Dyeability of Cotton Fabric with Banana Stem Extract

[*]T.R. MARIAMMA[1], S.K. JOSE [2]

[1]Dept. of Home Science, Vimala College, Thrissur, Kerala.
[2]Lecturer, Dept. of Home Science, Vimala College, Thrissur, Kerala
[*]**Corresponding Author E-mail:** thomasrubymariamma@gmail.com

Abstract

Pure unbleached cotton fabric in plain weave was scoured, bleached and used for dyeing. Banana stem extract obtained from the pseudostem of the Palayankodan banana plant was used as a dye. Alum and tannic acid were used as mordants. The colour differences obtained for the dyed samples were much higher than the commercial value. Better colour yield was produced using tannic acid as a mordant with the banana stem extract in pre mordanting and post mordanting processes. Tannic acid gave the best dye uptake than alum when dyed with banana stem extract. The rub fastness and wash fastness were excellent with no colour change for all the dyed samples in both the methods. Unlike other natural dyes which usually show low light fastness, banana stem extract was stable to sunlight with slight fading only.

Keywords: Banana stem extract, Palayankodan, , Post mordanting, Pre mordanting

Introduction

In textile processing, dyeing is an integral part of which textile coloration is done to make the fabric lively. Dyeing is an ancient art which predates written records and it was practiced since Bronze Age. Consumers are becoming increasingly very much conscious to environmental friendly consumer goods and much concerned about green processing. The tendency for eco- friendliness in textiles is important as it comes in contact with the skin for a prolonged period of the time.

Natural dyes were the main source of colorants for textiles until the end of 19th century. However, after the discovery of synthetic dyes, natural dyes, were completely replaced by them. Synthetic dyes are produced from cheap petroleum sources. The ease of application, availability of wide range of colors, better reproducibility and improved quality of dyeing at lower cost are the main advantages of synthetic dyes over natural dyes.

As green consumerism and environment friendliness are on an increase, the use of natural dyes are the latest trend. Researchers over the world are exploring natural substances and testing their potential as a dye. Banana stem extract obtained from the pseudostem of the banana plant which otherwise is a waste is proving its application in dyeing and mordanting. The sap is also a by product when the fibre is extracted from the pseudostem. Apart from being an eco friendly product, its production and use is economical and helps sustainable development.

Banana sap extracted from the pseudostem of harvested banana plant has been used as a mordant to dye silk fabric with natural dyes[1]. Dyeing with acacia pennata bark and banana stem extracts together showed better fastness levels as compared to dyeing with Accasia pennata alone on wool fabric[10]. Banana bark extract when used as a mordant in printing paste it obtained ocher tone on cotton / jute union fabric after dyeing and it showed very good wash fastness[4]. Banana floral stem sap was used to dye

cotton knitted fabric where it gave a light shade but as dyeing temperature increased the shade darkened[6].

Hence the dyeability of cotton fabric with banana stem extract using two different mordants in two concentrations and methods of dyeing has been investigated.

Material and Methods

Materials

Pure unbleached cotton fabric in plain weave (32 ends/inch, 23 picks/inch, 85g/m^2) was used. The fabric was scoured, bleached and used for dyeing. Samples used were of dimensions 30 x 30cm as swatch size.

The chemicals used were Hydrochloric Acid, Sodium Carbonate, Caustic Soda (sodium hydroxide), Sodium Silicate, Hydrogen Peroxide, Alum and tannic acid. All were of analytical grade and purchased from Chemind House, M.G. Road, Thrissur.

Banana stem extract obtained from the pseudostem of the Palayankondan banana plant was used as dye. It was extracted after the fruit bunch is harvested by scrapping with a blunt knife and squeezing. Extract was then filtered through a piece of cloth to yield the natural dye. It is a thin liquid having light brown or dusty color.

Fabric pre treatment

Cotton samples with dimensions of 30x30 cm each with an average weight of 8.03 gm were scoured by treating them with caustic soda (3% owf), sodium silicate (3% owf) and wetting agent (1gpl) at 100^0C for 3 hours with a material to liquor ratio of 1:20. The scoured fabrics were thoroughly washed with cold water and dried at room temperature. The scoured samples were further bleached using hydrogen peroxide (15ml/l), sodium silicate (5gpl) and sodium hydroxide (3gpl) at 90^0C for 1 hour at 1:20 material to liquor ratio. The samples were washed and dried.

Pre-mordanting dyeing

The pre treated samples were penetrated with 10% (owf) and 20% (owf) of alum and tannic acid separately with 1:20 material to liquor ratio at 60^0C for 30 min. The samples were squeezed of excess liquor and were introduced in to the dye bath prepared with 20% (owf) of banana stem extract with 1:20 material to liquor ratio at 40^0C. The dyeing was carried out for 90 minutes at 80ºC. The dyed samples were allowed to cool in the dyebath at room temperature after which they were taken out, squeezed, washed in cold water and dried at room temperature.

Post-mordanting dyeing

The dye bath containing 20% (owf) of banana stem extract with 1:20 material to liquor ratio was prepared for post mordanting method. Cotton fabric samples were introduced into the dyebath at 40^0C. The dyeing was carried out for 90 minutes at 80ºC. The dyed fabrics were squeezed and put in the respective mordant baths at 60^0C for 30 min. The mordant bath was prepared for 10% (owf) and 20% (owf) of alum and Tannic acid separately with a material to liquor ratio of 1:20. The samples were then squeezed of excess liquor and dried at room temperature.

Test Methods

Evaluation of Fastness properties

The colour fastness of the dyed fabric to rubbing, washing and sunlight was carried out. The rub fastness of the dyed textile material was carried out on a crockmeter according to Indian Standard IS: 766-1986-88.

The colour fastness to washing was done in a launderometer according to IS: 3361-1979, test method IS02 washing test. The sample specimen in contact with the given fabric piece is mechanically agitated in soap solution at 50^0C for 45 minutes rinsed and dried. The change in the colour of the specimen and the staining of the adjacent fabric are assessed with the help of the standard gray scale for staining.

The light fastness was carried out as per IS: 2454-1984 method. The dyed samples of 3 × 6 cm were fixed on a black cardboard in such a way that all samples were half exposed and half covered and placed under sunlight. The specimens were brought out after 10 hours and color fading was assessed against the grey scale.

Measurement of Color

The colour strength of the banana sap dyed cotton fabric samples dyed with Tannic acid and alum were measured for their colour strength under illuminant D65 daylight for the 10^0 standard observer on Spectrophotometer Gretag Macbeth over the range of 400-700 nm. The instrument was standardized by a given bleached sample.

The K/S is the ratio of the Absorption coefficient (K) versus the scattering coefficient (S) for reflectance which is given by the Kubelka Munk equation as

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

where R is the reflectance (Eq. 1)

Results and Discussion

The colour produced with banana stem extract using the two mordants is a light vanilla cream to light yellow in colour. Similar colour was obtained on silk fabrics using banana stem extract[1]. The fabric when dyed using tannic acid produced light yellow colour. Hence the value of b* obtained was positive indicating the presence of yellow nuance more as seen in Table 1 & 2.

Table 1: Colour coordinates of dyed cotton fabric with banana stem extract in pre-mordanting method

Parameters	Cotton fabric dyed with 10% Tannic acid	Cotton fabric dyed with 20% Tannic acid	Cotton fabric dyed with 10% Alum	Cotton fabric dyed with 20% Alum
a*	1.01	1.42	0.78	0.81
b*	7.41	9.12	3.00	3.83

c*	7.48	9.24	3.10	3.91
h°	82.21	81.13	75.43	78.08
L*	83.49	83.38	83.81	83.24

Table 2: Colour measurements of dyed cotton fabric with banana stem extract in post-mordanting method

Parameters	**Cotton fabric dyed with 10% Tannic acid**	**Cotton fabric dyed with 20% Tannic acid**	**Cotton fabric dyed with 10% Alum**	**Cotton fabric dyed with 20% Alum**
a*	-0.14	-0.90	0.50	0.28
b*	8.90	10.31	5.65	7.01
c*	8.90	10.35	5.8	7.01
h°	90.90	95.01	84.94	87.73
L*	80.15	78.88	83.78	83.38

Lower chroma values were observed for fabric dyed with alum in the pre mordanting method, which explains that the colour obtained is dull and less saturated. Comparatively higher values of chroma were noted for fabric dyed with tannic acid as a mordant in both the methods. The hue angle obtained for the fabric samples dyed with tannic acid as a mordant were higher (95.01^0) than those obtained for alum, indicated by brighter colour.

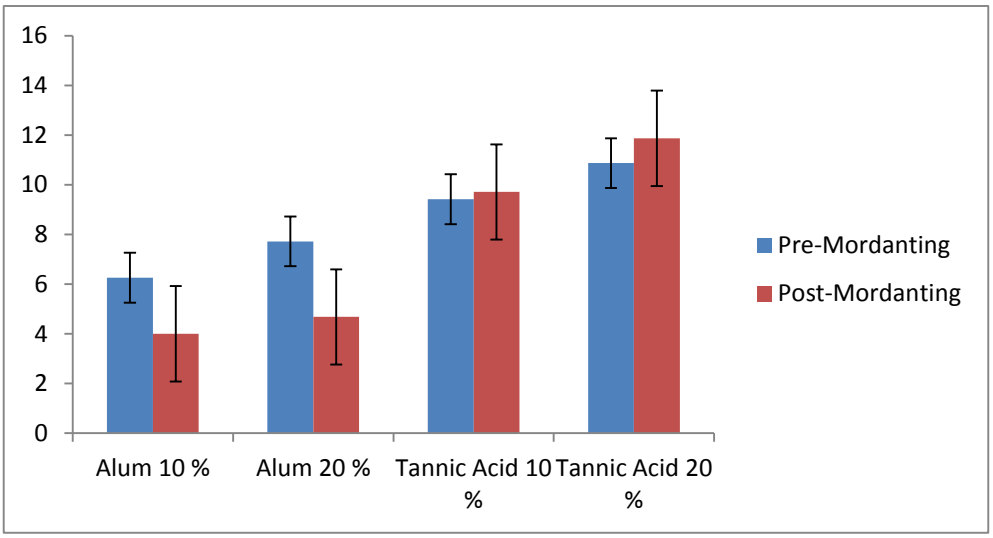

Fig. 1: Integrated colour strength of the dyed samples

The K/S values or the colour strength of the dyed samples as depicted from the graphical representation Fig. 1 shows better dye uptake for fabrics dyed with alum in the pre mordanting method and for tannic acid in the post mordanting method. Among the two mordants used tannic acid gave the best dye uptake than alum when dyed with banana stem extract. Higher concentration of tannic acid showed better results in terms of dye uptake.

The total colour difference ΔE was obtained for the dyed samples and was greater than 1. In commercial purpose, if ΔE < 1, the value of colour differences could be accepted in general[3].

The colour differences obtained for the dyed samples are much higher than the commercial value. Better colour yield was produced using tannic acid as a mordant with the banana stem extract in both the processes Fig.2.

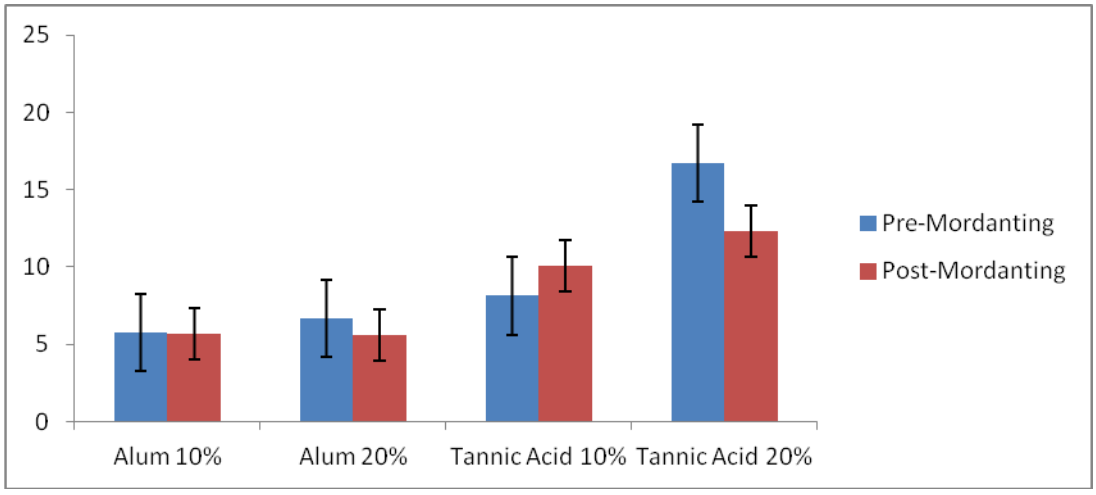

Fig.2: Colour difference of dyed samples in the two methods of dyeing

Fastness properties

Table 3: Grey scale ratings of the fastness properties of the fabrics dyed with banana stem extract

Dyed Fabric	Rub fastness		Wash fastness		Light fastness	
	Pre mordanting	Post mordanting	Pre mordanting	Post mordanting	Pre mordanting	Post mordanting
10% Alum	5	5	5	5	4	4
20% Alum	5	5	5	5	4	4
10% Tannic acid	5	5	5	5	3-4	3
20% Tannic acid	5	5	5	5	3-4	3

As seen in the above table, the rub fastness of the dyed fabric to dry and wet rubbing were excellent with no colour change for all the dyed samples in both the methods.

The wash fastness of the dyed samples showed excellent ratings with no colour change or staining in both the methods of dyeing. This proves that the dye and mordant form a strong bond inside the fibre structure without leaching out in aqueous medium.

The dyed fabric samples showed stability to sunlight as the gray scale rating indicated only a slight change in colour. Thus banana dye extract showed good light fastness towards sunlight when dyed on cotton fabric in both the methods.

Conclusion

Banana stem extract is composed of tannins which are polyphenolic compounds known for dye fixation and producing crosslinks which explains the stability of the dye producing excellent fastness properties. Moreover use of tannic acid as a mordant along with the banana stem extract gives additional tannin content. Hence Banana stem extract proves to have a high potential in dyeing cotton fabrics.

From the above study it can be concluded that

1. Unlike other natural dyes which usually show low light fastness, banana stem extract was stable to sunlight with slight fading only.
2. The other fastness properties like rub and wash were also excellent.
3. The chromophore in the dye is made of tannin which forms strong hydrogen bond, hence exhibited good fastness properties.
4. Tannic acid proved to be a better mordant than alum when dyed with banana stem extract as it provided additional tannins for a stable and strong hydrogen bond with the cotton fibre.
5. Higher concentrations of mordants showed better results in terms of dye uptake and colour yield.
6. The banana stem extract is easily available, economical and effective as a dye for cotton fabrics.

References

[1] L. Ammayappan, G.Kumar, D. Krishnan, *Man-Made Text India*, 2004, **47**, 218-220.
[2] S. Barhanpurkar, P. Bhat, A. Kumar, R. Purwar, *Int J Text Eng. Process*, 2015, **1**, 56-62.
[3] S. Canbolat, N. Merdan, H. Dayioglu, D. Kocak, *Marmara J. Pure Appl. Sci.*, 2015, **1**, 40-44.
[4] A.S. Deshmukh, A.S. Bedre, *Int. J. of Chem Phy Sci*, 2015, **4**, 382-386.
[5] R. Jihad, *Int J Scient. Eng Res*, 2014, **5**, 809-818.
[6] M.R. Repon, M.A. Mamun, M.T. Islam, *Universal J Eng Sci*, 2016, **4**, 14-20.
[7] A.K. Samanta, P. Agarwal, *Indian J. Fibre Text Res*, 2009, **34**, 384-399.
[8] I. Sanjeeda, A. N. Taiyaba, *J Env Res Dev*, 2014, **8**, 683-688.
[9] P. Saravanan, G. Chandramohan, *Universal J Env Res Tech*, 2011, **1**, 268-273.
[10] S.R. Shukla, S.C. Shinde, A.S. Banye and S.M. Patil, *Indian J. Fibre Text Res*, 2004, **29**, 350-352.
[11] M.D. Teli, P.V. Sanket, J.S. Mahajan, *J Text Assoc*, 2015, **75**, 341-344.
[12] A. Zubairu, Y.M. Mshelia, *Sci and Tech*, 2015, **5**, 26-32.