leaves that have been burned in a glass jar are also known to be a natural mosquito repellent [6].

MATERIALS AND METHODS

Source: The flowers of *Lantana camara Linn* was collected from Punalvasal village, Thanjavur district as shown in figure 1 and figure 2.

Fig.1: *Lantana camara Linn* plant
Fig.2: Flowers of *Lantana camara Linn*

Substrates: The 100% pure cotton woven fabric has been selected for the study. It was purchased from AL. LAN Texknit Processors, SIPCOT Industrial Growth Centre, Perundurai, Erode District.

Chemicals used: AR grade metallic salts such as copper sulphate, ferrous sulphate, alum, potassium dichromate, nickel sulphate and stannous chloride were used as chemical mordants.

Dye extraction: The flowers were soaked with 70% ethanol for 24 hours and then heated in a beaker kept over a water bath for 30 minutes to facilitate quick extraction. Then it was filtered and the filtrate was collected in a separate bottle.

Dyeing procedure: The cotton fabrics were dyed with dye extract keeping different M: L ratio such as 1:10, 1:20, 1:30 and 1:40. Dyeing was carried out different temperatures such as 40°C, 60°C and 80°C and continued for 1 hour.

Mordanting: The cotton fabrics were treated with different chemical mordants by following three methods [7].

(i) Pre-mordanting (PM): In this method, cotton fabrics were pretreated with the solution of different chemical mordants and then dyed with dye extract.

(ii) Post mordanting (POM) : In this method, dyed cotton fabrics were treated with solution of different chemical mordants.

(iii) Simultaneous mordanting (SM): In this method, the cotton fabrics were dyed with dye extract as well as different chemical mordants.

Colour fastness:

The colour fastness of the dyed cotton fabrics were tested according to IS standards. Colour fastness to washing, light and rubbing were determined from standard test methods IS-687-79, IS-2454-85 and IS-766-88 respectively [8].

Measurement of colour strength:

The colour strength of the dyed cotton fabrics were determined by K/S values. The light reflectance of the dyed cotton fabrics were measured using a Text flash spectrophotometer (Data colour corp.). The K/S values were calculated by Kubelka-Munk equation.

$$K / S = (1 - R)^2 / 2R$$

Where, R is the decimal fraction of the reflectance of the dyed samples at λ_{max}. K is the absorption coefficient and S is scattering coefficient [9].

ICPMS studies:

The presence of heavy metals like antimony, arsenic, cadmium and lead in the dye extract causes dermatological problems to the wearer and also eco-friendly dye should not contain these heavy metals [10]. The presence / absence of these heavy metals were tested by Inductive Coupled Plasma Mass Spectrometer (ICPMS).

RESULT AND DISCUSSION

Optimization of ethanolic extract of *Lantana camara Linn*

The flowers of *Lantana camara Linn* were found to discharge colour in 70% ethanol very easily. Increasing the quantity of flowers 5 g to 20 g per 100 mL ethanol and boiled for 30 minutes is accompanied with the increase in colour strength and depth in colour [11]. It was visually observed that colour of the dye extract was dark orange colour as shown in figure 3.

Fig.3: Ethanolic extract from flowers of Lantana *camara Linn*

Effect of mordanting:

The dye extract was found to be suitable for cotton fabric. The cotton fabrics were dyed with different chemical mordants. It was observed that the dye uptake was found to be good in pre mordanting (PM) method is shown in figure 4.

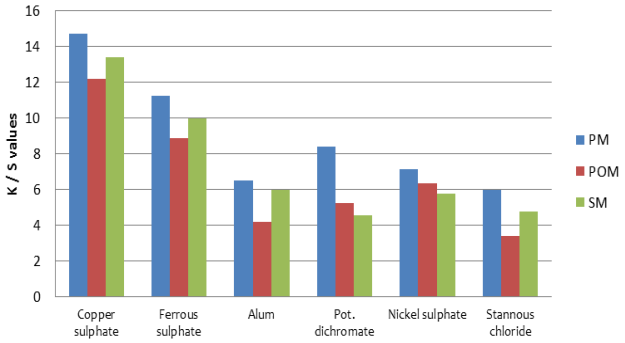

Fig.4: Surface color strength (K/S values) of dyed cotton fabrics after pre (PM), post (POM) and simultaneous mordanting (SM)

Effect of M: L ratio:

The cotton fabrics were dyed with dye extract keeping various M: L ratio such as 1:10, 1:20, 1:30 and 1:40. It was observed that, the dye uptake was good in M: L ratio 1:30.

Effect of dye bath temperature:

The effect of temperature on the dyeability of cotton fabric with the dye extract was conducted at different temperatures like 40°C, 60°C and 80°C. It was clear that, the colour strength (K/S) values increased with increase of dyeing temperature.

Optimization of mordants with K/S value and colour hue changes:

The different shades of colour were obtained from pre, post, simultaneous mordanted cotton with copper sulphate, ferrous sulphate, alum, potassium dichromate, nickel sulphate, and stannous chloride as shown in table 1. The different mordants not only cause difference in shades of colour and significant changes in K/S values but also changes in L* values and brightness index value. The effect of mordants on colour strength of cotton dyed with flowers of *Lantana camara Linn* is shown in figure 5.

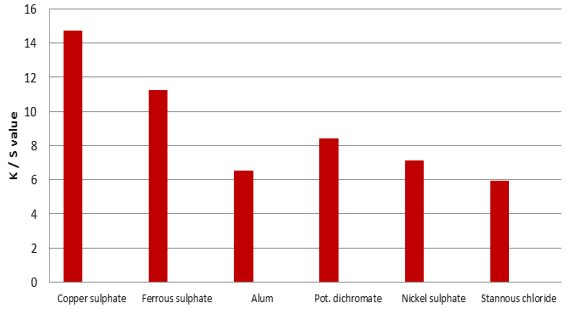

Fig.5: Effect of pre mordants on K/S values of dyed cotton fabrics

Table 1: Colour produced on cotton by different pre mordants with dye extract

S. No.	Name of the mordants	Colour obtained	S. No.	Name of the mordants	Colour obtained
1	Ferrous sulphate		4	Potassium dichromate	
2	Copper sulphate		5	Nickel sulphate	
3	Alum		6	Stannous chloride	

The L*, a*, b* and K/S values of dyed cotton fabrics are given in table-2. It can be noted that, mordants which show higher value of L* show lighter shades while lower L* value show darker shades for cotton. Similarly, the values of a* and b* represent the red / green and yellow / blue respectively. Among the chemical mordants used, the copper sulphate exhibited highest colour strength (K/S = 14.71) and stannous chloride exhibited lowest colour strength (K/S = 5.95).

Table 2: Different pre mordants, L*, a*, b* and K/S values for cotton dyed with flowers of *Lantana camara Linn*

S. No	Mordants	L*	a*	b*	K/S value
1	Copper sulphate	35.34	2.34	6.86	14.71
2	Ferrous sulphate	40.21	5.35	8.81	11.23
3	Alum	60.12	-4.51	1.23	6.51
4	Potassium dichromate	56.35	-8.80	6.72	8.41
5	Nickel sulphate	58.34	-5.69	3.62	7.12
6	Stannous chloride	63.56	-3.89	1.61	5.95

Fastness properties:

The fastness properties of dyed cotton fabrics were evaluated by standard IS methods. It was observed that, dyeing with *Lantana camara Linn* gave good fastness properties. The fastness properties of dyed cotton fabrics are shown in table 3. Overall, it could be used for commercial purposes and attain acceptable range.

Table 3: Fastness properties for cotton fabric dyed with flower extract of *Lantana camara Linn*

S. No	Mordants	Washing (IS-687-79)	Light (IS-2454-85)	Rubbing (IS-971-83)	
				Dry	Wet
1	Copper sulphate	4 –5	V	4 – 5	3 – 4
2	Ferrous sulphate	4 – 5	V	4 – 5	4 – 5
3	Alum	3 – 4	IV	4 – 5	3 – 4
4	Potassium dichromate	4 – 5	IV	3 – 4	4
5	Nickel sulphate	3 – 4	IV	4 –5	3 – 4
6	Stannous chloride	3 – 4	IV	3 – 4	4

ICP-MS studies:

Inductive Coupled Plasma Mass Spectrometer (ICPMS) studies have proved that, heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye obtained from flowers of *Lantana camara Linn* and will not cause any skin problems to the wearer.

CONCLUSIONS

The present work was proved that, flowers of *Lantana camara Linn* can be used as a dye for colouring textiles. *Lantana camara Linn* is grown throughout India and it is an easily available plant. Different shades of colour can be obtained using different chemical mordants. The washing, light and rubbing fastness of all dyeing with mordants were quite good. The dye has good scope in the commercial dyeing of cotton.

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