Available online at www.elixirpublishers.com (Elixir International Journal)

Corrosion and Dye

Elixir Corrosion & Dye 72 (2014) 25726-25728

ISSN: 2229-712X

Effect of chitosan and mordants on the dyeability of cotton fabrics with an Eco-friendly natural dye from the flowers of *Lantana camara*

P.Saravanan[1,*], G.Chandramohan[2] and J.Tennisanthuvan[3]

[1]Department of Chemistry, Kings College of Engineering, Punalkulam, Thanjavur-613303, Tamil Nadu, India.

[2]Department of Chemistry, A.V.V.M Sri Pushpam College, Poondi, Thanjavur-613503, Tamil Nadu, India.

[3]Department of Science and Humanities, Kumarasamy College of Engineering, Karur - 639114, Tamil Nadu, India.

ARTICLE INFO

Article history:

Received: 22 May 2014;

Received in revised form:

25 June 2014;

Accepted: 18 July 2014;

Keywords

Natural dye,

Lantana camara,

Chitosan,

Mordant and cotton fabric.

ABSTRACT

This research has focused on developing eco-friendly treatments for modifying the fabric surface. In the present study, the cotton fabric was treated with chitosan at different concentrations to find a suitable concentration on the dyeability with a natural dye from the flowers of *Lantana camara*. The influence of dyeing methods with mordants, i.e. pre-mordanting, post-mordanting and simultaneous mordanting was determined. The light, wash and rub fastness of chitosan treated samples were measured and compared with untreated samples. Chitosan-treated cotton fabrics improved both in dyeability and fastness compared with untreated cotton fabric. The cotton fabrics treated with chitosan not only provided better depth of shade but also provided better wash fastness and light fastness than those of the untreated fabrics. The use of different mordants and mordanting methods affected the dye shade and depth of shade differently on the dyed fabrics both with and without chitosan. The range of colour developed on the dyed materials was evaluated and the dye absorption on the cotton was studied by using K/S values.

Introduction

A dye is a coloured substance which can be made to adhere to fabrics such as cotton, silk, wool, etc. Natural dyes are obtained from flowers, flowers, seeds, shrubs, berries, leaves, insects and minerals. These dyes have been used for centuries to produce colours for fabrics, yarns, leather, food, etc. Natural dyes can give subtle and soft colours through the brightest colour to the yarns and fabrics [1]. Use of natural dyes in colouration of textile materials and other purpose is just one of the consequences of increased environmental awareness [2]. Natural dyes exhibit better biodegradability and generally have a better compatibility with the environment. Also they possess lower toxicity and allergic reactions than synthetic dyes [3]. Today, in the world of growing environmental consciousness, natural colourants have attracted the attention of everyone. Natural dyes used in food are screened for safety but the information is not known for most of the natural dyes used in craft dyeing and with potentially wider use. There is a tendency to assume that consumable natural products are safer and better than synthetic product because they came naturally [4].

Chitosan (Fig.1) is a polymer obtained from deacetylation of chitin, is a cationic polysaccharide with linear chain consisting of β-(1,4)-linked 2-acetamino-2- deoxy-β-D-glucopyranose and 2-amino-2-deoxy-β- D-glucopyranose [5]. Chitosan is used in dietary supplements, water treatment, food preservation, agriculture, cosmetics, paper, medicinal application and fabric modification [6]. There has been a large increase in chitosan research during the past decade. This is due to its biocompability, biodegradability, non-toxicity, and other unique properties such as film forming ability, chelation and adsorption properties and antimicrobial activity. It is a deacetylated chitin produced from prawn shells, shrimp shells, crab shells, fly larva shells and squid pens [7].

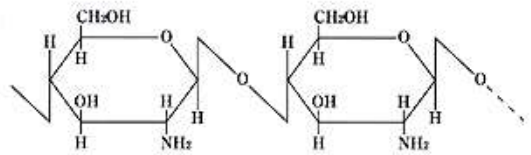

Figure 1. Structure of chitosan

Lantana camara amazing plant comes in many combinations of red, yellow, and orange flowers in small clusters. 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. This plant pacifies vitiated vata, kapha, convulsions, malaria, epilepsy, tooth ache, wounds, ulcers, swelling, skin diseases, fistula, pustules and arthritis [8].

Materials and methods

Source : The flowers of *Lantana camara* was collected from punalvasal village, Thanjavur district as shown in figure 3.

Figure 2. *Lantana camara* plant

Tele:

E-mail addresses: p.v.saravana@gmail.com

Figure 3. Flowers of *Lantana camara*

Substrates: Bleached cotton fabric was used for dyeing.

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.

Experimental Methods

Dye extraction

Flowers were crushed and soaked with 70% ethanol for 30 minutes and 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 beaker.

Preparation of chitosan solution

Chitosan solutions were prepared at 0.25%, 0.5%, 0.75% and 1.0% concentrations. Each amount of chitosan was dissolved in 1% acetic acid and left overnight at room temperature. Then the solution was filtered to remove any insoluble materials and it was used for treatment [9].

Pre-treatment of chitosan on cotton fabrics

Cotton fabrics were pre-treated by each chitosan solution. Chitosan treated cotton fabrics were dried at 100^{o}C for 5 minutes. After that, treated fabrics were dyed with the dye solution [9].

Dyeing procedure

The chitosan treated and untreated cotton fabrics 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.

Mordanting: The chitosan treated and untreated cotton fabrics were treated with different chemical mordants by following three methods [10].

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

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

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

Colour fastness

The dyed samples were tested according to IS standards. Colour fastness to washing, light and rubbing fastness were determined from standard test methods IS-687-79, IS-2454-85 and IS-766-1984 respectively.

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 [11].

Result and Discussion

Preparation and optimization of ethanolic extract of Lantana camara

The flowers of *Lantana camara* were found to discharge colour in 70% ethanol very easily. Increasing the quantity of flowers 5 g to 20 g per 100 mL 70% ethanol boiled for 30 minutes is accompanied with the increase in colour strength and depth in colour [12]. It was observed that, colour of the dye extract was dark orange colour as shown in figure 4.

Figure 4. Ethanolic extract from flowers of *Lantana camara*

Optimization of chitosan concentration

The results in table 1 showed the L*, a*, b* and K/S values of chitosan treated and untreated cotton fabrics. The K/S values of all chitosan-treated fabrics had higher values than the untreated fabrics. It was observed that the K/S values increased gradually with an increase in the concentration of chitosan. The results indicated that chitosan treatment on fabric provided more active sites for dyeing than untreated fabrics. These can be explained that natural dyes contain unsaturated moiety bearing ionisable groups such as hydroxyl and carboxylic groups. In water with right pH value, they become water soluble due to their presence in anionic forms. Cotton by its nature is negatively charged in water, thus exhibiting poor absorption for natural dyes due to repulsion effect. The application of chitosan could help to improve the absorption of natural dyes by the cationic characteristic property. It is well-known that chitosan is capable of forming ionic interaction with cotton cellulose, rendering cotton cellulose positively charged. As a result, chitosan treated cotton is anticipated to favorably absorb natural dyes through the ionic interaction mechanism between dye-anions and fiber-cations.

However, treatment of chitosan affected to colour of fabrics. Chitosan made the fabric stiffer and a bit yellower than untreated fabrics. In this research, 1% chitosan concentration was used for dyeing of cotton fabric because of desirable stiffness in fabric.

Table 1. K / S values of chitosan treated cotton fabric at different concentrations

Chitosan concentrations (%)	Chitosan treated cotton fabric				Chitosan treated cotton fabric with dyeing			
	L*	a*	b*	K/S at 400 nm	L*	a*	b*	K/S at 400 nm
0	92.84	-0.04	4.54	0	69.85	3.35	15.54	1.50
0.25	92.62	-0.18	4.95	0.01	58.65	6.62	19.32	4.97
0.50	92.75	-0.15	5.45	0.02	56.32	7.23	18.24	5.28
0.75	92.28	-0.12	5.78	0.03	55.48	7.36	18.75	5.63
1.0	91.89	-0.16	5.83	0.04	55.58	6.14	18.12	5.72
1.50	89.18	-0.13	6.26	0.08	49.74	7.42	17.31	7.68

Dyeing behavior of the dye extract

The cotton fabrics (both chitosan treated and untreated fabrics) were dyed with dye extract and chemical mordants. It has been noted that, the dye uptake was found to be good in pre mordanting method (PM). Pre modanting (PM) method showed a higher depth of shade than that of other two methods is shown in figure 5.

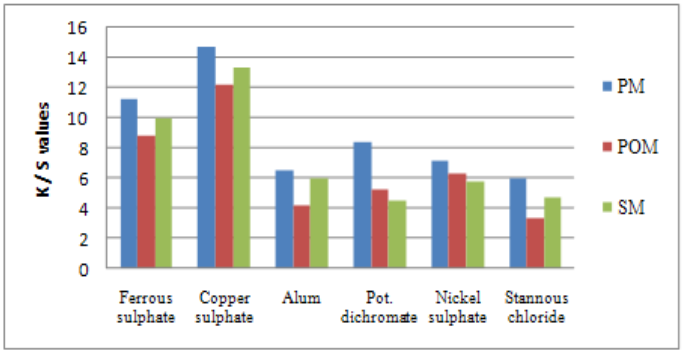

Figure 5. Surface colour strength (K/S values) of dyed cotton fabrics after pre, post and simultaneous mordanting methods

Effect of mordants and chitosan on dyed fabrics

The effect of mordants on colour intensity (K/S) of chitosan-treated and untreated fabric was examined by Text flash spectrophotometer. The effect of mordants on K/S value and colour differences of dyed fabrics treated with 1% chitosan and untreated as shown in table 2. Comparison of the results in table 2 showed that the chitosan treated cotton fabrics had a higher depth of shade (K/S value) than those of the untreated fabrics for all mordants as shown in figure 6. This result indicated that chitosan provided more active dyeing sites on fabric surface.

Table 2. Effect of mordants on dyeing properties of dyed fabrics with and without chitosan treatment

S.No	Mordants	Without chitosan treatment		With chitosan treatment	
		K/S Value	Colour obtained	K/S Value	Colour obtained
1	Ferrous sulphate	11.23		12.95	
2	Copper sulphate	14.71		16.18	
3	Alum	6.51		8.02	
4	Pot. dichromate	8.41		10.31	
5	Nickel sulphate	7.12		9.42	
6	Stannous chloride	5.95		7.16	

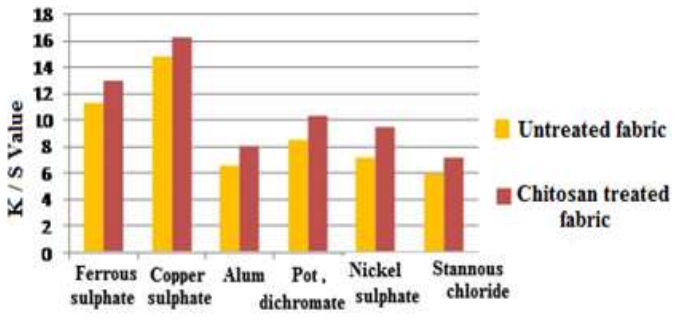

Figure 6. Effect of chitosan on dyed cotton fabrics

Fastness properties for the dyed cotton fabrics

Washing fastness (WF) Light fastness (LF) and Rubbing fastness (RF) results of the dyed fabrics with and without chitosan treatment are indicated in table 3. Dyed cotton fabric treated with chitosan improved washing, light and rubbing fastness. In addition, the results indicate that the use of mordants also improved the fastness property of the dyed fabric. This may be due to greater complex-forming ability of the metal ions with dye molecules.

Table 3. Fastness values for cotton fabrics (both chitosan treated and untreated) dyed with flowers of *Lantana camara*

Mordant	Fastness					
	Untreated dyed cotton fabric			Chitosan treated dyed cotton fabric		
	WF	LF	RF	WF	LF	RF
$FeSO_4$	4-5	IV-V	4-5	5-6	V-VI	5
$CuSO_4$	4-5	IV-V	4	5-6	V-VI	5
Alum	4	IV	4-5	4-5	V	5
$K_2Cr_2O_7$	4-5	IV	4	5	V	5
NiSO4	4	IV	4-5	4-5	IV-V	5
$SnCl_2$	4	II-IV	4-5	4-5	IV	5

Conclusions

The purpose of this work was to study the effect of chitosan on the dyeing properties of flowers extract of *Lantana camara* on cotton fabric. From this study it is concluded that, chitosan can improve the colour intensity on the cotton fabric. This may be due to the creation of more active dyeing sites by chitosan on the fabric surface. It was observed that chitosan treated fabrics not only provide better depth of shade, also provided better fastness properties. Use of different mordants and the mordanting methods affected the depth of the shade on the dyed fabrics differently.

References

1. Zin Mar Win and Moe Moe Swe, *World Academy of Science, Engineering and Technology*, 2008 pp 536-540,
2. Gupta, V.K. Sachan, R.A., Singh V.P. and Shasma, S.K., *Indian Textile Journal*, 1998, PP. 16-18, (1998)
3. Kumar, V. and Bharti, B.V. , *Indian Textile Journal*, PP. 18-20
4. M. M Alam, M. L. Rahman and M. Z. Haque, *Bangladesh J. Sci. Ind. Res*, 2007,42(2), 217-222
5. Pradip Kumar Dutta, Joydeep Dutta and V S Tripathi, J. Sc. Ind. Res., 2004, 63, 20-31
6. Md. Monarul Islama,, Shah Md. Masumb, M. Mahbubur Rahmana, Md. Ashraful Islam Mollab, A. A.Shaikhc and S.K. Roya, *International Journal of Basic & Applied Sciences*, 2011, 11 No: 01
7. Gu R., Sun W., Zhou H., Wu Z., Meng Z., Zhu X., Tang Q., Dong J. and Dou Q., *Biomaterials*, 2010, 31(6): 1270-1277
8. Kiritikar, K.R. and Basu, B.D., *Indian Medicinal Plants*, 2nd Edition, International Book Distributors, Book Sellers and Publishers, Dehradun, 1935
9. Piyaporn Kampeerapappun, Trongsu Phattararittigul, Sutida Jittrong and Dararat Kullachod, *Chiang Mai J. Sci.*, 2010, 38(1), 95-104
10. M.Kumaresan, P.N.Palnisamy and P.E.Kumar, *European Journal of Scientific Research*, 2012, Vol.52, No.3, pp.306-312
11. S.Habibzadeh, H.Tayebi, E.Ekrami, A.ShamsNateri, M.Allahinia and M.Bahmani, World *Journal of Applied Journal*, 2010, Vol 9(3), pp 295-299
12. RakhiShanker and Padma S Vangar, *Dyes and Pigments*, 2006, pp-1-6