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Crease resistant and antimicrobial finish on cotton : By using chitosan (Biomaterial) and citric acid

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ABSTRACT : In India cotton is used extensively for apparel purpose. It has many qualities which make it suitable for apparel purpose such as absorbency, strength, easily spinnable, washability, good conductor of heat which leads to comfort in wear during hot weather. It can bear high dry heat and high ironing temperature. But there are certain drawbacks associated with cotton fabric such as low elasticity and low resiliency which creates wrinkles. In the present study it was found that chitosan with citric acid act as a non-formaldehyde durable press finish to produce wrinkle resistance and antimicrobial property on cotton fabric.it is an environmental friendly finish. Chitosan have many biological properties such as biocompatible in terms of natural biopolymer, biodegradable, safe and non toxic. It is step towards ecofriendly textile because it is demand of the day.

Key words : Chitosan, cotton fabric, wrinkle resistance

In India cotton is used extensively for apparel purpose. It has many qualities which make it suitable for apparel purpose such as absorbency, strength, easily spinnable, washability, good conductor of heat which leads to comfort in wear during hot weather. It can bear high dry heat and high ironing temperature .But there are certain drawbacks associated with cotton fabric such as low elasticity and low resiliency which creates wrinkles. Cellulose materials are highly prone to creasing. Creasing occurs when fibers are stressed. The hydrogen bonds which hold them in their original orientation are broken and new bonds are formed in the new orientation. When the stress is removed, there are no forces to cause the fibers to return to their original orientation. They are left in the new orientation until some force is applied which will reorient the fibers. The cotton fabric must have crease resistance property to return their original position. This crease resistance is important property of the fabric, which causes the fabric to recover from folding deformations that normally occur during its use. Alternatively, the cross-links may be strained without breaking and show a recovery on deloading. To solve the problem of wrinkle, crease resistant finish, usually applied to fabrics made from cotton or other cellulosic fibres which improves the crease recovery and smooth-drying properties of a fabric. Bacterial growth is another problem of the cotton fabric. This problem can be solved by using the antibacterial finish agents. Chitosan shows both the properties such as anti-crease and antibacterial property if it is applied on the cotton fabric as a finish (Karolia *et al.*, 2007). Chitosan, a natural polysaccharide, is a derivative of chitin, which is commonly found in shells and exoskeletons of some crustacean and is the second most abundant bio polymer with unique structural and physiological characteristics. They have a unique combination of properties such as biocompatibility, biodegradability and antibacterial activity which makes it an ideal polymer for industrial applications in the field of textiles and biomedical. It also solves the problem of waste deposition, replaces the harsh chemicals used for providing different types of finish on different fabrics and helps in controlling the pollution,

which is the biggest concern for the textile industry now a days (Joshi *et al.*, 2009). This study will be an attempt to solve the problems which are associated with *cotton* fibre such as wrinkle and bacterial problem. The use of natural fibres is encouraged because natural fibres are also good source for textiles as they are renewable resources. In India not much work has been done so far on cotton fabric by using chitosan and citric acid .It is an attempt to replace carcinogenic chemical finish for crease resistance and antibacterial activity.

For the application of crease resistant finish the pure grey cotton fabric was purchased. It has fabric count 50 ends and 49 picks, 103.6 g/m^2 weight per unit area with 0.31 mm thickness. Then it was given scouring pre-treatment to remove the vegetative impurities from the grey cotton fabric. The scouring the grey cotton fabric was done by sodium hydroxide for 2 hours. After scouring the fabric count of the fabric increased while the weight / unit area and thickness of the fabric decreased. fabric count became 52 ends × 51 picks ,weight / unit area changed into 100.8 g/m^2 having 0.29 mm thickness. Chitosan with 82% degree of deacetylation was purchased from Indian sea Food Company for application of finish. Citric acid, catalyst and silicon softener were also used along with chitosan. The crease resistant finish was applied on scoured cotton fabric by using pad dry cure method after standardizing different concentrations of chemicals and conditions. To obtain better crease recovery properties with minimum tensile strength loss, experiments were conducted to optimize various concentrations of different chemicals used to impart the crease resistant finish viz. concentrations of chitosan, citric acid, catalyst, silicon softener, M: L ratio. (Table 1)

Table 1. Standard concentrations and conditions for application of finish

Concentration (%)			
Chitosan		4	
Citric acid		10	
Catalyst (di-sodium hypophosphite)		6	
Silicon softener (Sarapeach AM)		6	
M:L ratio		1:20	
Conditions			
Temperature (^{0}C)		**Time(Min)**	
Drying	100	Drying	4
Curing	170	Curing	3
-	-	Treatment	15

RESULTS AND DISCUSSION

After application of crease resistant finish on the scoured cotton fabric, the crease resistant and antibacterial property of the fabric was measured to see the effect on crease resistant finish on the crease recovery characteristics and antibacterial property of the treated fabric and compared with the scoured fabric to see the effect of finish.

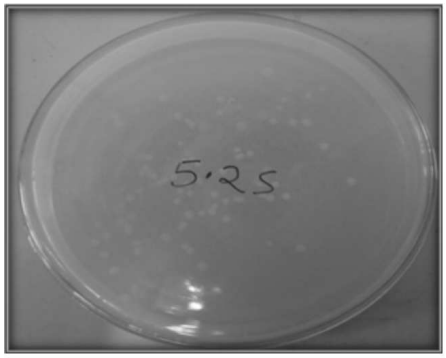
Assessment of crease recovery characteristics : After applying the crease resistant finish on the scoured fabric following the standardized conditions. The crease recovery characteristics of fabrics were assessed. Crease recovery characteristics of scoured and treated fabrics were assessed.

It is evident from the Table 2 that when the crease resistant finish was applied on scoured cotton fabric. Treated fabric showed the increase in the crease recovery angle in warp 106 **±** 1.14 degree and 105.0 **±** 0.83 degree weft directions as compared to the scoured cotton fabric (control) which had 85.4 ±1.25 degree crease recovery angles at warp and 83.8 ± 0.73degree in the weft direction. The fabric crease recovery was 84.54 per cent and after application of finish it became 104.04 per cent. The results of Daniela Enescu (2008) supported the study that durable press and antimicrobial finishing of cotton with citric acid by the conventional pad dry cure process, improved the crease recovery angle.

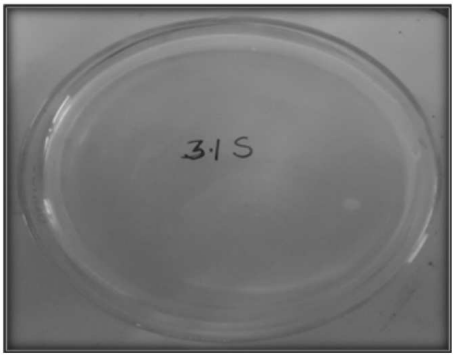
Table 2. Crease recovery characteristics of treated fabric

Fabric/ Properties Fabrics	Crease recovery angle(Degree)						Fabric crease recovery (%)
	Warp Mean ± S.E.(m)	C.V.	Weft Mean ± S.E.(m)	C.V.	Mean (warp + weft)	Per cent change in crease recovery angle	
Scoured Fabric (control)	**85.4 ± 1.25**	**3.27**	**83.8 ± 0.73**	**1.96**	**84.6**	**-**	**84.54**
Treated Fabric	106 ± 1.14	2.40	105.0 ± 0.83	1.78	105.5	+19.81	104.04

S.E. (m) = Standard Error of Mean **, C.V.=** Coefficient of Variance



Scoured Fabric (Control)



Treated fabric

Determination of microbial growth : To study the effect of finish on treated fabrics, the bacterial growth was counted quantitatively by AATCC 100 test method. After imparting the finish to fabric microbial population was determined and percentage bacterial reduction was calculated.

The growth of bacterial was measured on different dilutions factor (10^{-1}, 10^{-2}, and 10^{-3}). At one dilution factor, the growth of bacteria was 150 and 2 in control and treated fabric respectively and at two dilution factor bacterial growth was 130 and one. At the three dilution factor growth of bacteria was 16 for the scoured fabric (control) and nil for the treated fabric. Then the average microbial load (cfu/ml) was calculated for scoured and treated fabric. On the scoured fabric the average microbial load (CFU/ml) was 1.03×10^{4} and it decreased to 4.0×10^{1} for the treated fabric. It was found that when the chitosan and citric acid based crease resistant finish was applied on the scoured cotton fabric, there was reduction in the growth of bacteria on the treated fabric. Here the bacterial growth reduction per cent measured against scoured cotton fabric. Crease resistant finish treated cotton fabric showed the 99.61per cent bacterial growth reduction. The crease resistant finish also showed the good bacterial reduction against bacteria.

Efficacy of applied finish of different fabrics : The effectiveness of the finish was assessed in terms of crease recovery angle; fabric

Table 3. Bacterial growth on treated fabric by quantitative method

Fabrics serial dilutions	Scoured fabric(control)	Treated fabric
10^{-1}	150	2
10^{-2}	130	1
10^{-3}	16	Nil
CFU/ml	1.03×10^{4}	4.0×10^{1}
Per cent reduction	-	**99.61**

C.F.U =Colony Forming Unit

crease recovery and rate of bacterial reduction. To determine the efficacy of crease recovery finish of laundered fabric. The treated fabrics were subjected to different laundering cycles (5, 10, 15 and 20) keeping in mind different parameters. The crease recovery characteristics and antimicrobial properties of different fabrics.

Efficacy of crease resistant finish on crease recovery characteristics : Crease recovery properties were studied after passing the finished fabrics under different laundering cycles. Crease recovery angle and fabric crease recovery was detected on treated fabric subjected to different laundering cycles.

It is evident from the Table 4 that when the crease resistant finished treated fabric was given five laundering cycles, there was decrease in the crease recovery angle in warp and weft direction 100.2± 0.80 degree and 99.4± 0.51, degree respectively after 5 laundering cycles with fabric crease recovery was 99.6 per cent. It was found that there was progressive decrease in the crease recovery angle when the number of laundering cycles increased from 5 to 20, the crease recovery angle was 90.2±1.68 degree and 89.2±0.86 degree for the warp and weft direction, respectively and per cent fabric crease recovery was 89.5 per cent. When the change in the crease recovery angle of the laundered treated fabric was compared with the treated fabric (control), the per cent reduction in the crease recovery angle was from 5.40 to 14.97 per cent when fabric was subjected to laundering from 5 to 10 laundering cycles respectively. It was found that the fabric crease recovery decreases with the progressive laundering cycles. Sung Huang Hsieh *et al.*, (2006) also found that the anti-wrinkle property of treated fabrics is decreased after laundering 20 times; the softness of the fabric was improved.

Table 4. Effect of laundering on crease recovery characteristics of treated fabric

Fabrics		Fabric property	Crease recovery angle (Degree)				Fabric crease recovery (%)
			Warp Mean± S.E(.m)	Weft Mean± S.E(.m)	Mean (warp± weft)	Per cent change in C.R.A.	
Laundered Fabric	Number of laundering cycles	5	100.2 ± 0.80	99.4 ± 0.51	99.8	-5.40	99.60
		10	96.6 ± 2.06	96.0 ±1.14	96.3	- 8.72	96.13
		15	94.6 ±1.03	92.6 ± 0.75	93.6	- 10.33	93.50
		20	90.2 ±1.68	89.2 ±0.86	89.7	- 14.97	89.5
Treated fabric(Control)		-	106 ±1.14	105 ± 0.83	105.5	-	104.04
C.D. (p=0.05)			4.22	2.50	-	-	

S.E.(m) = Standard Error of Mean , C.R.A.= Crease Recovery Angle

Table 5. Bacterial growth on treated fabric after laundering cycles

Fabrics		Serial Dilutions	10^{-1}	10^{-2}	10^{-3}	Average microbial count (CFU/ml)	Percent Reductionin Bacterial Growth
laundered Fabric	Number of laundering cycles	0	2	1	Nil	4×10^{1}	99.61
		5	1	2	1	4.03×10^{2}	96.10
		10	2	3	2	7.73×10^{2}	92.51
		15	30	14	6	2.56×10^{3}	75.19
		20	52	13	10	3.55×10^{3}	65.64
Scoured Fabric (Control)		-	150	130	16	1.03×10^{4}	-

C.F.U =Colony Forming Unit

Efficacy of crease resistant finish on antibacterial properties : Antimicrobial properties were studied after passing the finished fabrics under different laundering cycles. Microbial growth was detected on scoured, treated and fabrics subjected to different washing cycles.

When the scoured fabric was given crease resistant finish with chitosan and citric acid the average microbial load (CFU/ml) was 1.03×10^{4}. It was found that there was decrease in the bacterial growth, when the crease resistant finish treated fabric was given different number of laundering cycles, there was decrease in the bacterial growth reduction rate. When the laundering cycles increased from 5 to 10 laundering cycles, there was increase in the average microbial load from 4.03×10^{2} to 3.55×10^{3}. When the average microbial count (CFU/ml) was compared with the scoured fabric (control) having 1.03×10^{4} average microbial load. It was found that there was decrease in the per cent reduction in growth of bacteria from 5 to 20 laundering cycles which was 96.10 per cent to 65.64 per cent, respectively. This may be due to the removal of finish after progressive laundering cycles with the removal of the finish effect of the chitosan also reduces which is also responsible for antibacterial property by inhibiting the growth of bacteria. Owing to this the antibacterial performance of the treated fabric decreases with progressive laundering cycles. Krishnaveni and Mani, 2010 found that the antimicrobial activity diminished gradually as the number of wash frequencies increase.

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