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***J. Nat. Prod. Plant Resour.*, 2013, 3 (2):80-85**
(http://scholarsresearchlibrary.com/archive.html)

Journal of Natural Product and Plant Resource
Scholars Research Library

ISSN : 2231 – 3184
CODEN (USA): JNPPB7

Extraction and application of eco-friendly natural dye obtained from barks of *Odina wodier*.L on cotton fabric

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ABSTRACT

The present investigation was carried out to revive the old art of dyeing with natural dye from barks of Odina wodier.L. Odina wodier.L belongs to family Anacardiaceae, commonly known as votiyar tree. The dye has good scope in the commercial dyeing of cotton in garments industry. In the present study, bleached cotton 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, rubbing fastness and perspiration fastness properties properties. The various colour changes were measured by computer colour matching software. ICPMS studies have proved that, heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye extract. Anti-bacterial and anti-fungal activities of the dye were also studied.

Keywords: Extraction, natural dye, barks, *Odina wodier*.L, cotton, textiles.

INTRODUCTION

Natural dyes are known for their use in colouring of food substrate, leather, wood as well as natural fibers like wool, silk, cotton 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 roots, bark, leaves, flowers, and fruit. 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].

Dyeing is an ancient art which predates written records. It was Bronze Age. 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 twenties century [4]. 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 [5]. 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.

Odina wodier.L is a large tall tree (Fig.1) found in de-ciduous forest in India, Myanmar, Srilanka, China, Malaysia, Cambodia and Philippine Islands. It is popularly known as Kashmala, Odiamaram and in English it is called Rhus odina. Various parts of this plant have been found to be used as medicines in Ayurveda. The leaves have been reported to use in Elephantiasis of the legs. Juice of green branches is used as an emetic in case of coma or insensibility produced by narcotic. The dried and powdered bark is found to use as tooth powder by poor villagers [6]. The bark extract has been reported to be useful in vaginal trouble, curing ulcer, heart diseases etc. [7].

MATERIALS AND METHODS

2.1 Materials:

2.1.1 Source *:*

The barks of *Odina wodier*.L was collected from saliamangalam village, thanjavur district (fig.2).

Figure 1 : *Odina wodier*.L tree

Figure 2 : Barks of *Odina wodier*.L

2.1.2 Substrates: Desized, scoured and bleached cotton fabric was used for used for dyeing

2.1.3 Chemicals used: AR grade metallic salts such as copper sulphate, ferrous sulphate, alum [$(K_2SO_4.Al_2(SO_4).24H_2O$], 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 cotton 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 Mordating: The Cotton samples were treated with different metallic salts and natural mordants by following three methods [8].

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

(ii) Post mordtanting : In this method, dyed cotton samples were treated with solution of different chemical and natural mordants.

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

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.

$$\mathbf{K / S = (1 - R)^2 / 2R}$$

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].

2.2.6 **ICPMS studies**
The presence of heavy metals like antimony, arsenic, cadmium and lead in dyed fabric 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).

2.2.7 Anti-Bacterial and anti-fungal activity Studies
2.2.7.1 Antibacterial activity
For the purpose of antibacterial evaluation, five bacterial pathogens were used [11]. Staphylococcus sp., Salmonella typhi, Klebsiella sp., Staphylococcus aureus and Enterobactor sp were employed for determination of antibacterial activity of the dye.

2.2.7.2 Antifungal activity
For the purpose of antifungal evaluation, five fungal pathogens were used [11]. Fusarium sp., Cryptococcus sp., A. niger, Candida sp. and A.flavus were employed for determination of antifungal activity of the dye.

RESULTS AND DISCUSSION

3.1 Preparation and optimization of aqueous extract of *Odina wodier*.L
The barks of *Odina wodier*.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 [12]. It was observed that, colour of the dye extract was dark red colour.

Figure 3 : Aqueous extract from barks of *Odina wodier.L*

3.2 Dyeing behavior of the dye extract
The dye extract was found to be suitable for cotton. The cotton fabrics were dyed with chemical and natural mordants. It was observed that, the dye uptake was found to be good in post mordanting method is shown in Figure 4.

3.3 Optimization of mordants with K/S value and colour hue changes
Various hues of colour were obtained from simultaneous mordanted cotton with copper sulphate, ferrous sulphate, alum [$(K_2SO_4.Al_2(SO_4).12H_2O$], potassium dichromate, nickel sulphate, stannous chloride, myrobolan and cow dung. As shown in Table I. 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 cotton dyed with barks of *Odina wodier*.L is shown in Figure 5.

Table I : Colour produced on cotton by different mordants in post mordanting

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

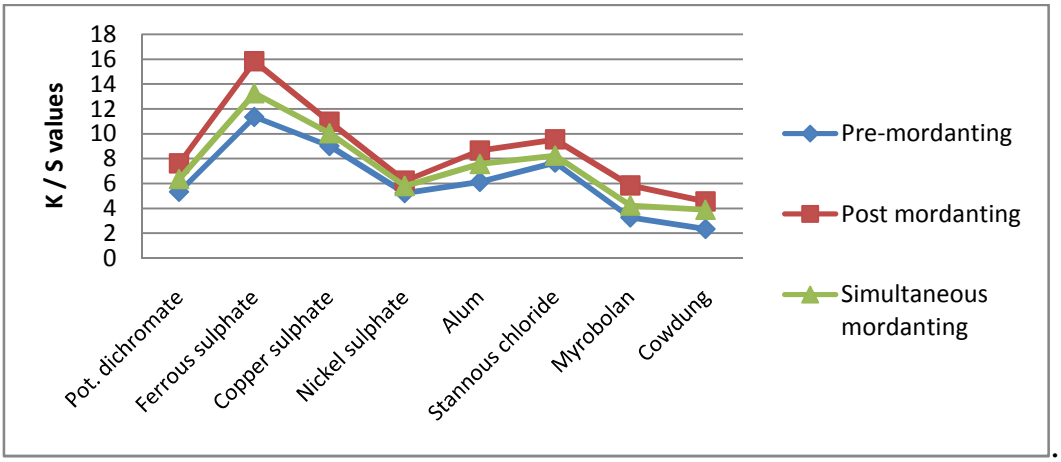

Figure 4: Surface colour strength (K/S values) of dyes cotton fabrics after pre, post and simultaneous mordanting methods

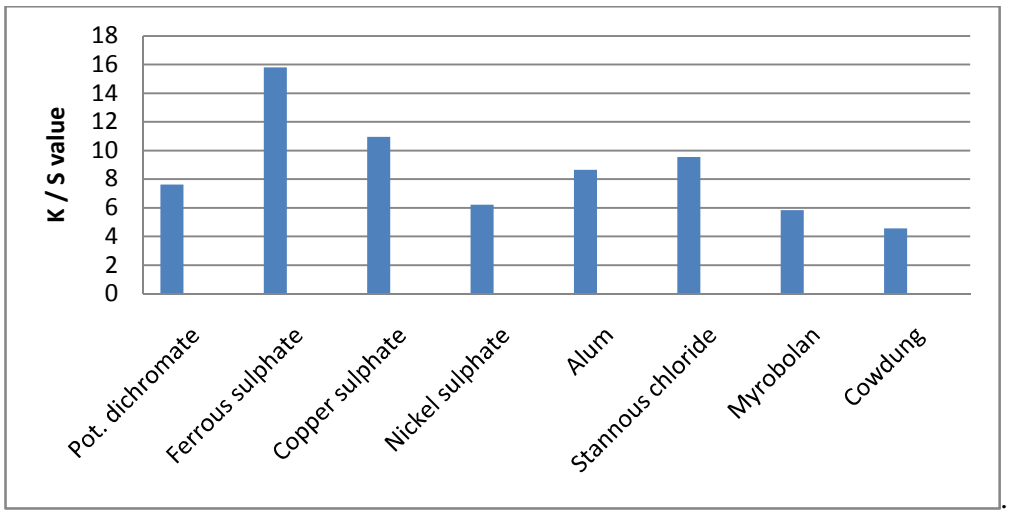

Figure 5: Effect of mordtants on colour values of dyed cotton fabrics

Table II 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 cotton. Similarly, negative values of a* and b* represent green and blue respectively. Among the chemical mordants used, the highest colour value (K/S = 15.81) was obtained with ferrous sulphate and lowest colour value (K/S = 6.22) with nickel sulphate. Natural mordant like myrabolan showed the higher colour value (K/S = 5.84) than the cow dung (K/S = 4.56) [9].

Table II : Different post mordants, L*, a*, b* and K/S values for dyed cotton *Odina wodier*.L.L

S.No	Mordants	L*	a*	b*	K /S value
1	Potassium dichromate	62.35	4.56	26.36	7.62
2	Ferrous sulphate	42.61	5.62	14.40	15.81
3	Copper sulphate	58.62	2.18	28.49	10.95
4	Nickel sulphate	56.40	5.26	19.56	6.21
5	Alum	58.21	-1.62	22.56	8.65
6	Stannous chloride	44.20	10.78	15.72	9.54
7	Myrobolan	58.26	5.65	18.69	5.84
8	Cow dung	62.53	5.32	17.36	4.56

3.5 Fastness properties

It was observed that, dyeing with *Odina wodier*.L gave good fastness properties. The fastness properties of dyed cotton fabrics are shown in Table III. Overall, it could be used for commercial purposes and attain acceptable range.

Table III : Fastness properties for cotton fabric dyed with *Odina wodier*.L

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

3.6 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 extract. Hence, dye obtained from barks of *Odina wodier.L.L* will not cause any skin problems to the wearer.

3.7 Anti-Bacterial and anti-fungal activity Studies

In this study, five different bacterial and fungal pathogens were used to screen the possible antimicrobial activity of dye extract. Dye extract exhibited antibacterial and antifungal activity against all tested microorganisms.

Antibacterial activity : The dye showed good antibacterial activity against *Staphylococcus* sp., *Staphylococcus aureus* and *Enterobactor* sp. bacterial pathogens. As it is shown in Table IV, the generation of most bacterial and the

A**nti-fungal activity :** The dye showed good antifungal activity against *A. niger, Candida* sp. *and A. flavus* fungal pathogens. As it is shown in Table V, the generation of most bacterial and the

Table IV : Antibacterial activities of dye extract from barks of *Odina wodier*.L.L

S.No	Name of bacterial pathogens	Zone of Inhibition (mm)	
		Control	Dye sample
1.	*Staphylococcus* sp.	-	8
2.	*Salmonella typhi*	-	-
3.	*Klebsiella* sp.	-	-
4.	*Staphylococcus aureus*	-	11
5.	*Enterobactor* sp.	-	13

Table V : Antifungal activities of dye extract from barks of *Odina wodier*.L.L

S.No	Name of fungal pathogens	Zone of Inhibition (mm)	
		Control	Dye sample
1.	*Fusarium* sp.	-	-
2.	*Cryptococcus* sp.	-	-
3.	*A. niger*	-	15
4.	*Candida* sp.	-	10
5.	*A. flavus*	-	14

CONCLUSION

The present work shows that, barks of *Odina wodier*.L can be used as dye for colouring textiles. These are grown throughout India and it is easily available plant. 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 and also dye extract has shown good antibacterial antifungal activity. The dye has good scope in the commercial dyeing of cotton.

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