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Dyeing of Silk with Ecofriendly Natural Dye obtained from Barks of *Ficus Religiosa.L*

[1] Saravanan P. and [2]Chandramohan G.

Department of Chemistry, Mohamed Sathak A.J College of Engineering, Rajiv Gandhi Road (OMR), IT Highway, Egattur, Chennai, TamilNadu-603103, India.

Department of Chemistry, A.V.V.M Sri Pushpam College, Poondi, Thanjavur, TamilNadu- 613503, India.

Corresponding author: p.v.saravana@gmail.com

Abstract:

The present investigation was carried out to revive the old art of dyeing with natural dye obtained from barks of *Ficus religiosa.L. Ficus religiosa.L* belongs to family moraceae, commonly known as peepal tree. The dye has good scope in the commercial dyeing of silk in garments industry. In the present study, bleached silk fabrics were dyed with chemical and natural mordants. Dyeing was carried out by pre-mordanting, post mordanting and simultaneous mordatning. The dyed samples have shown good washing, light and rubbing fastness properties. The various colour changes were measured by computer colour matching software. The heavy metals like antimony, arsenic, cadmium and lead present in the extract were determined by Inductive Coupled Plasma Mass Spectrometer.

Keywords: Extraction, ecofriendly dye, *Ficus religiosa.L*, silk, textiles

1. Introduction:

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 (D.Jothi, 2008). The natural dyes present in plants and animals are pigmentry molecules, which impart colour to the materials. These molecules containing aromatic ring structure coupled with a side chain are usually required for resonance and thus to impart colour. There is a correlation of chemical structure with colour, chromogen-chromophore with auxochrome (Purrohit, 2011).

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 twenties century (Purrohit, 2011). Presently there is an excessive use of synthetic dyes, estimated at around 10,000,000 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 (Goodarzian, 2010). Nowadays, fortunately, there is increasing awareness among people towards natural dyes. Natural dyes have better biodegradability and generally have higher compatibility with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable (Kulkarni, 2011).

Ficus religiosa.L is a large, fast growing deciduous tree with heart shaped leaves. It is a medium size tree and has a large crown with the wonderful spreading branches. It sheds its leaves in the month of March and April. The fruits of the peepal are hidden with the figs. The figs which contain the flower grow in pairs just below the leaves and look like the berries. Its bark is grey and peels in patches. It is one of the blondest living trees. Other names of this tree are Bo tree, Bodhi tree, Buddha tree, sacred tree, etc. This tree is grown throughout India. It is mainly grown in state of Haryana, Bihar, Kerala and Madhya Pradesh. *Ficus religiosa.L* is used in traditional medicine for about 50 types of disorders including asthma, diabetes, diarrhea, gastric problems, inflammatory disorders and sexual disorders.

2. Materials and Methods

2.1 Materials:

2.1.1 Source:

The barks of *Ficus religiosa.L* was collected from Mohamed Sathak A.J college of Engineering campus. Sirucheri,Chennai.

Figure 1: *Ficus religiosa.L* tree

Figure 2: Barks of *Ficus religiosa.L*

2.1.2 Substrates: Silk fabric was purchased from Kamala store, Thanjavur and it was used for dyeing.

2.1.3 Chemicals Used:

AR grade metallic salts such as copper sulphate, ferrous sulphate, alum (K_2SO_4. $Al_2(SO_4)_3.24H_2O$), potassium dichromate, nickel sulphate and stannous chloride were used as chemical mordants. Myrobolan and cow dung were used as natural mordants.

2.2 Experimental Methods

2.2.1 Dye Extraction

Barks of plant were cut into small pieces and soaked in distilled water and heated in a beaker kept over a water bath for 2 hours to facilitate quick extraction. Then it was filtered and the filtrate was collected in a separate beaker.

2.2.2 Dyeing Procedure:

The silk samples were dyed with dye extract keeping M : L ratio as 1:30. Dyeing was carried out at 80^{o} C and continued for 1 hour.

2.2.3 Mordanting:

The silk samples were treated with different metallic salts and natural mordants by following three methods;

(i) Pre-mordanting:

In this method, samples were pretreated with the solution of different chemical and natural mordants. The pretreated silk fabric was introduced into the dye bath containing required amount of dye extract and water. After 5 minutes acidic acid was added. After 30 minutes sodium sulphate was added. The dyeing was carried out for 1h at 80 ^{o} C. The dyed samples were taken out, squeezed, washed with water and dried at room temperature (Kumaresan, 2011).

(ii) Post Mordanting:

In this method, silk fabric was introduced into the dye bath containing required amount of dye extract and water. After 5 minutes acidic acid was added. After 30 minutes sodium sulphate was added. The dyeing was carried out for 1h at 80 ^{o} C. The dyed samples were taken out, squeezed and treated with solution of different chemical and natural mordants (Kumaresan, 2011).

(iii) Simultaneous Mordanting:

In this method, the silk samples were dyed with dye extract as well as different chemical and natural mordants simultaneously (Kumaresan, 2011).

2.2.4 Colour Fastness:

The dyed samples 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.

2.2.5 Measurement of Colour Strength:

The spectral reflectances of the dyed samples 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 (S. Habibzadeh, 2010)

2.2.6 Spectral Analysis:

The presence of heavy metals like antimony, arsenic, cadmium and lead in dyed fabric causes dermatological problems to the wearer and also ecofriendly dye should not contain these heavy metals (Pabita Saha, 2010). The presence/ absence

of these heavy metals were tested by Inductive Coupled Plasma Mass Spectrometer (ICPMS).

3.0 Result and Discussion:

3.1 Preparation and Optimization of Aqueous Extract of Ficus Religiosa.L

The barks of *Ficus religiosa.L* were found to discharge colour in hot water very easily. Increasing the quantity of barks 5 g to 20 g per 100 mL water boiled for 1 hour is accompanied with the increase in colour strength and depth in colour (Rakhi Shaker, 2006). It was observed that, colour of the dye extract was dark red colour as shown in Figure 3.

3.2 Dyeing Behavior of the Dye Extract:

The dye extract was found to be suitable for silk. The silk fabrics were dyed with chemical and natural mordants. It was observed that, the dye uptake was found to be good in pre-mordanting method is shown in Figure 4.

Figure 3: Aqueous Extract from Barks of *Ficus religiosa.L*

3.3 Optimization of Mordants with K/S Value and Colour Hue Changes:

Various hues of colour were obtained from pre-mordanted silk with copper sulphate, ferrous sulphate, alum (K_2SO_4. $Al_2(SO_4)_3.24H_2O$), potassium dichromate, nickel sulphate, stannous chloride, myrobolan and cow dung. As shown in Table 1. The different mortants not only cause difference in hues of colour and significant changes in K/S values but also changes in L* values and brightness index value The effect of mordtants on colour values of silk dyed with barks of *Ficus religiosa.L* is shown in Figure 5.

Table 1: Colour Produced On Silk by Different Mordants in Pre-Mordanting

Mordants	Colour obtained	Mordants	Colour obtained
Potassium dichromate		Alum	
Ferrous sulphate		Stannous chloride	
Copper sulphate		Myrobolan	
Nickel sulphate		Cow dung	

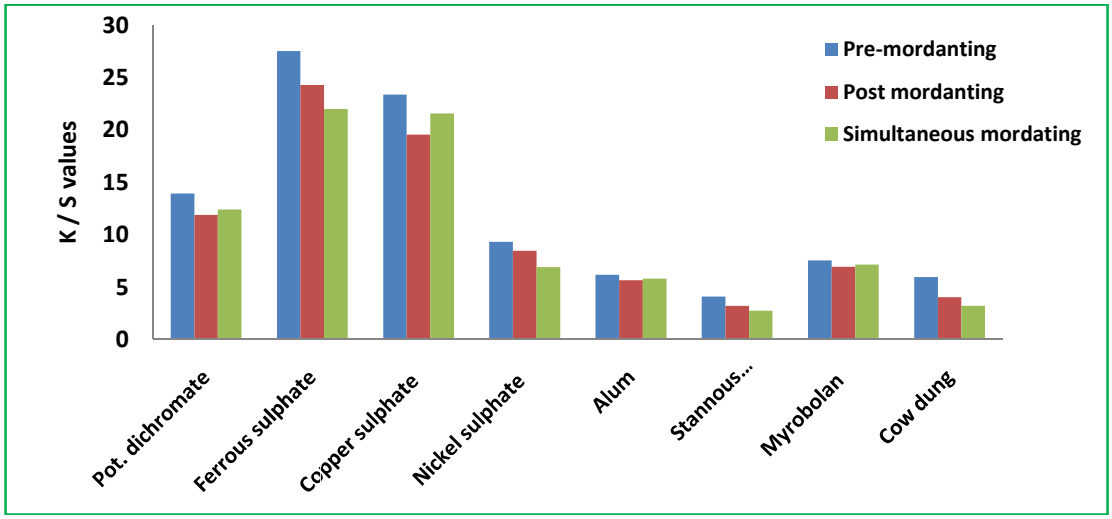

Figure 4: Surface Colour Strength (K/S Values) of Dyes Silk Fabrics after Pre, Post and Simultaneous Mordanting Methods

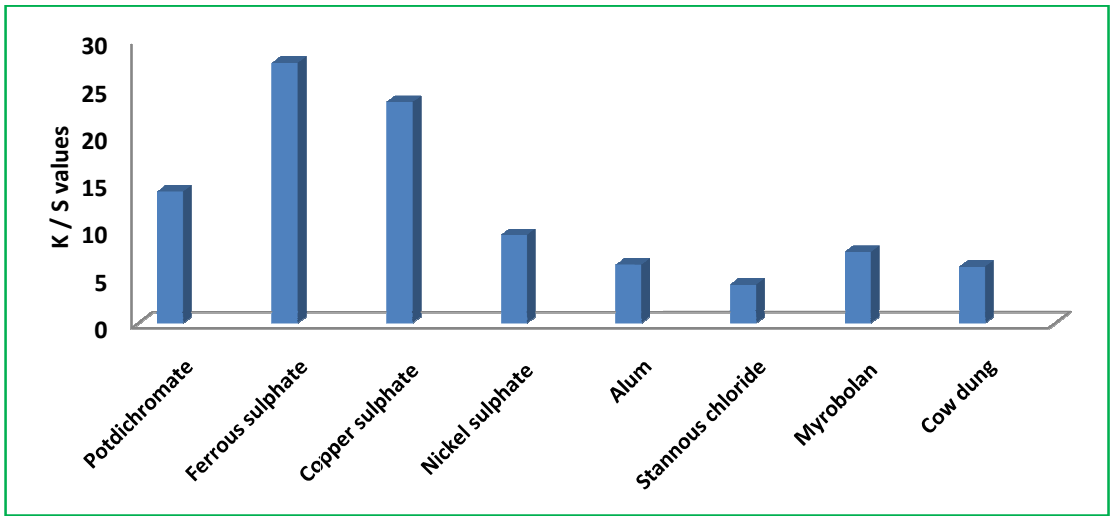

Figure 5: Effect of Mordants on Colour Values of Silk Dyed with Barks of *Ficus religiosa*.L (Pre-Mordanted)

Table 2 shows L*, a* b* and K/S values and it can be seen that, mordants which show higher value of L* show lighter shades while lower L* value show darker shades for silk. Similarly, negative values of a* and b* represent green and blue respectively. Among the chemical mordants used, the highest colour value (K/S = 27.56) was obtained with ferrous sulphate and lowest colour value (K/S = 2.08) with stannous chloride. Natural mordant like myrabolan showed the higher colour value (K/S = 5.53) than the cow dung (K/S = 3.96) (Habibzadeh, 2010).

3.5 Fastness Properties:

The fastness properties of dyed silk fabrics are shown in Table 3. It was observed that, dyeing with *Ficus religiosa.L* gave good washing, light and rubbing fastness properties. Overall, it could be used for commercial purposes and attain acceptable range.

Table 2: Different Pre-Mordants, L*, A*, B* and K/S Values for Silk Fabric Dyed with *Ficus Religiosa.L*

No	Mordants	L*	a*	b*	K / S value
1	Potassium dichromate	-1.21	-5.74	-12.63	13.93
2	Ferrous sulphate	-8.56	-13.79	-22.27	27.56
3	Copper sulphate	-2.96	6.64	-1.95	23.40
4	Nickel sulphate	3.37	-3.13	-0.30	6.31
5	Alum	8.03	-2.52	-3.43	4.17
6	Stannous chloride	14.86	-6.94	-7.32	2.08
7	Myrobolan	3.90	-2.15	-1.46	5.53
8	Cow dung	6.13	-4.66	-5.75	3.96

Table 3: Fastness Properties for Silk Fabric Dyed with *Ficus religiosa.L*

No	Mordants	Washing (IS-687-79)	Light (IS-2454-85)	Rubbing (IS-971-83)	
				Dry	Wet
1	Potassium dichromate	4	IV	3-4	3
2	Ferrous sulphate	4- 4/5	IV	4	3-4
3	Copper sulphate	4-4/5	III	4	4
4	Nickel sulphate	4-4/5	IV	3-4	3-4
5	Alum	4-5	IV	4-5	4-5
6	Stannous chloride	4-4/5	III	3-4	3-4
7	Myrobolan	4-5	IV	4-5	4
8	Cow dung	3-4	III	3-4	3-4

3.6 Spectral Analysis:

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 extract. Hence, dye obtained from barks of *Ficus religiosa.L* will not cause any skin problems to the wearer and also will not pollute the environment.

4.0 Conclusion:

The present work shows that, barks of *Ficus religiosa.L* can be used as dye for colouring textiles. These are grown throughout India and so are easily available. Different shades of colour can be obtained using different chemical and natural mordants. The washing, light and rubbing fastness of all dyeing with mordants were quite good. Heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye extract. Hence, this dye will not cause any skin problems to the wearer and also will not pollute the environment. The dye has good scope in the commercial dyeing of silk.

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