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Research Paper

Evaluation of colour fastness and colour strength properties of naturally dyed banana corpet yarns

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ABSTRACT : One can get colouring matter from almost all vegetable matter. However, only a few of these sources yield colourants which can be extracted and work out to be commercially viable. Colour fastness property of these dyed yarns need to be tested, and it refers to the resistance of the colour of textiles to different agencies such as washing, sunlight and rubbibg. Annatto seeds, flame of forest flowers and dhawadi flowers were used for dyeing banana carpet yarns and after treatment was done with pomegranate fruit skin and later studied for colour fastness and colour strength properties. The colour fastness of naturally dyed banana yarns was noticed to be from fair to excellent. Among the four colours dyed on banana yarns, maximum colour difference was noticed in abraded maroon sample and minimum in abraded dark yellow sample. The colour strength after rubbing came down in all the naturally dyed banana yarns.

KEY WORDS : Banana yarns, Colour fastness, Colour strength, Colour difference, Natural dyes

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The growing concerns for the degrading environmental conditions have led to the development of eco-friendly and biodegradable fibres in the ever expanding horizon of textile fibres. Banana fibres and natural dyes being eco-friendly do not pose the toxicity and waste disposal problems that are associated with some of the synthetic and mineral fibres and synthetic dyes. Natural dyeing really stands for the pride and glory of the craft of India as it has been in Indian culture since long time. Because of the beauty of its results, those who used them claimed that no chemical dye has that luster, the under glow of rich colour that delicious aromatic smell and the soft light and shadow that gives so much pleasure to the eyes (Mukharjee, 2005) .

Colour fastness property of these dyed yarns need to be tested, and it refers to the resistance of the colour of textiles to different agencies such as washing, sunlight and rubbing to which the yarn or fabric is exposed during manufacture and subsequent use. It is important because it directly affects the serviceability of fabrics (Lyle, 1997).The most common serviceable conditions for which a carpet is generally exposed are sunlight, washing and crocking. Hence, these tests were selected for evaluation of colour fastness of dyed carpet yarns.

The carpets are put up mostly indoors and do not undergo washing frequently, but they are subjected to lot of abrasion and wear when people walk on carpets. Hence, the carpet yarns were studied for colour strength properties before and after rubbing. Even though colour shades on yarns are obtained by dyeing in different sources, the consumers identify the colours and fastness only and do not mind the sources. Moreover, most of the colours were obtained by using two to three sources, therefore in discussion the names of the colours are used instead of sources.

RESEARCH METHODS

Optimization of pre mordanting of carpet yarns with alum :

The alum solutions were prepared from 1-10 per cent. The volume of water required for the treatment was estimated as per the material to liquor ratio of 1:20. The wetted yarn was entered slowly into the bath and the required temperature of about 40° C-50° C was maintained and worked for one hour. Later, the yarn was thoroughly squeezed and dried in shade. The alum solutions were optimized for each dye depending

on the colour to be obtained as given in Table A. A combination of alum 10 per cent and myrobolan 20 per cent were optimized for the yarns which were to be dyed with peach and dark red/maroon colour. This was purely performed to get the benefit of the shade and to improve the fastness of the shades produced.

Table A : Natural sources used in the study for pre mordanting, dyeing and after treatment

Source	Scientific name	Common name	Part of the plant used	Purpose
	*Terminalia chebula*	Myrobolan	Fruits	Pre-mordanting
	*Bixa orellana linn*	Annato	Seeds	Dyeing
	*Butea monosperma*	Flame of forest	Flowers	Dyeing
	*Wood fordia fruiticosa*	Dhawadi flowers	Flowers	Dyeing
	*Punica granatum*	Pomegranate	Fruit skin (rind)	After treatment

Optimization of dyeing variables :

The dyeing variables such as dye material concentration, dyeing time, after treatments which were optimized for each dye were taken as optimum conditions of dyeing for producing dye shades using mordants. The optimum conditions used in the study are presented in the Table B.

Extraction of dye from dye source :

The dye source or the plant part was soaked in water and then heated at 60 degree C to 90 degree C for 45-90 minutes. The colourant present in plant part/dye source was transferred to the aqueous solution. Then the dye solution extracted from the source was filtered and collected (Vankar, 2007). The dye extraction was carried out for 45, 60 and 90 minutes for optimization as shown in Fig. A.

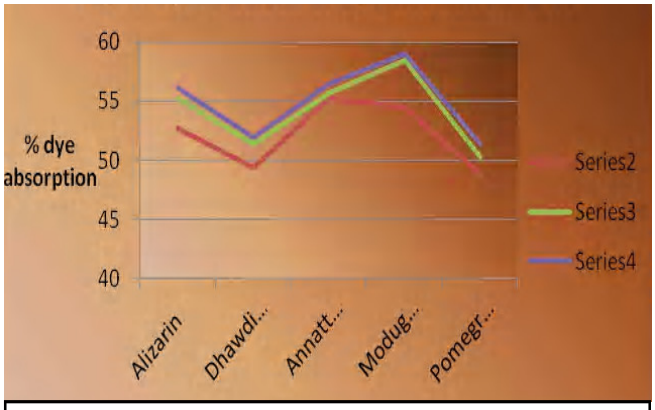

Fig. A : Optimization of dye extraction time

Dyeing procedure :

The yarn to be dyed was weighed. The extracted dye liquor was taken as per the weight of the material to be dyed (Table B). A material to liquor ratio of 1: 30 was maintained.

Table B : Summary of optimum dyeing conditions for lighter and darker shades on banana yarns

Sr.No.	Colour	Dye source	Dye concentration (per cent by the wt. of the material)	Pretreatment with mordant (per cent by the wt. of the material)	No. of dips	Total dyeing time	Dyeing temperature	pH	After treatment (per cent by the wt. of the material)
1.	Peach	Alizarin	1.50	Alum 5.0	2	90 min	I bath- 45-50ºC	7.5	Alum1.5
		Dhawadi flowers	2.50	Myrobolan 20			II bath-65-70ºC		Pomegranate rind extract 2
2.	Dark red/ maroon	Alizarin	4.00	Alum 10.0	2	90 min	I bath- 45-50ºC	7.5	Alum1.5
		Dhawadi flowers	4.00	Myrobolan 20.0			II bath-65-70ºC		Pomegranate rind extract 2
3.	Light yellow	Annato seeds	16.00	Alum 3	2	90 min	I bath- 45-50ºC	7	Alum1.5
		Moduga flowers	5.00				II bath-65-70ºC		Pomegranate rind extract 2
4.	Dark yellow	Annato seeds	32.00	Alum 5.0	2	90 min	I bath- 45-50ºC	7	Alum1.5
		Moduga flowers	10.00				II bath-65-70ºC		Pomegranate rind extract 2

The optical density of the dye liquor before dyeing was recorded. The premordanted yarn was placed in the dye liquor and dyed for optimized dyeing time with occasional stirring. The yarn was removed and optical density of the dye liquor was noted. The yarn was then post treated with optimized concentrations of alum and pomegranate rind extract, then soaped, washed and dried in shade. The percentage of dye absorption by the yarn was estimated by using the following formula :

$$\text{Percent of dye absorption} = \frac{\text{O.D. of dye liquor before dyeing} - \text{O.D. of the dye liquor after dyeing}}{\text{O.D. of dye liquor before dyeing}} \times 100$$

Natural dyeing with combination of dye sources :

Each natural dye inherits one or two types of pigments that give rise colour to the fibre. Combination of two dyes will produce mixed shades that are inherited from each dye. In case of synthetic dyes shades can be well predicted if the proportions are known. In case of natural dyes, one cannot predict shade, as the shade is not influenced by the proportion of the dyes alone but it also depends on the substantivity of the dye towards the fibre. Depending on the substantivity of the dyes, the fibre takes up the shade and generally the dye that has more substantivity dominates the shade (Devi, 2002). Most of the shades produced were the result of union dyeing using either two dye sources or more. The dyeing was done as per the optimum conditions given in Table B.

Selection and optimization of eco friendly fixing agents

One can improve the wash fastness of some of the natural dyes by a post treatment with alum or a dye fixing agent resulting in the formation of a dye-fibre complex or a cross-link between the dye and fibre, respectively (Gulrajani, 1999). After dyeing the yarn, suitable after treatments are required to fix the natural dyes. Alum and pomegranate rind extracts were selected for post treatment and used in the study based on their eco friendliness, ability to improve the fastness properties and cost effectiveness. Different concentrations of these agents were optimized for each dye as mentioned in the dyeing procedures (Table B).

Soaping and washing :

Soaping and washing were taken up after 24 hours of completion of dyeing activity to remove the excess deposition of dye. Soap nut powder 1.5 per cent (by wt. of yarn) was optimized and soaping and washing were carried out with adding to a tub of cold water. After washing, 1.5 per cent coconut oil (by wt. of yarn) was added in the last rinse to give shine and smoothness to all dyed yarns as it does not allow the dye molecules to leach out of the yarn.

Atmospheric conditions for testing :

Prior to testing, samples were conditioned as per Bureau of Indian Standard IS 6359-1977. The test specimens were kept in the standard atmospheric conditions at 65 ± 2 per cent relative humidity and 27 ± 2°C for 24 hours before testing.

Colour fastness to sunlight :

The tests for colour fastness to sunlight were carried out as per AATCC standards (IS: 686-1985) for testing the resistance of the material to the action of sunlight under glass, based on the length of exposure.

Colour fastness to washing :

Washing test to assess the colour fastness of the dyed samples was carried out as per the Bureau of Indian Standards (IS 3361-1979).

Colour fastness to crocking :

As per the Bureau of Indian standard (IS 766-1988) the test for colour fastness to crocking was measured with Crock-meter for the dyed sample. The test specimens were tested for both dry and wet rubbing. The colour change on the dyed specimen and colour staining on the undyed specimen were estimated using the grey scale.

■ RESEARCH FINDINGS AND DISCUSSION

The colour fastness grades of banana yarn dyed with natural dyes are given in Table 1. Peach dyed banana yarns showed excellent fastness (5) to sunlight, fastness of light yellow was fair to good (3/4) and dark yellow registered (3) *i.e.*

Table 1 : Fastness grades of banana yarn dyed with natural dyes

Sr. No.	Natural dyes	Sun light fastness	Washing fastness			Rubbing fastness					
						Dry			Wet		
			CC	CS		CC	CS		CC	CS	
				C	S		C	S		C	S
1.	Light yellow (annato+moduga flowers)	3/4	5	5	5	5	5	5	5	4	4
2.	Dark yellow (annato+moduga flowers)	3	5	4	4	4	4	4	5	4	4
3.	Peach (alizarin+dhawdi flowers)	5	5	4/5	4/5	4/5	4/5	4	4/5	4	4
4.	Maroon (alizarin+dhawdi flowers)	4	3	3	3	3/4	3	3	4	3	3

sunlight fastness was fair. This might be due to the reason that, yellows obtained from plant materials are usually pale, *i.e.,* the depth of the shade is low and the fading is quicker. Few yellow dyes are rendered susceptible to light because they emit fluorescence. Thus, the brighter a yellow shade is, the less fast it is to light. About ninety per cent of all yellow dyes are flavonoids, the fading of these dyes to yellow brown can be attributed to their inherent tendency to form quinones on exposure to light (Vankar, 2007).

Wash fastness was found to be good to excellent to colour change in all the samples. Only maroon dyed sample showed noticeable staining on both cotton and silk. Whereas, negligible staining was seen on all other samples.

Dry rub fastness to colour change was excellent for light yellow and good for dark yellow and fair to good for maroon, good to excellent for peach samples. Dry rub fastness to staining was found to be negligible for light yellow and slight staining was noticed for dark yellow shade on both cotton and silk samples. On cotton samples peach, colour registered slight to negligible staining and on silk slight staining was noticed. Dry rub fastness was found to be fair in case of maroon dyed sample.

Good to excellent wet rubbing fastness was observed all colours and slight staining by all colours except maroon which showed noticeable change on cotton. Similar results were observed on silk samples.

Table 2 illustrates the colour co-ordinate values of banana yarn dyed with natural dyes. In case of light yellow colour, a* values of abraded sample decreased which indicated that; sample was more towards less redder shade when compared to control (Fig. 1). Negligible difference was noticed in b* values and higher values were noticed in L* values which indicated lighter shade than control. The K/S values of abraded sample decreased when compared to control indicated reduction in colour strength of abraded sample. Hence, the sample was lighter, less red, less yellow and duller.

The banana yarns dyed with dark yellow colour showed slightly lighter shade after rubbing as indicated by its L* values, very less reduction in both a* and b* values. ÄE value was reported to be 0.99. The K/S value decreased from 5.401 to 5.168 indicated decreased colour strength values. Abraded dark yellow coloured banana yarn was lighter, less red, less yellow and duller when compared to control (Fig. 2).

Table 2 : Colour co-ordinates of banana yarn dyed with natural dyes

Sr. No.	Treatments	Colour	L*	a*	b*	ΔE	K/S	Strength
1.a	Control	Light yellow	58.36	11.04	24.55	0.0	4.452	100.0
1.b	Abraded	Light yellow	61.93	9.57	24.50	3.86	3.701	83.13
2.a	Control	Dark yellow	58.24	15.37	33.60	0.0	5.401	100.0
2.b	Abraded	Dark yellow	58.32	15.31	32.61	0.99	5.168	95.69
3.a	Control	Peach	45.23	24.91	20.41	0.0	7.019	100.0
3.b	Abraded	Peach	47.54	25.35	21.55	2.61	6.127	87.30
4.a	Control	Maroon	24.60	32.16	14.92	0.0	29.683	100.0
4.b	Abraded	Maroon	33.86	32.61	14.62	9.28	13.102	44.14

L- The lightness/darkness co-ordinate, a* - The red/green co-ordinate with +a* indicating red& -a* indicating green
b*- The yellow/blue co-ordinate with +b* indicating yellow & -b*indicating blue, ΔE- Total colour difference

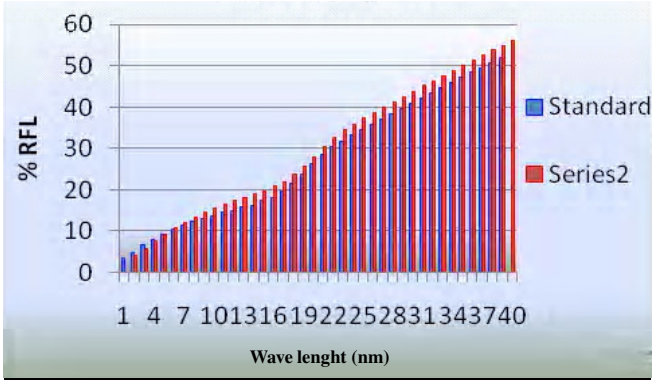

Fig. 1 : Colour strength of banana yarn dyed light yellow

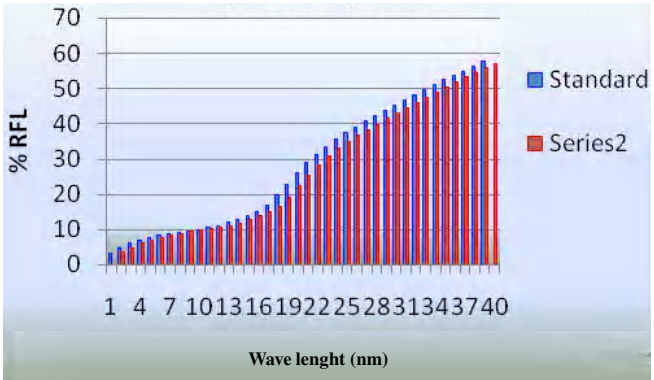

Fig. 2 : Colour strength of banana yarn dyed dark yellow

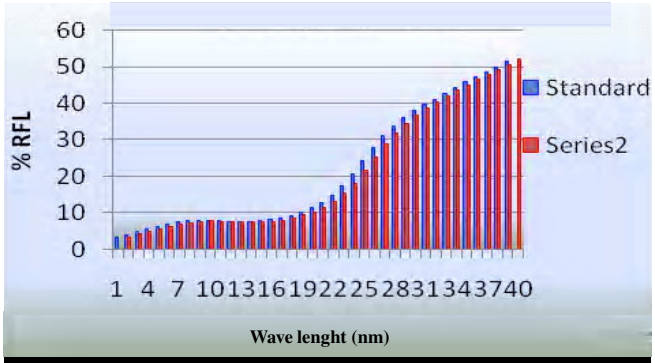

Fig. 3 : Colour strength of banana yarn dyed peach

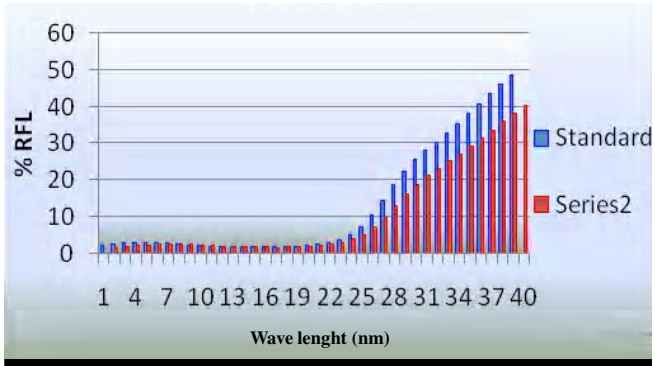

Fig. 4 : Colour strength of banana yarn dyed maroon

Increase in L* values was noticed in banana yarn dyed with peach colour indicated increased lightness co-ordinate. The a* and b* values also increased for abraded sample, whereas K/S values decreased (Fig. 3). So, the abraded sample was lighter, redder, yellower and brighter when compared to control.

Maroon colour dyed banana yarn showed higher values of L* values when compared to control which indicated lightness co-ordinates. Not much difference was observed in a* and b* values. The K/S values of abraded sample decreased from 29.68 to 13.10 hence; there was more reduction in colour strength. The sample was lighter, redder, bluer and brighter (Fig. 4).

Conclusion :

Among the four colours dyed on banana yarns, maximum colour difference was noticed in abraded maroon sample and minimum colour difference in abraded dark yellow sample. Light yellow and dark yellow coloured samples were lighter, less red, less yellow and duller whereas, peach and maroon samples were lighter, redder, yellower and brighter.

The colour strength after rubbing slightly came down in all the naturally dyed banana yarns and the yarns looked duller. This might be due to reason that, the dye has not deeply penetrated into the fibres and when it is superficially held it gets removed because of severe rubbing.

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