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# Study on dyeing behavior of cotton/organic cotton knitted fabrics

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#### Abstract

Organic cotton is grown using methods and materials that have a low impact on the environment. Organic cotton is grown and processed without toxic chemicals that can be absorbed easily when in contact with the user's skin. This paper describes the dyeing behavior of organic cotton vs conventional cotton to find what will be the significance between them. The ring spun yarns of 40<sup>s</sup> combed organic (GOTS certified) and ordinary cotton were produced with similar parameters like beating point and settings. Knitted fabrics were produced with similar loop length and weight using organic and ordinary cotton yarn. Both the fabrics were processed in GOTS certified Processing unit using reactive dyes in soft flow machine in single dye bath. Processed fabrics were tested for colour fastness to washing, water, rubbing, perspiration and light. Colour difference and strength were also measured using Spectrophotometer (DATA*COLOUR*). Presence of metals were also analyzed in both the processed fabrics and reported here.

Keywords: Organic cotton, dyeing, fabrics, textile.

#### Introduction

Around the world, more toxic insecticides are used on cotton than on any other crop. A sustainable alternative is the certified organic cultivation of the "white gold". The farmers have only a chance to convert their production into a controlled organic cultivation of organic cotton is grown using methods and materials that have a low impact on the environment. Organic production systems replenish and maintain soil fertility, reduce the use of toxic and persistent pesticides and fertilizers, and build biologically diverse agriculture. Third-party certification organizations verify that organic producers use only methods and materials allowed in organic production (Punj, 2000).

The conventional cultivation of cotton leads to massive environmental and health problems (Meredith, 1945). Consumers interested in the sustainable use of clothes and textiles will find the opportunity to search for producers and retailers. Organic cotton is grown and processed without toxic chemicals that can be absorbed easily when in contact with the user's skin. Pesticides, fertilisers and chemicals used to grow and process conventional cotton fabrics may go directly to the users blood stream, which consequently affects the body's organs and tissues. Organic cotton production is not simply an elimination of fertilisers and insecticides but it is a complete production system, which requires equally sound knowledge of cotton production practices. With respect to insect control in particular, a thorough knowledge of non-chemical means of insect control is a pre-requisite for organic production. Organic cotton production requires careful planning so as to realise optimum yield. It includes a number of factors like site selection, crop rotations, variety, weed control, nonchemical means of insect control and skill to manage organic crop (Morton et al., 1975). Similarly, there is a need to perfect the agronomic requirements of a crop to

be grown without synthetic fertilisers and pesticides. Besides, the naturally soft organic cotton fabric is a lot more comfortable to use and is available at competitive prices.

Organic cotton has various end uses ranging from personal care items to home furnishings and even with garments of all styles and kinds even for kids wear organic cotton is the best recommended one. Nowadays more and more spinning mills are opting for organic cotton for organic cotton yarn, to be used in knitting and wearing (Ruppenicker, 1977). Thus the future trend of organic cotton is increasing day by day as the awareness among consumers in growing for the eco friendliness from the fibre stage itself. Thus, our paper will be more useful for the industries to analyse the Dyeing behaviour of organic cotton with the conventional cotton and to identify any change in process route for organic cotton by providing them important test results.

#### Materials and methods

Yarn sample (Table 1)

Organic cotton yarn samples of 40s and Ordinary cotton 40s were spun in super spinning mill, Coimbatore with the following machines and process parameters.

*Machine:* Knitting machine make:Yearchina; Type of fabric produced: Interlock; Dia:30; Loop length: 30 cm; GSM:155.

*Process parameters:* <u>Grey fabric sample</u>. Organic cotton knitted fabric and ordinary cotton fabrics are knitted in Sri Knits, Avinashi, India with following machines and process parameters (Prakash *et al.*, 2010). <u>Dyed fabric sample (Table 2)</u>: Processing of organic and inorganic fabric based on global organic standards is done and then they are subjected to testing of behavior of organic cotton fabric vs ordinary cotton fabric (kizil *et al.*, 2005). The fabrics of both organic and inorganic nature are treated simultaneously in the same process sequence with same recipes in soft flow machine. *Dyeing properties* 



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	Table 1. Process parameters								
Cotton	Lap	Card sliver	Draw frame	Comber	Rove	Yarn			
Collon	hank	hank	sliver hank	sliver hank	hank	count			
Organic cotton	0.001475	0.14	0.140	0.14	1.4	40 <sup>s</sup>			
Ordinary cotton	0.001475	0.14	0.140	0.14	1.4	40 <sup>s</sup>			

## Table 3. Method and instrument

Test /dyeing	Method	Instrument name
properties		
Wax content	SITRA/TC/G/21	Soxhlet apparatus
Scouring loss	IS1383	Caustic method
Absorbency test	IS2369	Purit
Whiteness index		MACBEPTH 7000 A
		spectrometer
Light fastness	AATCC16	Xeno tester 150 S+
		model
Washing fastness	IS105C06	RBE - Fastness
		machine
Washing to	IS105C06	Perspiro meter
perspiration		
Washing to water	IS105C06	RBE - Fastness
Washing to Water		machine
Rubbing fastness	IS105C06	Crock meter
Hoovy motal	IS790	Atomic absorbsion
riedvy filetai		spectrophotometer
Colour difforence		Spectrophotometer
		(DATACOLOUR)
Colour strongth		Spectrophotometer
		(DATACOLOUR)

#### Table 9. Colour fastness to perspiration (alkaline)

Colour	Ordinary cotton			Organic cotton		
test	Yellow	Blue	Pink	Yellow	Blue	Pink
Acetate	3-4	3-4	3	3-4	3-4	3
Cotton	3	3	2-3	3	3	2-3
Nylon	4	3-4	3	4	3-4	3
Polyester	4	3-4	3	4	3-4	3
Acrylic	3-4	3	3	3-4	3	3
Wool	3-4	3	3	3-4	3	3

#### Table 10 Colour fastness to perspiration (acid)

Colour	Ordir	nary cotto	n	Organic cotton			
Test	Yellow	Blue	Pink	Yellow	Blue	Pink	
Acetate	3-4	3	3	3-4	3	3	
Cotton	3	3	2-3	3	3	2-3	
Nylon	4	3	2-3	4	3	2-3	
Polyester	4	3	2-3	4	3	2-3	
Acrylic	3-4	3	2-3	3-4	3	2-3	
Wool	3-4	3	2-3	3-4	3	2-3	

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Table 2. Dye receipe						
Remazol RR	2%					
Sodium chloride	50 g/l					
Sodium carbonate	5 g/l					
Sodium hydroxide	1 g/l					
Fixation Time	60 min					
Liquor ratio	1:10					
Dyeing	55°-60°C					

# Table 4. Scouring loss

Ordinary cotton	Organic Cotton		
6.97%	5.93 %		

Table 5. Wax Content				
Ordinary cotton Organic Cotton				
6.97%	5.93 %			

Table 6. Absorbency rate				
Ordinary cotton Organic Cotton				
6.97% 5.93 %				

Table 7. Whiteness index					
Ordinary cotton Organic Cotton					
48.24 (-3.97 Reddish)	45.75 (-4.28 Reddish)				
Whiteness index C	IE (With Bleaching)				
Ordinary cotton Organic Cotton					
78	79				

#### Table 8. Colour fastness to perspiration (alkaline)

Colour	Ordinary cotton			Organic cotton		
Test	Yellow	Blue	Pink	Yellow	Blue	Pink
Acetate	3-4	3-4	3	3-4	3-4	3
Cotton	3	3	2-3	3	3	2-3
Nylon	4	3-4	3	4	3-4	3
Polyester	4	3-4	3	4	3-4	3
Acrylic	3-4	3	3	3-4	3	3
Wool	3-4	3	3	3-4	3	3

#### Table 11. Colour fastness to water

Colour	Ordinary cotton			Org	anic cot	ton
test	Yellow	Blue	Pink	Yellow	Blue	Pink
Before	4	4	4	4	4	4
After	3	3	2-3	3	3	2-3



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Fig. 3. Washing fastness comparison chart













Fig. 8. Light fastness comparison chart



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Value



measured (Table 3): Dyeing properties are tested at South India Textile Research Association in Coimbatore and Trinity Colours India Pvt. Ltd., Perundurai, India. All tests are carried out under the ISO Standards (Table 2).

Table 12. Colour fastness to wet and dry rubbing

Colour	Ordinary cotton			Organic cotton			
test	Yellow	Blue	Pink	Yellow	Blue	Pink	
Dry	4-5	4-5	4-5	4-5	4-5	4-5	
Wet	4	4	4	4	4	4	

Fig 10(a) Fabric sample-Blue colour; Ordinary blue vs Organic blue



#### Results and discussion

The grey hosiery fabric samples (organic cotton, ordinary cotton) were scoured and dyed as desired using 2% Remazol Yellow RR, 2% Remazol Blue RR and 2% Remazol Red RR on the same bath. The dyed sample test results are as follows:

#### Scouring loss (Table 4 & Fig. 1)

Organic cotton (6.97%) is having less scouring loss when compare to ordinary cotton (5.93%).

### Wax content (Table 5 & Fig. 2)

Wax content is comparatively less in organic cotton (0.9%) when compare to ordinary cotton (0.79%).

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#### Colour fastness to perspiration (acid) (Table 10 & Fig. 5)

both organic and ordinary cotton gives same

performance ie., avg. scale value is 3-4. Except for pink colour where, it is pink colour

Colour fastness to perspiration (acid) report for the both organic and ordinary cotton gives same performance ie., avg. scale is 3-4, except for pink colour where, it is pink colour comparatively less. Colour fastness to perspiration for alkali is better than acid.

#### Colour fastness to water (Table 11 & Fig. 6)

In washing fastness with water, organic cotton and ordinary cotton gives same performance before and after wash.

Table 13. Colour fas	stness to light		
Colour	Ordinary	Organic	
Coloui	cotton	cotton	
2% Remazol yellow RR	3-4	3-4	
2% Remazol blue RR	3-4	3-4	
2% Remazol red RR	3-4	3-4	

#### Table 14. Heavy metals detection

Colour	Organic cotton dye strength	Ordinary cotton dye strength
Yellow	97.74	99.32
Blue	100.57	99.84
Red	99.03	100.98

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Table 15. Heav	v metals detection in Colour strenath
lable let lied	

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Whiteness index (Table 7)

4)

+DL\*

-25

-DL\* DARKER

Metals	Ordinary cotton	Organic cotton
Copper	1.04	0.98
Nickel	ND	ND
Zinc	4.45	3.72
Cobalt	ND	ND
Iron	4.09	3.66

ND-Not detected up to 1 ppm

Absorbancy is below 1 for Ordinary cotton (sec) and

Washing fastness range is good (Avg. scale value is 4) in organic and conventional cotton except in blue

Colour fastness to perspiration (alkali) report for the

Colour fastness to perspiration (alkaline) (Table 9 & Fig.

Test: Whiteness index CIE (Without Bleaching)

Test: Whiteness index CIE (With Bleaching)

Colour fastness to washing (Table 8 & Fig. 3)

comparatively less.

colour sample (Avg. scale value is 3-4).

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Fig 10 (b) Organic blue vs Ordinary blue



Fig 10 (c) Fabric sample-Pink colour; Ordinary pink vs Organic pink



		Fig	д 10 (d	) Organic	: pink v:	s Ordin	ary pink	٢
%R LAV SCI UV	/ Inc							
STANDARD N	AME :			02-Jun	-08	21:12:10		
C818 PINE	<pre>&lt; ORGAN</pre>	IC CO	IOTI	1		<b>↓</b> Std:	Inst 🛓	E
New Std S	tore Std Retrieve	Std List S	td			3000 S <b>R</b>		S D-*AKER
400-450 nm 19.98	21.99 23.47 24	4 16 23 63	21.42					
460-510 nm 17.97	14.73 11.89 9	9.94 8.36	7.34					
520-570 nm 6.92	6.86 6.97 7	7.53 9.13	12.57					D
580-630 nm 18.58	27.60 38.87 50	0.54 60.54	67.60					
640-690 nm 72.50	76.37 79.54 82	2.39 84.65	86.22					4
700 nm 87.45	CHECK SUM : 1	1158.94						
BATCH NAME	<u>:</u>			02-Jun	-08	21:12:42		<u>_</u>
↑ C819 PINI	K ORDINA	RY CO	OTTO	N		<b>₽</b> Bat:	Inst 🛓	BATCH
New Bat S	Store Bat Retrieve	Bat List B	lat					Dittoiti
400-450 nm 19.74	21.76 23.22 23	3.92 23.45	21.24					
460-510 nm 17.88	6.82 11.83 9	9.91 8.33	7.29					STRENC
520-570 nm 6.89	14.66 6.92 7	7.46 9.05	12.45					STRENG
580-630 nm 18.38	27.32 38.50 50	0.11 60.05	67.05					CMC P
640-690 nm 71.90	75.71 78.76 8	1.42 83.51	85.08	Current II	1:D65 10	Deg	Next IIIU	
700 nm 86.20	CHECK SUM : 1	1147.41						STD
<u>ill/Obs</u>	CMC DECISION	CMC DE*	<u>DL*</u>	<u>Da*</u>	<u>Db*</u>	<u>DC*</u>	<u>DH*</u>	
D65 10 Deg	Pass	0.12	-0.09	-0.20	-0.03	-0.07	-0.02	
F11 10 Deg	Pass	0.11	-0.09	-0.16	-0.04	-0.06	-0.02	
A 10 Deg	Pass	0.12	-0.09	-0.17	-0.10	-0.07	-0.04	





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Colour fastness to wet and dry rubbing (Table 12 & Fig. 7) In dry and rubbing, both the cotton gave similar result. Colour fastness to light (10 h exposer) (Table 13 & Fig. 8)

In colour fastness value, both the organic and ordinary cotton responded similarly.

Heavy metals detection (Table 14 & Fig. 9)

Presence of Heavy metals in organic cotton is lesser than

Fig 10(e)Fabric sample-Yellow colour; Ordinary yellow vs Ordinary yellow



#### Fig. 10(f). Organic yellow vs Ordinary



%R LAV SCI UV Inc						MORE YELLOW	LIGHTER
STANDARD NAME :		02-Jun	-08	21:21:14		STRONGER	102
CC 818 YELLO	<b>NORGANIC</b>	COTTON		<b>↓</b> Std:	Inst 🛓	E	M 2.5
New Std Store Std	Retrieve Std List Std			22 - A		S LLOWER	E DO
400-450 nm 12.57 11.52 1	0.70 10.22 10.15 10.	19				B	в
460-510 nm 10.43 10.84 1	1.80 13.29 15.84 19.	31				E BEDDEB	Ë H
520-570 nm 24.70 31.43 3	9.60 48.53 57.49 65.	06				D	D 2.5-
580-630 nm 70.84 75.22 7	8.37 80.75 82.53 83.	83				WEAKER -	
640-690 nm 84.91 85.94 8	6.59 87.32 87.74 88.	09				<b>4</b>	-DL*
700 nm 88.52 CHECK	SUM : 1564.65					-Db*	DAHKEH
BATCH NAME :		02-Jun	-08	21:21:49		120072200	
CC 819 YELLO	W ORDINAR`	( COTTO	N	➡ Bat:	Inst 🛓	BATCHIS	
						DALL DIS CONCAR	
New Bat Store Bat	Retrieve Bat List Bat	]				less saturated	
New Bat Store Bat	Retrieve Bat List Bat 0.79 10.31 10.24 10.	27				BATCHIS. darker less saturated more yellow	
New Bat Store Bat   400-450 nm 12.70 11.59 1   460-510 nm 10.52 31.39 1	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.	27				BATCHIS: darker less saturated more yellow	
New Bet Store Bet   400-450 nm 12.70 11.69 1   460-510 nm 10.52 31.39 1   520-570 nm 24.73 10.93 3	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 48.14 56.93 64.	27 70 34				STRENGTH: 99.32	
New Bat Store Bat   400-450 nm 12.70 11.59 1   460-510 nm 10.52 31.39 1   520-570 nm 24.73 10.93 3   580-630 nm 70.05 74.40 7	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 48.14 56.93 64.   7.48 79.84 81.59 82.	27 70 34 97				STRENGTH: 99.32	
New Bat Store Bat   400.450 nm 12.70 11.59   460.510 nm 10.52 31.39   520.570 nm 24.73 10.93   580.630 nm 70.05 74.40   640.690 nm 84.03 85.06	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 48.14 56.93 64.   7.48 79.84 81.59 82.   5.69 86.41 86.82 87.	27 70 34 37 17 Currentil	II : D65 10	Deg	Next IIIu	STRENGTH: 99.32	
New Bat Store Bat   400-450 nm 12.70 11.59 1   460-510 nm 10.52 31.39 1   520-570 nm 24.73 10.93 3   580-630 nm 70.05 74.40 7   640-690 nm 87.03 85.06 8   700 nm 87.61 CHECK 7	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 48.14 56.93 64.   7.48 79.84 81.59 82.   5.69 86.41 86.82 87.   SUM: 1552.19 10. 10.24	27 70 34 97 17 Current il	II : D65 10	Deg	Next IIIu	STD BAT	
New Bat Store Bat   400-450 nm 12.70 11.69   460-510 nm 12.70 11.69   520-570 nm 24.73 10.93   580-630 nm 74.01 57.64   7640-690 nm 84.03 85.06   700 nm 84.01 CHECK   ill/Obs CMC DE CMC DE	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 46.14 56.93 64.   7.48 7.864 81.59 82.   5.69 86.41 86.82 87.   SUM: 1552.19 CISION CMC DE*	] 27 70 34 37 17 Current II <u>DL* Da*</u>	II : D65 10 <u>Db*</u>	Deg	Next IIu	STRENGTH: 99.32 CMC P/F: Pass STD BAT	
New Bat Store Bat   400-450 nm 12.70 11.59   405-510 nm 10.52 13.91   520-570 nm 24.73 10.93   580-630 nm 70.03 85.06   700 nm 87.61 CHCCK   11/Obs CMC DE D65 10 Deg	Battieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.38 15.93 19.   9.41 46.14 56.93 64.   7.48 81.59 82. 57.   5.69 86.41 86.82 87.   SUM : 1552.19 CISION CMC DE* 58   0.28 0.28 0.28 0.	] 27 70 34 37 17 Current il D <u>L* Da*</u> 1.09 -0.30	II : <i>D</i> 65 10 <u>Db*</u> -0.69	Deg <u>DC*</u> -0.26	Next IIu <u>DH*</u> 0.01	Arteris. darker less saturated more yellow STRENGTH: 99.32 CMC P/F: Pass SID BAT	
New Bat Store Bat   400-450 nm 12.70 11.59   450-510 nm 10.52 31.39   520-570 nm 24.73 10.93   520-5630 nm 70.05 74.40   640-690 nm 84.03 85.06   700 nm 87.81 CHECK   Ill/Obs CMC DE D65 10 Deg   Pati 11 Doeg Pati	Retrieve Bat List Bat   0.79 10.31 10.24 10.   1.90 13.83 15.93 19.   9.41 48.14 56.93 64.   7.48 79.84 81.59 82.   5.69 86.41 86.82 87.   SUM: 1552.19 CISION CMC DE*   \$\$ 0.28 40. 82.	] 27 70 34 37 17 Current il 0 <u>L* Da*</u> 1.09 -0.30 1.10 -0.24	II : D65 10 <u>D6*</u> -0.69 -0.75	Deg <u>DC*</u> -0.26 -0.26	Next IIIu <u>DH*</u> 0.01 0.01	STRENGTH: 99.32 STRENGTH: 99.32 CMC P/F: Pass STD BAT	

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ordinary cotton.

# Colour strength and colour difference (Table 15 & Fig. 10(a)-10(g))

The colour strength value also similar for both the ordinary and organic cotton. However, there is very less significance of colour difference value was noticed.

#### Conclusion

There was no major significant difference in fastness properties, colour difference value, dyeing strength of organic cotton when compare to ordinary cotton. Also there is no major difference in dyeing behavior of organic cotton when compare to ordinary cotton except the feel or smoothness of the organic cotton fabric, less metal content, wax content and better absorbency when compare to ordinary cotton. Our investigation concludes that organic cotton processing does not require any new kind of modification in the already existing process sequence for conventional cotton.

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