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ECOFRIENDLY CREASE RESISTANT FINISH AND ITS EFFECT ON PHYSICAL PROPERTIES AFTER APPLICATION AND LAUNDERING CYCLES

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ABSTRACT

The study was conducted to see the effect of crease resistant finish on an antibacterial property of cotton. For the application of crease resistant finish the chitosan, citric acid, silicon softener and catalyst were used. Before application of finish the different condition such as drying time, drying temperature, curing time, curing temperature and concentrations of chemicals along with M: L ratio were standardized. The optimized concentrations and conditions were the 4% chitosan, 10% citric acid, 6% catalyst, and 6% silicon softener ,4 minute drying and curing time, treatment time 15 minute, 100 ^{0}C drying temperature, 170 ^{0}Ccuring temperature,. The finish was applied on the scoured cotton fabric with optimized proportion of chemicals maintaining the 1:20 m: l ratio by using the padding mangle. Assessment of the crease recovery properties and antibacterial property was done. It was found that there was increase in the crease recovery angle and fabric crease recovery in addition to it the crease resistant finish showed good bacterial percent reduction. The finish is safe and non toxic for use. The treated fabrics will not only provide health benefits to the common masses but will also benefit the workers who are engaged in finish sector of textile industries. Crease resistant finish with antibacterial property will add value to cotton so the cultivation, production and export of cotton will also boost

KEYWORDS: Crease Resistant Finish, Chitosan, Citric Acid

INTRODUCTION

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.

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. The recovery depends on time, varying for different fabrics from an instantaneous recovery to slow disappearance of the creases. Bacterial growth is another problem of the cotton fabric. This problem can be solved by using the antibacterial finish agents. There are many synthetic antibacterial agents available in the market but due to the environment concern and health problems, the manufacturers and consumers are making step toward the herbal finish and ecofriendly finishing agents. Conventional non-ecofriendly chemicals are being replaced by natural based products that are safe to environment and health during manufacturing and usage. Chitosan is one of promising natural products offering the desirable properties to be used in the field of textiles. Chitosan shows both the properties such as anti-crease and antibacterial property if it is applied on the cotton fabric as a finish.

The number of bio-functional textiles such as cotton fabric with crease resistant finish and antimicrobial activity has gained considerable attention over the last few years. Textiles are widely used in day-to-day life and there has been a growing need to develop finishes for textile materials that can offer improved protection, to the users, from microbes (bacteria, fungi), which can cause numerous problems. Hence there is a need to develop such textiles which are resistant to microbes (Gomes *et al.*, 2010). The awareness of environment impact of chemical processing of textile, combined with the increased polluting nature of textile effluent, social pressure and increased strict legislation is also increasing on the textile processing industries to use more environmental friendly finishing processes for making the *cotton* garments more competitive in the global market. There is pressing need to develop such type of finish which will solve the problems of wrinkles and bacterial growth simultaneously. 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.

MATERIALS AND METHODS

The following materials and methods have been used for application of finish.

Materials

Chitosan, Citric Acid, Silicon Softener, Catalyst

For the application of crease resistant finish the pure grey 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 two hours. After scouring the fabric count of the fabric increased while the weight per unit area and thickness of the fabric decreased. fabric count became 52 ends × 51 picks ,weight per 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.

Methods

The crease resistant finish was applied on scoured *cotton* fabric by using pad dry cure method. After standardizing different concentrations of chemicals and optimum condition on the basis of these properties viz. crease recovery angle, tensile strength, elongation were measured. After optimization of concentrations of chemicals, the finish was finally applied on the *cotton* fabric. *Cotton* fabric was first impregnated in a solution containing the finish. Scoured fabric was passed from the finish. Then the impregnated fabric sample was pressed between the squeezing rollers of the padding mangle machine. The pressure of 2kg/cm was maintained and 70 %-75 % expressions were achieved. The samples were dried at 100^{0}C for 4min and cured in an oven at a specified temperature (170^{0}C) for a specified time (3min). Following are the standard concentrations and conditions used to apply finish on scoured fabric.

RESULTS

After application of standard crease resistant finish on the scoured *cotton* fabric, the crease recovery angle of the fabric was measured to see the effect on crease resistant finish on the crease recovery characteristics of the treated fabric.

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 1 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% and after application of finish it became 104.04%.

Table 1: Crease Recovery Characteristics of Treated Fabric

Fabric Properties / Fabrics	Crease Recovery Angle (Degree)						Fabric Crease Recovery (Percent)
	Warp Mean ± S.E.(M)	C.V.	Weft Mean ±S.E.(M)	C.V.	Mean (Warp+ Weft)	% 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

Due to the presence of citric acid and chitosan crosslinking bonds formed. These bonds require maximum amount of energy to break these bonds. These bonds keep the cellulose molecules in to their respective position. Thus it resists the breakage and slippage of the cellulose molecules. It results in increase in the crease recovery angle. 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.

Efficacy of Applied Finish of Different Fabrics

The effectiveness of the finish was assessed in terms of crease recovery angle; fabric 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.

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 2 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± 0.51degree respectively after 5 laundering cycles with fabric crease recovery was 99.6 percent.

Table 2: Effect of Laundering on Crease Recovery Characteristics of Treated Fabric

Fabrics	Fabric Property		Crease Recovery Angle (Degree)				Fabric Crease Recovery (Percent)
			Warp Mean±S. E (M)	Weft Mean±S. E.(M)	Mean (Warp±Weft)	Percent Change in C.R.A.	
Laundered Fabric	No. 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.(0.05)			**4.22**	**2.50**	-	-	
S.E.(m) = Standard Error of Mean , **C.R.A.**= Crease Recovery Angle							

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 percent fabric crease recovery was 89.5 percent. When the change in the crease recovery angle of the laundered treated fabric was compared with the treated fabric (control), the percent reduction in the crease recovery angle was from 5.40 percent to 14.97 percent 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. This may be due to that with progressive laundering cycles the crease resistant finish removes gradually by the rubbing and friction movement caused during laundering process. The results of the study were in line with. Yang (1997) experimented with the durable press finish on *cotton* fabric. The different number of laundering cycles was given to evaluate the durability of finish to laundering he found that the sample treated with citric acid and it was found that the crease recovery angle decreased with increase in 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.

CHANGE IN THE PHYSICAL PROPERTIES AFTER APPLICATION OF CREASE RESISTANT FINISH TO THE SCOURED FABRIC

Tensile Strength

The results of the study showed that the tensile strength for the treated fabric decreased 12.92 percent as compared to scoured fabric. The reason may be the magnitude of the fabric strength loss, is affected by the temperature and exposure time and the concentration of chemicals. Crosslinking of cellulose molecules by a polycarboxylic acid (citric acid) causes reversible tensile strength loss. The magnitude of the loss increases as the degree of crosslinking increases which makes the fabric brittle. The result of the study were in accordance with the Kang In-Sook (1998), gave the durable press finish to the cotton fabric by using the polycarboxylic acid (citric acid). It was found that the strength loss of cotton treated with polycarboxylic acid is a result of the combined effects of acid degradation and crosslinking.

Elongation

The results of study expressed that the elongation of the scoured fabric decreased after application of finish and it became 19.82 percent. The percent decrease in the elongation was 7.38. It may be due to the stiffness of the fabric which was attained by crosslinking after application of finish. When the fabric becomes stiff the elongation of the fabric decreased due to the restricted movements of the cellulose molecules within the fibre. As a result of it, instead of stretching the fabric tears off and break. Results of the study supported by Mulasavalagi (2005) found that there was decrease in the elongation with crease resistant treatment compared to control.

Bending Length

The results revealed that there was 24.92 percent increase in the bending length of the treated fabric. This may due the crosslinking reaction which makes the fabric stiff. Due to the stiffness of the fabric there was increase in the bending length of the fabric. The results were in line with Chattopadhyay *et al.* (1998) stated that the crosslinking improves the dimensional stability and affects the softness of the material negatively, which ultimately have increased bending length and bending modulus of treated fabric, irrespective of the type of catalyst used. Similar results were found by Younsook *et al.* (1999) where it was observed that bending length increased with increase of treatment concentration due to deposition of chitosan molecules.

Air Permeability

The air permeability of the scoured fabric decreased for the treated fabric from 275.02 m ^{3}/m^2 /min to 253.38 m3 /m^2/ min with 7.86 percent decrease. The reason may be that the chitosan forms a film on the surface of the fabric which decreases the air permeability. Another reason may be deposition of finish with the interstices of fibre which blocks the passage of air to pass. The results were supported by Ali *et al.* (2007) who reported that air permeability was less for treated sample as compared to untreated one.

Tables 3: Physical Properties of Different Fabrics in Accordance to Mechanical Properties

Fabric Properties / Fabrics	Tensile Strength (kg)						Elongation (%)						Bending Length (cm)						Air Permeability (m³/m²/min)	
	Warp Mean ± S.E(m)	C.V.	Weft Mean ± S.E(m)	C.V.	Mean	Percent Change in Tensile Strength	Warp Mean ± S.E(m)	C.V.	Weft Mean ± S.E(m)	C.V.	Mean	Percent Change in Elongation	Warp Mean ± S.E(m)	C.V.	Weft Mean ± S.E(m)	C.V.	Mean	Percent Change in Bending Length	Mean	Percent Change in Air Per-Meability
Scoured fabric (control)	15.60 ± 0.22	3.17	13.80 ± 0.14	2.29	14.70	-	19.96 ± 0.19	2.14	22.84 ± 0.42	4.19	21.4	-	2.75 ± 0.07	4.98	2.60 ± 0.08	5.65	2.68	-	275.01	-
Treated Fabric	13.80 ± 0.11	1.80	12.16 ± 0.04	0.81	12.98	-12.92	17.89 ± 0.31	3.96	21.76 ± 0.27	2.78	19.82	-7.38	3.50 ± 0.09	5.15	3.15 ± 0.05	3.03	3.33	+24.92	253.38	-7.86

S.E.(m) = Standard Error Of Mean, C.V. = Coefficient Of Variance
+= Increase , - = Decrease

CHANGE IN THE PHYSICAL PROPERTIES WITH PROGRESSIVE LAUNDERING CYCLES

Tensile Strength

The tensile strength of the crease resistant finish treated fabric decreased with increase in laundering cycles. The percent decrease in the tensile strength was observed 7.01 to 19.80 with progressive laundering cycles 5 to 20 correspondingly. It may be due to the reason that fabric structure deteriorated because of friction action involved in progressive laundering cycles. Sarkar and Munsi (2001) and Desai (2002) also reported similar findings and stated that percent decrease in tensile strength of after laundering with soap and detergents was observed as compared to control sample.

Elongation

The results showed that the elongation of the treated fabric increased with progressive laundering cycles. This may be due to the removal of finish which binds the cellulose molecules in their respective position during laundering .with removal of finish cellulose molecules are free to move and elongation increased. It was noticed that the percent increase in the elongation was 1.05 percent to 8.70 percent for the laundered treated fabric from 5 to 20 laundering cycles respectively. The results of the study supported by Sarkar and Munshi (2001) also reported that the elongation of laundered fabrics was more than that of control sample.

Tables 4: Physical Properties of Laundered Fabrics with Reference to Mechanical Parameters

Fabric Properties / Fabric Types		Tensile Strength (kg)				Elongation (%)				Bending Length (cm)				Air Permeability ($m^3/m^2/min$)	
		Warp Mean ± S.E(m)	Weft Mean ± S.E(m)	Mean (Warp+Weft)	% Change in Tensile Strength	Warp Mean ± S.E(m)	Weft Mean ± S.E(m)	Mean (Warp+Weft)	% Change In Elongation	Warp Mean ± S.E(m)	Weft Mean ± S.E(m)	Mean (Warp + Weft)	% Change in Bending Length	Mean (Warp + Weft)	% Change in Air Permeability
Treated fabric(control)		**13.80 ± 0.11**	**12.16 ± 0.04**	**12.98**	-	**17.89 ± 0.31**	**21.76 ± 0.27**	**19.82**	-	**3.50 ± 0.09**	**3.15 ± 0.05**	**3.87**	-	**253.38**	-
Laundered fabrics	**5**	12.62 ± 0.20	11.52 ± 0.15	12.07	-7.01	19.40 ± 0.31	20.65 ± 0.58	20.03	+1.05	3.88 ± 0.16	3.24 ± 0.08	3.56	-8.01	291.72	+13.00
	10	12.36 ± 0.21	10.82 ± 0.25	11.59	-10.7	19.76 ± 0.19	20.81 ± 0.24	20.29	+2.31	3.60 ± 0.07	3.20 ± 0.05	3.4	-12.14	298.39	+15.00
	15	11.42 ± 0.13	10.10 ± 0.07	10.76	-17.10	20.03 ± 0.35	21.93 ± 0.22	20.98	+5.53	3.22 ± 0.08	2.86 ± 0.09	3.04	-17.44	300.06	+15.55
	20	11.02 ± 0.57	10.02 ± 0.29	10.02	-19.80	21.12 ± 0.22	22.30 ± 0.28	21.71	+8.70	3.16 ± 0.05	2.82 ± 0.05	2.99	-18.73	303.39	+16.48
C.D.(0.05)		**0.89**	**0.56**	-	-	**0.85**	**1.04**	-	-	**0.30**	**0.19**	-	-	-	-

C.D.=Critical Difference, S.E(m) = Standard Error of Mean
+= Increase, - = Decrease

Bending Length

Bending length of the treated fabric decreased with progressive laundering cycles. There was percent decrease was 8.01 to 18.73 for 5 to 20 laundering cycles respectively. This may be due to that with the laundering cycles, the finish releases from the fabric and stiffness which was the result of the crease resistant finish; reduces and the fabric become limp after succession of laundering cycles. Thus bending length of the fabric decreased with progressive laundering cycles. The findings of Desai (2002) also supported the results of the present investigation and reported that bending length reduced for the treated fabric with progressive laundering.

Air Permeability

The air permeability of the treated fabric increased with progressive laundering cycles. The decrease in percent was noticed from 13 to 16.48 with successive laundering cycles 5 to 20 respectively. This may be due to the deposition of the finish done in between the interstices of the fibres which blocks the passage of the air from passing removes during laundering cycles as a result air permeability increase during laundering cycles. The findings of study supported by the Karolia (2007) stated that air permeability of the treated fabric increased after laundering cycles.

CONCLUSIONS

It is concluded from the results that the crease resistance finish showed the good resistant against wrinkle formation. It was found that there was increase in the crease recovery angle of the fabric after application of crease resistant finish. It proves that the chitosan with the citric acid shows the good results against crease formation and it also showed maximum retention of the finish by maintaining the satisfactory crease recovery angle after 20 washing cycles.

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