

Comparative study of colour fastness properties of naturally dyed carpet yarns cellulosic in composition

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■ **ABSTRACT** : The natural fibres such as cotton, sisal, banana and jute which are cellulosic in nature were spun into yarns and dyed using natural sources. The carpet yarns were further tested for colourfastness to sunlight, washing and rubbing. The results of the study showed that, in case of banana yarns, good to excellent wet rubbing fastness was observed in all colours and slight staining by all colours except maroon which showed noticeable change. Naturally dyed jute yarns showed good to excellent fastness properties to sunlight, washing and rubbing. The sunlight fastness of naturally dyed cotton yarns ranged from poor to good for most of the yarns. The dyed cotton yarns registered good to excellent wash fastness to change in colour, slight to negligible staining was seen on both cotton and silk samples. On the whole, the sunlight fastness properties of dyed cotton yarns were poor when compared to jute, banana and sisal yarns. Many dyes which have poor fastness to light are fluorescent dyes and usually more photosensitive and fade more rapidly because the active life period of their molecules is longer and the chances of collision with oxygen of the air, therefore is greater.

■ **KEY WORDS** : Natural dyes, Yarns, Colour fastness, Test specimen, Washing, Crocking

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Colour fastness 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, the tests were selected for evaluation of colour fastness of dyed carpet yarns.

■ RESEARCH METHODS

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 $27 \pm 2^\circ\text{C}$ for 24 hours before testing.

Colour fastness to sunlight (IS: 686-1985)

The tests for colour fastness to sunlight were carried

out as per AATCC standards for testing the resistance of the material to the action of sunlight under glass, based on the length of exposure. Samples of size 1x 6 cm were mounted on cardboard and covered by an opaque cover.

Exposure to sunlight was carried out between 8.30 am to 4.30 pm in sunlight cabinet, facing north at 14° angle. According to Lyle (1997), most apparel fabrics are tested for colour fastness to sunlight for a period of 40 hours. Hence, the samples were exposed for 40 hours. The colour fastness of the exposed yarns was assessed by using grey scale and assigned suitable colour fastness rating.

Colour fastness to washing (IS: 3361-1979):

Washing test to assess the colour fastness of the dyed samples was carried out as per the Bureau of Indian Standards IS 3361-1979. A test specimen of 10 x 4 cms was placed between the two adjacent fabrics, one side silk and the other side cotton and stitched all along four sides. The test solution was prepared by dissolving 5 g of neutral soap (lissapol-D) in one

litre of distilled water. The composite specimen was placed in a container and soap solution was added which was pre-heated to $40 \pm 2^\circ \text{C}$ at material to liquor ratio of 1:50. The composite specimen was treated for 30 minutes in the mechanical washing device. The composite specimen was removed, rinsed in cold running tap water for 10 minutes to make the sample free from soap. Then the stitches on all three sides except one short side were removed and shade dried.

Colour fastness to crocking:

As per the Bureau of Indian standard IS 766-1988, the test for colour fastness to crocking was measured with Crockmeter for the dyed sample. The test specimens were tested for both dry and wet rubbing.

The test specimen of size 14 x 5 cm was fixed on a flat rectangular steel platform. The undyed samples of size 5 x 5 cm was placed over the end of the finger of the rubbing device and was rubbed to and fro in a straight line along the track of 10 cm for 10 seconds with a downward force of 900 g. The above procedure was similar for both wet and dry rubbing except that in wet crocking the undyed piece was saturated with distilled water and squeezed before use. The colour change on the dyed specimens and colour staining on the undyed specimens were estimated using the grey scale.

Colour fastness rating:

Grey scale for evaluating change in colour (ISO 105 A 02: 1993):

Original sample and tested specimens were placed side by side in the same plane and oriented in the same direction along with the respective grey scale. The visual difference between original and tested specimens in the presence of sunlight at an angle of 45° was compared by viewing perpendicular to the plane of the surfaces with the respective grey scale and assigned suitable colour fastness rating.

Rating of Grey scale for change in colour

Grade	Observation
1.	Very poor
2.	Poor
3.	Fair
4.	Good
5.	Excellent

Grey scale for evaluating staining (ISO 105 A 03: 1993):

Unstained and tested adjacent fabric samples were placed side by side in the same plane and oriented in the same direction along with the respective grey scale. The visual difference between unstained and stained sample in the presence of sunlight at an angle of 45° was compared by viewing perpendicular to the plane of the surfaces with the respective grey scale and assigned suitable colour fastness rating.

Rating of grey scale for staining:

Grade	Observation
1.	Much change
2.	Considerable change
3.	Noticeable change
4.	Slight change
5.	Negligible change

■ RESEARCH FINDINGS AND DISCUSSION

The colour fastness grades of banana yarn dyed with natural dyes is 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.* 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 and Vankar *et al.*, 2007).

Wash fastness was found to be good to excellent to colour change in all 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

Sr. No	Natural dyes	Sun light fastness	Washing fastness			Rubbing fastness					
			CC	CS		CC	Dry		CC	Wet	
				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

noticed. Dry rub fastness was found to be fair in case of maroon dyed sample.

Good to excellent wet rubbing fastness was observed in 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 depicts the fastness grades of sisal yarns dyed with natural dyes. Peach coloured yarn had excellent fastness to sunlight. Maroon, indigo blue and grey coloured yarn showed good to excellent fastness, black and dark yellow showed good fastness. Whereas, light yellow coloured yarn registered fair to good fastness and some fading in colour was observed.

Wash fastness of all the dyed samples showed excellent fastness to colour change and staining except indigo blue and black which showed slight or negligible staining on silk. Maroon and indigo blue samples also showed slight to negligible staining on cotton.

The poor wash fastness of many natural dyes is mainly attributable to the factors such as weak dye to fibre bond between the natural dye and the fibre, change in hue due to the breaking of the dye-metal complex during washing and ionisation of the natural dyes during alkaline washing (Gulrajani, 1999).

The fading of dyes might involve three photochemical reactions-oxidation, reduction and decomposition or photolysis. Photosensitization may also occur. Fading of dyes by the action of light and air is usually an oxidation process. No direct relation between fluorescence and fading of dyes

has been established, but they are related phenomenon. Many dyes which have poor fastness to light and are fluorescent dyes and are usually more photosensitive and fade more rapidly because the active life period of their molecules is longer and the chances of collision with oxygen of the air, therefore is greater (Venkataraman, 1952).

Dry rub fastness of light and dark yellow, peach and indigo blue was excellent, maroon showed (4/5) *i.e.* good to excellent fastness for colour change. Grey and black coloured yarn also registered good colour fastness to dry rubbing in terms of colour change. Light yellow coloured yarn showed negligible staining. Whereas, all other colours showed slight staining on both the cotton and silk samples.

Wet rub fastness of all colours dyed on sisal yarns was found to be good to excellent for colour change. Light yellow showed negligible staining, black dyed sisal yarns showed noticeable change and other colours showed slight change. Indigo blue registered slight to negligible change (4/5) on both the cotton and silk samples.

Fastness grades of jute yarn dyed with natural dyes for sunlight, washing and rubbing are presented in Table 3. It was observed that, all the colours on jute showed good to excellent colour fastness to sunlight. Colour fastness to washing was excellent in terms of colour change with negligible staining on both cotton and silk.

Dry rub fastness was excellent for all dyed yarns with very slight staining on cotton samples. Light yellow, greenish yellow and olive green dyed yarns did not register any staining on silk samples. Whereas, dark yellow, peach and maroon

Sr. No	Natural dyes	Sun light fastness	Washing fastness			Rubbing fastness					
			CC	CS		Dry			Wet		
				C	S	CC	CS		CC	CS	
						C	S		C	S	
1.	Light yellow (Annato+Moduga flowers)	3/4	4/5	4/5	5	5	5	5	5	5	5
2.	Dark yellow (Annato+Moduga flowers)	4	4/5	4/5	5	5	4	4	5	4	4
3.	Peach (Alizarin+Dhawdi flowers)	5	4/5	4/5	5	5	4	4	5	4	4
4.	Maroon (Alizarin+Dhawdi flowers)	4/5	4	4	5	4/5	4	4	4	4	4
5.	Indigo blue	4/5	4	4	4/5	5	4	4	4/5	4/5	4/5
6.	Grey(Kasim)	4/5	4/5	4	5	4	4	4	4	4	4

Sr. No	Natural dyes	Sun light fastness	Washing fastness			Rubbing fastness					
			CC	CS		Dry			Wet		
				C	S	CC	CS		CC	CS	
						C	S		C	S	
1.	Light yellow (Annato+Moduga flowers)	4	5	5	5	5	5	5	5	4/5	4
2.	Dark yellow (Annato+Moduga flowers)	4	5	4	4	5	4/5	4	5	4	4
3.	Peach (Alizarin+Dhawdi flowers)	4/5	5	4	4	5	4/5	4	4	4	4
4.	Maroon (Alizarin+Dhawdi flowers)	4/5	4/5	4	4	5	4/5	4	4	4	4
5.	Greenish yellow (Annatto + Pomegranate rind)	4	5	4/5	4/5	5	5	5	4	4/5	4/5
6.	Olive green (Kasim+Alum)	4/5	5	4/5	4/5	5	5	5	4	4/5	4

Table 4 : Fastness grades of cotton yarn dyed using natural dyes

Sr. No	Natural dyes	Sun light fastness	Washing fastness			Rubbing fastness						
			CC	CS		CC	Dry			Wet		
				C	S		C	CS		CC	CS	
								C	S		C	S
1.	Light yellow (Annato+Moduga flowers)	3	4	4	4	5	5	5	5	4	4	
2.	Dark yellow (Annato+Moduga flowers)	2/3	4	4	4	4/5	4	4	4	3/4	3/4	
3.	Peach (Alizarin+Dhawdi flowers)	4	4/5	5	5	4/5	4/5	4/5	4/5	4/5	4/5	
4.	Indigo blue	3/4	4	4/5	4/5	4	4	4	4/5	4	4	
5.	Light blue (Pomegranate rind+Indigo blue)	3	4	4	4	5	5	4/5	4/5	4	4/5	
6.	Olive green (Kasim+Alum)	¾	4	4	4	5	5	5	5	4	4/5	
7.	Violet (Alizarin+Kasim+Dhawdi flowers)	4	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4	4/5	

dyed yarns showed slight staining on silk samples.

The colour change due to wet rub fastness was found to be excellent for light and dark yellow samples and good for peach, maroon, greenish yellow and olive green dyed yarns. Slight staining was noticed on all samples except greenish yellow on silk samples. Dark yellow, peach and maroon registered slight staining. Whereas, other samples showed slight to negligible change on cotton samples. On the whole, the colour fastness grades were good to excellent for colour change. Naturally dyed jute yarns showed slight to negligible staining.

The fastness grades of cotton yarns dyed with natural dyes are presented in Table 4. The colour fastness to sunlight was found to be between poor to fair i.e 2/3 for dark yellow coloured yarn. Light yellow, light blue coloured yarn reported fair fastness. For indigo blue and olive green coloured yarn, the fastness to sunlight was fair to good. Peach and violet samples showed good fastness to sunlight.

Poor light fastness of some of the natural dyes can be attributed to the inherent propensity of the dye chromophore to photochemical oxidation. The chromophore in some cases can be protected from photochemical oxidation by forming a complex with transition metal, whereby a six member ring is formed. The photons sorbed by the chromophoric groups dissipate their energy by resonating with the ring and hence the dye is protected (Gulrajani, 1999 a and b).

The wash fastness of all the samples were in good to excellent range for colour change with from slight to negligible staining both on cotton and silk. Blue dye exhibited good to excellent fastness to washing. The dye is applied in the soluble leuco form but once it is inside the fibre, the dye gets oxidized to insoluble form and gets firmly held by the fibre.

The dry rub fastness of light yellow, light blue and olive coloured cotton yarn was found to be excellent for colour change and negligible staining was found on both cotton and silk samples. Peach and violet coloured samples were found to have slight to negligible staining. Indigo blue and dark yellow showed slight staining to dry rubbing on cotton and silk samples.

The wet rub fastness of yellows and olive green was

found to be excellent for colour change. Peach, indigo blue, violet and light blue coloured cotton yarns showed good to excellent fastness to colour change. All the samples showed slight staining on cotton except peach coloured yarn which showed negligible staining. Dark yellow coloured yarn showed slight to noticeable change. On silk, light yellow and indigo blue showed slight change, dark yellow registered slight to noticeable change, all other samples reported slight to negligible change.

Conclusion:

Banana yarns:

Yellow dyed banana yarns registered excellent fastness to washing and rubbing but for sunlight fair to good fastness was noticed. Good to excellent fastness to sunlight, washing and rubbing were noticed for peach and maroon/dark red coloured yarns except for wet rubbing in which maroon sample showed noticeable staining.

Sisal yarns:

All naturally dyed sisal yarns registered good to excellent sunlight fastness properties except light yellow which showed fair to good fastness to sunlight. Wash fastness properties of dyed sisal yarns were good to excellent for change in colour and slight to negligible staining was seen on both cotton and silk. Good to excellent fastness was seen for dry and wet rubbing to change in colour and slight to negligible staining except for black which showed noticeable staining on both cotton and silk.

Jute yarns:

Naturally dyed jute yarns showed good to excellent fastness properties to sunlight, washing and rubbing. Naturally dyed jute yarns showed slight to negligible staining.

Cotton yarns:

The sunlight fastness of naturally dyed cotton yarns ranged from poor to good for most of the yarns. The dyed cotton yarns registered good to excellent wash fastness to change in colour, slight to negligible staining was seen on

both cotton and silk samples. Dry and wet rubbing fastness of cotton yarns was found to be good to excellent for change in colour and slight to negligible changes were noticed for staining except dark yellow dyed yarn which showed noticeable to slight change on both cotton and silk. On the whole, the sunlight fastness properties of dyed cotton yarns were poor when compared to jute, banana and sisal yarns.

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