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A comparative study on the color fastness properties of Lyocell and Bamboo fabrics after dyeing with a natural dye: Chavalkodi

M. Nazeem Banu and Mrs. Shayestha Fathima

Abstract
The technology moves forward and we all realize a greater need to preserve our planet and fibre - processing companies are doing their part in the effort. Conscientious companies are creating new fibres that not only possess important health attributes comparable to natural fibres, but also are manufactured using the principles of sustainable management and high environmental standards. Lyocell is a fabric most known better by its brand name Tencel®. It is made from cellulose (vegetable matter), or wood pulp (typically a mix of hardwood trees such as oak and birch). Bamboo is also made from the pulp of bamboo grass which is totally eco-friendly.
The main purpose of this study was to compare the colour fastness properties of LYOCELL and BAMBOO fabrics dyed with a natural dye. Chavalkodi was the natural dye selected.
The tests to evaluate the colour fastness properties of both the dyed samples were assessed by subjecting it to laundering, sunlight, dry and wet conditions of pressing, dry and wet crocking and for acid and alkaline perspiration.

Keywords: Lyocell, Bamboo, Natural dye- Cahvalkodi, Colour fastness properties

Introduction
Textile is becoming an increasingly sustainable product in today's world. Textile consumers all over the world are perpetually looking for biodegradable and eco-friendly textiles to preserve the environment. Thus use of eco-friendly fibres and fabrics are gradually gaining importance throughout the world. As the ecological parameters becoming more stringent, it becomes the prime concern of the textile processor to be conscious about quality and ecology. Again the guidelines for the textile processing industries by the pollution control board create concern over the environment friendliness of the processes.
The raw material for lyocell is cellulose from wood pulp which is broken down chemically in a soupy sludge that is squirted out through a showerhead spinneret and reformed as fibres. Lyocell is more accurately described as a recovered or regenerated fibre. Lyocell uses an amine oxide as a non-toxic solvent which is continually recycled during the production process. Production plant emissions into the air from smokestacks and from wastewater are significantly lower in comparison to many other man-made fibre operations.
Bamboo fabric is a natural textile made from the pulp of the bamboo grass. To make bamboo fibre, bamboo is heavily pulped until it separates into thin component threads of fibre, which can be spun and dyed for weaving into cloth.
Oldenlandia umbellata (called chay root or choy root, from its Tamil name) is a low-growing plant native to India. A colour-fast red dye can be extracted from the root bark of (preferably) a two year old plant. Chay root dye was once used with a mordant to impart a red colour to fabrics such as calico, wool, and silk. It is grown on the Coromandel Coast in India.

The specific objectives of the study are
1. To dye the samples of Bamboo fabric and Lyocell fabric with natural dye - Chavalkodi.
2. To compare the color fastness properties of the dyed sample with respect to laundering, sunlight, pressing, crocking and perspiration.

Methodology
The main purpose of the study was to compare colour fastness properties of LYOCELL and BAMBOO fabrics dyed with a natural dye -chavalkodi.

Selection of Fabrics
70% Lyocell fabric with 30's count of lyocell yarns in the weft direction and 60's count of cotton yarns in warp direction was selected for the study. 70% Bamboo fabric with 30's count of Bamboo yarns in the weft direction and 60's count of cotton yarns in warp direction was obtained for the study.

Selection of Dyes
The dye selected for the study was a natural dye chavalkodi or chaya vaer.

Selection of Mordant
The mordants used for the study are myrobalan.

Pre Treatment of The Fabrics
Before dyeing the Lyocell and Bamboo fabrics were desized to remove the finishing agent in the fabrics.

Boiling Process
Recipe:
Fabrics weight - 260 g
Luzyme HP - 1cc/ litre
Amollan FB-OLS - 1g / litre
Material to liquor ratio - 1: 20
Duration - 45 minutes
Temperature - 60° c
The fabrics were steeped in the desizing solution at 60°c for 45 minutes. The fabrics were then rinsed twice in cold water. This process was done to remove all dirt and impurities present in the fabric that could hinder in dyeing process.

Preparation of Test Sample
Lyocell and bamboo fabrics each measuring 2m was taken for pre-treatment with myrobalan and alum.

Mordanting of Fabric With Myrobalan And Alum
20 g/l of myrobalan pods were taken, crushed and soaked in hot or cold water overnight. The next day the soaked ingredients were boiled for 30 minutes. The extract was taken and water was added to it with a ML ratio of 1:30. The fabric samples were steeped in this solution for 1 hour at room temperature. Then it was taken out squeezed and dried in shade.
20 g/l of alum was taken, powdered and dissolved in hot water. It was mixed with cold water with a ML ratio of 1:30. The fabric samples treated with myrobalan were again steeped in this alum solution for 1 hour at room temperature. They were then taken out, squeezed and dried in shade.

Dyeing Procedure
Recipe:
Chavalkodi - 30 g/l
Weight of the fabrics - 260 g
Material to liquor ratio - 1:40
30 grams of chavalkodi was crushed to minimum particle size and soaked in water in separate containers overnight. The next day it was boiled for 30 minutes, filtered out and warm water was added to chavalkodi residue to extract the dye completely and water was added to the extract to bring its level to material liquor ratio. The dye bath was divided equally into two and the two above treated samples were immersed in the dye bath separately and worked for 5 to 10 minutes. The temperature of the dye bath was raised to boiling. At boiling temperature the dyeing was continued for 30 minutes, and allowed to cool in the dye bath itself for a period of one to two hours. The material was then taken out, rinsed in cold running water, squeezed and dried in shade.

Tests for colour Fastness
Colour fastness tests were carried out on the sample to find out which fabric shows better colour fastness properties after dyeing. The following tests of colour fastness were carried out and the ratings were noted.

Colour Fastness to Laundering
The test was conducted to find whether the test samples showed colour change, colour transference or both when subjected to laundering. A piece of fabric was cut from each sample with dimensions of two inches by four inches. Grey multi fibre cloth of similar measurements was attached to the right side of the fabric which formed the test specimen.
Weight of test specimen and attached white piece: 5 gms
Soap powder: 1 gm
Water: 100 milliliter
The test specimen was soaked in the above solution at room temperature for 30 minutes with occasional kneading and squeezing. They were then rinsed twice in tap water, air-dried and all the time it was made it was made sure that the white piece of multi fibre cloth attached was in full contact with the specimen. The samples were then evaluated for colour change, colour transference or both using grey scale.

Colour Fastness to Pressing
This test was carried out to determine whether the samples showed any colour change and colour transference when subjected to wet and dry pressing. Two tests specimens measuring four inches by two inches were cut from each fabric and white piece of multi fibre cloth measuring the same dimensions were attached to the right side of each sample by stitching.

Dry Pressing
A dry specimen was used to carry out the dry pressing test. The test specimen was ironed with a thermostatically set iron for 30 seconds without additional pressure, all the time making sure that the white piece of multi fibre fabric was in full contact with the specimen.

Wet Pressing
The test specimen was soaked in distilled water and squeezed to retain 100% moisture and the test was carried out in the same manner as that of dry pressing. The evaluation of the samples for colour change, colour transference or both was done using the grey scale.

Colour Fastness to Crocking
This test was done to determine the resistance of the specimen to rubbing. Two tests specimens measuring six inches by two inches were cut from each fabric to be used for dry crocking and wet crocking.

Dry Crocking
The crocking test was done using a Crockmeter. The test specimen was fixed firmly to the surface using the clamp

screws. A dry piece of white cloth measuring two inches square was mounted at the end of the testing devise. The test specimens were subjected to crocking by moving the white test piece on the wooden block to and fro ten times in ten seconds. Care was taken to apply pressure evenly and to slide the block at a uniform speed.

Wet Crocking

For wet crocking, the white cotton piece was wetted with distilled water and the test was carried out in the same manner as that of dry crocking. The samples were assessed for colour change, colour tranference or both using the grey scale.

Colour Fastness to Perspiration

This test was conducted to find out the colour fastness and colour transference of the samples when subjected to acid and alkaline perspiration. Two test specimens were taken from each fabric, both measuring 2 inches x 4 inches and a grey multi fibre of cloth measuring similar dimensions was attached to the right side of each sample by stitching. One was used for acid perspiration and the other was used for alkaline perspiration.

Acid Perspiration

Sodium chloride	:	10 gms
Sodium phosphate	:	1 gm
Lactic acid	:	1 gm

The three ingredients were added to one liter of distilled water to form a solution. The test specimens were thoroughly wetted in the acid solution, rolled with the un-dyed grey multi fibre cloth on the outside and inserted into a glass tube, leaving one third of the roll projecting outside. These tubes were placed in an oven at a temperature of 37± 2° c for 6 hours. The composite specimens were then dried in air.

Alkaline Perspiration

Sodium chloride	: 10 gm
Sodium phosphate (dibasic)	: 1 gm
Ammonium carbonate	: 4 gm

The three ingredients were mixed in one liter of distilled water and stirred to form a solution. The procedure adopted was the same as for acid perspiration. The samples were then evaluated for colour change, colour transference or both using the grey scale.

Colour Fastness to Sunlight

This test was done to assess the colour fastness of the test samples when exposed to sunlight. One test specimen measuring 5 inches x 2 inches was cut from each sample. They were fixed on to a white cardboard and covered by a plain glass to protect it from direct dirt. The specimens were placed on a horizontal plane in an open area, so that the sun's rays can fall directly on them. The specimens were exposed to sunlight from 10 a.m to 4 p.m. for one week. These specimens were evaluated for colour change, if any, using the grey scale.

Guide for Spectrophotometer Rating:

5 – Excellent -Negotiable rate of colour change or colour transference

4 – Very Good - Very little rate of colour change or colour transference

3 – Good - Little rate of colour change or colour transference

2 - Fair - Appreciable rate colour change or colour transference

1 - Poor - Objectionable rate of colour change or colour transference

Results and discussion

a. Colour Fastness to Laundering Colour Change

The average rating for colour change of Lyocell and Bamboo fabric were found to be 3.93 and 3.76 respectively.A little rate of colour change was observed in both Lyocell and Bamboo fabrics.

Table 1: Colour Change-Laundering

S.no	Laundering	Dyed samples	Mean Ratings	't' Value	'p' Value
1.	COLOUR CHANGE	LYOCELL	3.93	1.04	0.3571
		BAMBOO	3.76		

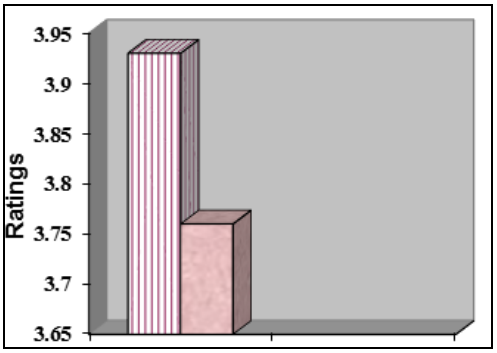

Fig 1: Colour Change-Laundering

Colour Transference

The average rating for colour staining of Lyocell and Bamboo fabrics on acetate fabrics are 4.8 and 4.76, on cotton fabrics are 4 and 3.83, on nylon fabrics are 4.9 and 4.83, on polyester fabrics are 4.83 and 4.53, on acrylic fabrics are 4.83 and 4.7 and on wool fabrics are 4.9 and 4.83 respectively in terms of colour transference when subjected to laundering.

There was a very little rate of colour transference in multi fibre white fabric which was kept along with both the dyed samples. Both the fabrics showed good colour fastness to laundering.

Table 2: Colour Transference- Laundering

S. NO	STAINING ON	DYED SAMPLE	MEAN Ratings	'T' VALUE	'P' VALUE
1.	ACETATE	LYOCELL	4.8	0.1952	0.8548
		BAMBOO	4.76		
2.	COTTON	LYOCELL	4	1.772	0.1510
		BAMBOO	3.83		
3.	NYLON	LYOCELL	4.9	0.663	0.5436
		BAMBOO	4.83		

4.	POLYESTER	LYOCELL	4.83	2.415	0.0732
		BAMBOO	4.53		
5.	ACRYLIC	LYOCELL	4.83	0.671	0.5390
		BAMBOO	4.7		
6.	WOOL	LYOCELL	4.9	0.3757	0.7262
		BAMBOO	4.83		

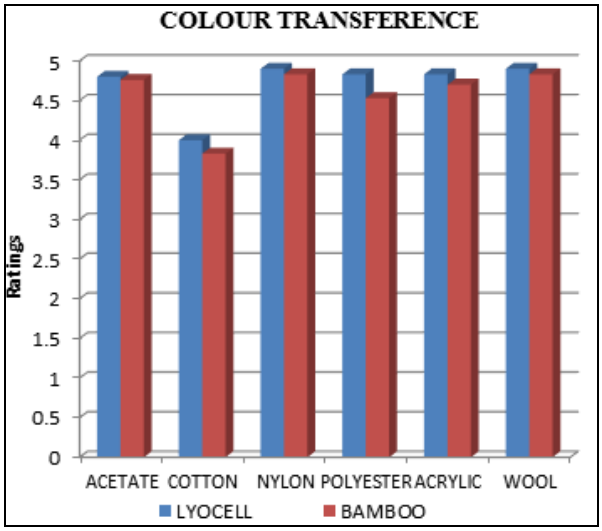

Fig 2: Colour Transference- Laundering

b. Colour Fastness to Pressing

Dry Pressing

Colour Change

The average rating for colour change of Lyocell and Bamboo fabric was found to be 3.96 and 3.96 respectively.

Colour Transference

The average rating for colour change of Lyocell and Bamboo fabric was found to be 3.94 and 3.58 respectively in terms of colour transference when subjected to pressing in a dry condition.

There was a little rate of colour transference was observed in white fabric which was kept along with both the dyed samples. Both the fabrics showed better colour fastness to dry pressing.

Wet Pressing

Colour Change

The average rating for colour change of Lyocell and Bamboo fabric was found to be 3.96 and 3.83 respectively.

A little rate of colour change was observed in both Lyocell and Bamboo fabrics.

Colour Transference

The average rating for colour transference of Lyocell and Bamboo fabrics was found to be 3.64 and 2.92 respectively in terms of colour transference when subjected to wet pressing.

A little rate of colour transference was observed in white fabric which was kept along with both the dyed samples. Bamboo fabric showed poor colour fastness to wet pressing than Lyocell.

Table 3: Colour Fastness to Pressing

S.No	Pressing	Dyed Samples		Mean Ratings	'T' Value	'P' Value
1.	Dry	Colour Change	Lyocell	3.96	0	1.0000
			Bamboo	3.96		
		Colour Transference	Lyocell	3.94*	2.431*	0.0411*
			Bamboo	3.58*		
2.	Wet	Colour Change	Lyocell	3.96	1.377	0.2476
			Bamboo	3.83		
		Colour Transference	Lyocell	3.64*	4.864*	0.0012*
			Bamboo	2.92*		

*- Significant

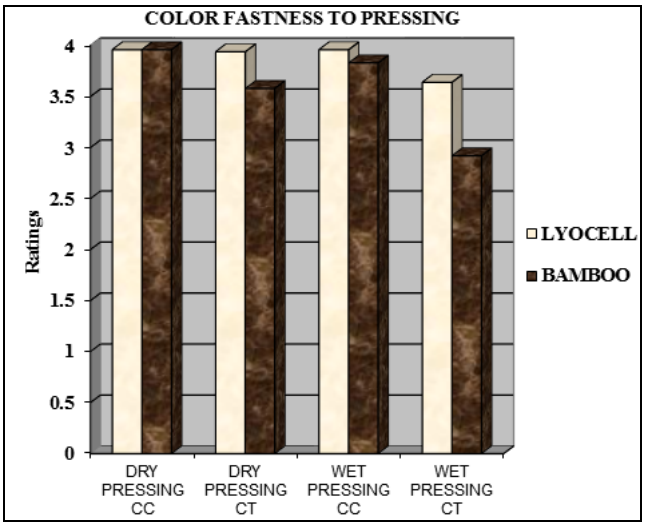

Fig 3: Colour Fastness to Pressing

Crocking was done in dry and wet condition on the dyed sample and the colour fastness tests were carried out.

Dry Crocking

Lyocell and bamboo fabrics showed the average rating of 2.9 and 1.9 respectively in terms of colour transference when subjected to dry crocking.

There was an appreciable rate of staining of both the fabrics in dry crocking, but Bamboo showed more stain than Lyocell.

Wet Crocking

The average rating for colour staining of Lyocell and Bamboo fabrics subjected to wet crocking was found to be 1.6 and 0.833 respectively.

The Lyocell had an appreciable rate of staining whereas Bamboo fabric had an objectionable rate of staining when subjected to wet crocking. Bamboo stained more than Lyocell fabric.

Table 4: Colour Fastness to Crocking

S.NO	CROCKING	DYED SAMPLES	MEAN Ratings	'T' VALUE	'P' VALUE
1.	DRY	LYOCELL	2.9*	12.24	0.003
		BAMBOO	1.9*		
2.	WET	LYOCELL	1.6	2.414	0.0732
		BAMBOO	0.833		

* - Significant

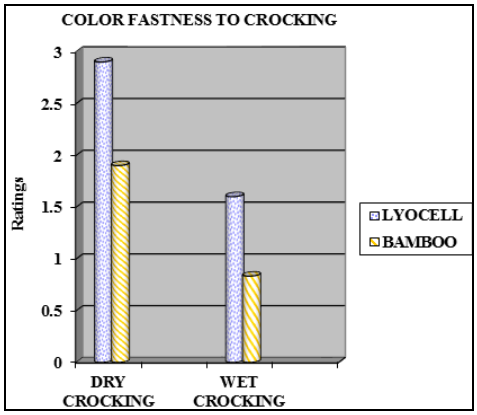

Fig 4: Colour Fastness to Crocking

The test for colour fastness to perspiration was done in acidic and alkaline conditions on the dyed samples.

Acid Perspiration
Colour Change

The average for colour change of the Lyocell and Bamboo dyed sample was found to be 3.96 and 3.96 respectively.

There was a little rate of colour change in both the dyed samples.

Table 5: Colour Fastness to Perspiration (Acid) Colour Change

S.NO	PERSPIRATION		DYED SAMPLES	MEAN Ratings	'T' VALUE	'P' VALUE
1.	ACID	COLOUR CHANGE	TENCEL	3.96	1.407	0.2320
			BAMBOO	3.96		

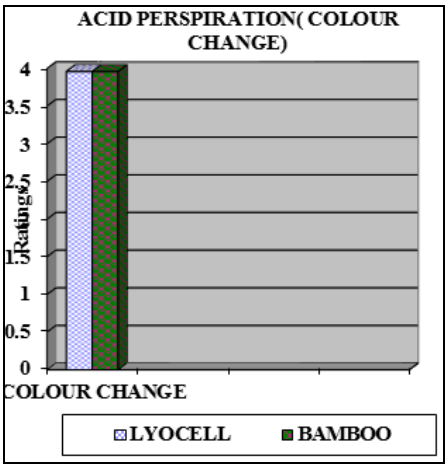

Fig 5: Colour Change -Acid Perspiration

The average rating for colour staining of Lyocell and Bamboo fabrics on acetate fabrics are 0.96 and 1.6, on cotton fabrics are 1.83 and 1.93, on nylon fabrics are 0.9 and 0.96, on polyester fabrics are 1.96 and 2.96, on acrylic fabrics are 2.9 and 3.63 and on wool fabrics are 1.6 and 1.96 respectively in terms of colour transference when subjected to laundering.

There was an appreciable rate of colour transference in both the dyed fabric samples. Both the fabrics possessed poor colour fastness to acid perspiration.

Table 6: Colour Fastness to Perspiration (Acid) Colour Transference

S.NO	STAINING ON	DYED SAMPLE	MEAN Ratings	'T' VALUE	'P' VALUE
1.	ACETATE	LYOCELL	0.96	2.083	0.1057
		BAMBOO	1.6		
2.	COTTON	LYOCELL	1.83	1.176	0.3048
		BAMBOO	1.93		
3.	NYLON	LYOCELL	0.9	0.807	0.4649
		BAMBOO	0.96		
4.	POLYESTER	LYOCELL	1.96*	24.48*	<0.0001*
		BAMBOO	2.96*		
5.	ACRYLIC	LYOCELL	2.9*	3.097*	0.0363*
		BAMBOO	3.63*		
6.	WOOL	LYOCELL	1.6	1.175	0.3052
		BAMBOO	1.96		

* -statistically significant

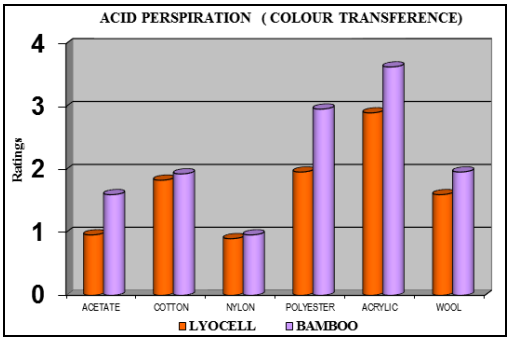

Fig 6: Colour Transference -Acid Perspiration

Colour Change

The Average For Colour Change Of The Lyocell And Bamboo Dyed Sample Was Found To Be 3.96 And 4 Respectively. A Little Rate Of Colour Change In Both The Dyed Samples Was Observed.

Table 7: Colour Fastness to PerspirationAlkaline (Colour Change)

S.NO	PERSPIRATION		DYED SAMPLES	MEAN Ratings	'T' VALUE	'P' VALUE
1.	ALKALINE	COLOUR CHANGE	LYOCELL	3.96	0.979	0.3827
			BAMBOO	4		

Colour Fastness to Perspiration Alkaline (Colour Change)

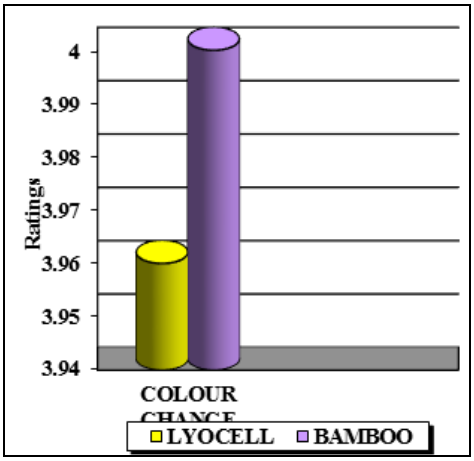

Fig 7: Colour Change- Alkaline Perspiration

The average rating for colour staining of Lyocell and Bamboo fabrics on acetate fabrics are 1.93 and 1.96, on cotton fabrics are 1.96 and 2.9, on nylon fabrics are 1.86 and 1.9, on polyester fabrics are 3.86 and 2.96, on acrylic fabrics are 2.6 and 3.5 and on wool fabrics are 1.96 and 1.9 respectively in terms of colour transference when subjected to laundering.

There was an appreciable rate of colour transference in both the dyed fabric samples. Both the fabrics processed poor colour fastness to alkaline perspiration.

Table 8: Colour Fastness to Perspiration (Alkaline) Colour Transference

S. No	Staining On	Dyed Sample	Mean Ratings	'T' Value	'P' Value
1.	Acetate	Lyocell	1.93	0.238	0.8236
		Bamboo	1.96		
2.	Cotton	Lyocell	1.96*	14.56*	0.0001*
		Bamboo	2.9*		
3.	Nylon	Lyocell	1.86	0.398	0.7110
		Bamboo	1.9		
4.	Polyester	Lyocell	3.86**	9.8357*	0.0006*
		Bamboo	2.96*		
5.	Acrylic	Lyocell	2.6	2.159	0.0970
		Bamboo	3.5		
6.	Wool	Lyocell	1.96	0.578	0.5942
		Bamboo	1.9		

*- Significant

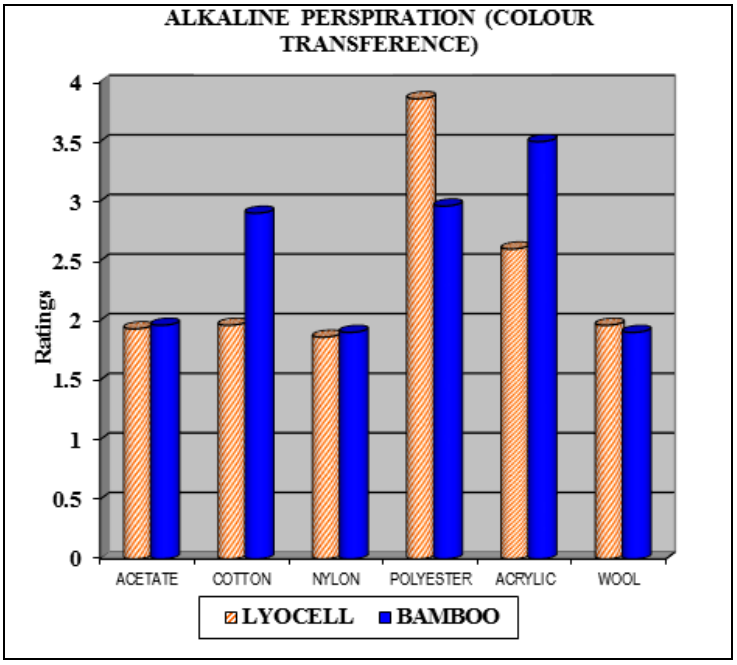

Fig 8: Colour Transference-Alkaline Perspiration

The test for colour fastness to sunlight was done on the dyed samples.

Colour Change

The average for colour change of the Lyocell and Bamboo dyed sample was found to be 3 and 3.57 respectively.

A little rate of colour change was observed in both the dyed samples.

Table 9: Colour Fastness to Sunlight

S. NO	DYED SAMPLES	MEAN Ratings	'T' VALUE	'P' VALUE
1.	LYOCELL	3	1.333	0.207
2.	BAMBOO	3.57		

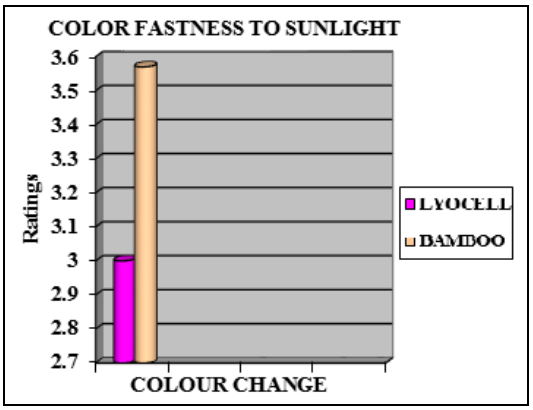

Fig 9: Color fastness to sunlight

Conclusion

From the analysis of the results it can be concluded that Lyocell showed good performance in terms of colour fastness properties with respect to laundering, pressing, crocking. But Bamboo fabric showed better results than Lyocell fabric in colour fastness to perspiration. Both had similar colour fastness rating for sunlight.

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