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Effect of Endotoxin Eradication Techniques in Different Cotton Varieties with Respect to Grown Area (Location upon the Fibre Length, Strength and Micronaire Value

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Abstract: Four techniques to remove the byssinogenic agent `endotoxin' from the cotton varieties grown in different area of the Punjab were applied. Autoclave technique was the best treatment for optimum endotoxin eradication alongwith minimum fibre damage. Cotton grown in Sargodha zone recorded the lowest level of endotoxin.

Key words: Endotoxin eradication techniques, cotton varieties

Introduction

Textile is the backbone of industrial sector of Pakistan. It does not only provide basic requirements of clothing to the local population but also earns foreign exchange from the export of its products and is the major source of employment in the country. Unfortunately a large number of workers are facing the respiratory problem caused due to the presence of byssinogenic agent in cotton dust which becomes air born during the fibre processing. Inhalation of this dust is believed to be related to the development of the respiratory disease commonly called brown lungs disease in textile workers.

Different methods have been used to make cotton free from endotoxin. These endotoxins are water-soluble. Washing changes fibre surface characteristics by removing/redistributing the natural surface coating materials. This altere structural properties of fiber, hinder the smooth processing of fibre into yarn. Mechanical cleaning through Shirley Analyzer reduced the total number of air-born dust particles in card room. But did not prevent or reduce respiratory disfunctioning in exposed individuals sensitive to cotton dust, while the reduction of endotoxin up-to a workable limit can also be achieved by flash heating or through steaming in autoclave (Nasir 1998).

Sasser (1980) reported that none of the washing treatments affected the fibre length significantly, except for treatment in which the cotton was scoured and bleached. Rousselle and Domelsmith (1993) tabulated the fibre length of cotton pre and post treatments at 235EC as 27.94 and 27.18 mm, respectively and it reduced from 29.46 to 28.45 mm at 280EC. Sasser (1980) noted that all wash treatments slightly decreased the micronaire of the cotton. This change was likely caused by the removal of small trash particles from the lint. The maximum change was from 4.22 to 4.05 in micronaire units under washing at 333Ek. Nasir (1998) recorded that average value for micronaire decreased from 4.67 to 4.53 ìg/inch under wash treatment. Rousselle and Domelsmith (1993) stated that fibre bundle tenacity decreased 3% when cotton samples were heated between metal plates at temperature 215EC for 0.5 to 2.0 minutes and at temperature 250EC for 60 seconds in forced draft oven. Fibre bundle tenacity and elongation decreased 12% in gas fired pilot plant dryer at temperature 260EC for 20 seconds. Nasir (1998) noted that in heating treatment, average values for fibre strength decreased from 23.47 to 21.20 g/tex on the other hand in cases of autoclave and washing treatments the average fibre strength increased from 23.47 to 24.03 and 24.77 g/tex respectively. The present study was carried out to deactivate the toxic agents in cotton fibres and to examine the effects of these treatments on fibre surface structure and their impact upon fibre properties i.e. length, strength and micronaire value.

Materials and Methods

Cotton samples of varieties S.S.-1, C.M.-1100, C.M.-448 and FH-634 (denoted as V_1, V_2, V_3 and V_4 respectively) were collected from Ayub Agricultural Research Institute, Faisalabad (L_1) and from its sub-stations at Sargodha (L_2) and Jhang (L_3). Present study was conducted in the Departments of Fibre Technology, Microbiology, Hi-Tech Lab, Ayub Agricultural Research Institute, Faisalabad and at Central Cotton Research Institute, Multan. Following four treatments were applied according to the standard methods.

Mechanical cleaning: Cotton samples were mechanically cleaned by passing them through "Shirley Analyzer" according to ASTM Standards (1997).

Autoclave: Autoclave treatment to the samples was given at temperature 121EC under a pressure of 18 lbs. for 30 minutes.

Flash heating: Cotton samples were heated in an electric furnace at 250EC temperature for 25 to 30 seconds.

Washing: Washing was done with water (1:50; cotton to water ratio) at 60 to 65EC, and then the washed samples were air-dried. The physical characteristics of cotton fibres were noted on High Volume Instrument (HVI-900 SA).

Endotoxin estimation: Endotoxin content was determined by the method as suggested by Broglen (1978), Akhtar (1995) and Rousselle (1996). All glassware was depyrogenated by heating at 180EC overnight. A weighted sample of 2 grams was extracted with 200 ml pyrogen-free water by shaking in a glass-stoppered flash.

The cell suspensions were centrifuged 5000 rpm/30 minutes/4EC and pellets were re-suspended in physiological saline solution containing 0.3 percent formalin. The cell suspension was stirred continuously on a magnetic stirrer for two days and centrifuged. Each pellet was re-suspended in 5 ml sterile Phosphate. Buffered saline (PBS) and mixed well on vortex., all sterile PBS by centrifugation.

- The packed cell were suspended in 10 ml of distilled water and heated at 68EC in a water bath for 15 minutes.
- Glass distilled 10 ml of 65EC heated 90 percent phenol was added to the suspension and incubated at 56EC for 10-15 minutes in a water bath.
- The suspension was centrifuged (2500 rpm/30 minutes) and aqueous phase (LPS) was cleared off phenol by dialyzing against several changes of distilled water at 40EC. Glucose was considered as a representative of LPS, and measured by calorimetric method (Kolmer *et al.* 1959).

Statistical analysis: Three factors Completely Randomized Design was applied in the analysis of variance of testing differences among quality characters studied in this investigation. Duncan's Multiple Range (DMR) test was applied for individual comparison of mean values as suggested by Faqir (1991), using M-STAT Computer package (Freed, 1992).

Results and Discussion

Endotoxin reduction level: Analysis of data for endotoxin level by the applied techniques shows significant differences among mean values (Table-1). Autoclave treatment liberated the endotoxin from 17.42 (control) to 6.98 ppm of endotoxin that is about 60 percent eradication of this hazardous organism without any noticeable damage to the fibres. It proved the validity of autoclave technique. However, wash treatment removed maximum amount of toxin, rating as estimated as 17.42 to 3.03 ppm i.e. 83% with the draw back fibre entanglement after washing which lowered spinning efficiency with increased yarn imperfections, particularly neps. Present results confirm the findings of Nasir (1998) who noted 68 to 75% reduction of endotoxin from raw cotton by autoclave method while he further found that water washing of raw cotton minimized the endotoxin level up to 84%. Moreover, Rousselle and Domelsmith (1988) reported water wash as a effective treatment for the eradication of the byssinogenic agent. No. doubt, flash heating significantly reduced the toxin from 17.42 ppm to 4.91 ppm i.e. 75% but severe loss of fibre strength and discolouring was the negative point, while the mechanical treatment remained absolutely inert, without prominent removal of endotoxin.

Under varietal effect, statistically significant differences in endotoxin level for all the four varieties S.S.-1, C.M.-1100, C.M.-448 and FH-634 were found. Values ranked as 9.16, 8.44, 7.77 and 6.98 ppm., respectively. However, significant differences for the mean values of endotoxin level were noted for stations. Values for Faisalabad and Jhang were 9.17 and 8.93 ppm. Whereas, the results of the samples from Sargodha differ significantly, showing mean value as 6.16 ppm. The present results reveal that baled cotton of different regions varies in endotoxin levels.

Fibre length: The analysis of data indicates that differences in the mean values for varieties (V), treatments (T), locations (L) as well as their V x L interaction are highly significant (Table-2).

The impact of these treatments has shown some shortening of staple length. Treatments registered fibre length shrinkage from 1.008-inch (control), down to 0.998, 0.993 and 0.975 inch respectively. Sasser (1980), observed that none of the washing treatments significantly affected the fibre length and all washing treatments had slightly shortened the fibre length average. Perkins (1981) extended that more severe washing condition adversely affected fibre length. Whereas Rousselle *et al.* (1996) reported that fibre length and strength were generally not affected by most washing treatments if an effective finish was applied. The result of present study supported the findings of Nasir (1998) who recorded non-significant shortening in staple length under autoclave as well as washing treatments.

Flash heating treatment revealed that fibre length reduced from 1.008 to 0.975 inch, which confirmed the views, reported by Rousselle and Domelsmith (1988) and Rousselle *et al.* (1996) who concluded that cotton fibres heated at 255EC showed a considerable reduction in fibre length. Similarly, Brushwood (1988) noted that the fibre length decreased slightly at temperature below 180EC for cotton that have not received mechanical working after heating. At temperature 200EC, the fibre length decreased at an average of 0.3 percent per minute. Rousselle and Domelsmith (1993) noted the fibre length before and after heating as 29.46 and 28.45 mm respectively for cotton samples heated at 250EC in a forced draft oven. Nasir (1998) measured the average decrease in the staple length from 1.135 to 1.106 inches.

In case of varietal effect, statistically non-significant differences in fibre length of varieties C.M.-1100, C.M.-448 and FH-634 are observed whereas variety differs significantly from rest of the varieties. Locations L_1, L_2, L_3 affect significantly upon staple length. Balls (1928) who narrated that cotton lint length is a heritable character supports the present results. Longenecker and Eric (1968) also support that the important fibre properties i.e. length, strength and fineness are strongly controlled by genetic factors and nominally by the environmental or management practices.

Fibre strength: The analysis of data shows that differences in the mean values for varieties, treatments and location are highly significant, while their interactions indicate significant results (Table-3).

Significant differences in the mean values for fibre strength are observed under flash heating treatment. This treatment decreased the strength from 20.54 to 18.08 g/tex. Similarly Rousselle *et al.* (1996) expressed that heating reduced all tensile and length parameters of cotton fibres. Rousselle and Chun (1995) also noted a 24% reduction in fibre strength when cotton was heated in a gas fired pilot plant dryer at 255EC for 20 seconds.

Statistically significant increase in the mean values of fibre strength is recorded under autoclave treatment (T_2). it is found that T_2 increased fibre strength from 20.54 to 21.25 g/tex. This gain in strength might be due to the removal of natural lubricants that are on the fibre during autoclave (T_2) treatments thus reducing the fibre slippage effects.

Also, the significant increase in the mean value of fibre strength is observed under wash treatment. Washing increased the strength from 20.54 to 22.05 g/tex. Similar are the findings of Sasser (1980) who endorsed that fibre strength reading for all washed treatments were higher than those for all unwashed cottons. Our findings get

Table 1: Individual Comparison of "Mean Values for Endotoxin Level after Treatment

Treatment	Endotoxin level	Varieties	Endotoxin level	Location	Endotoxin level
T_1	17.42a	V_1	9.16a	L_1	9.17a
T_2	6.98b	V_2	8.44b	L_2	8.93a
T_3	4.90c	V_3	7.77e	L_2	6.16b
T_4	3.03d	V_4	6.98d		

Table 2: Individual Comparison of Means for Fibre Length

Treatment	Fibre length	Varieties	Fibre length	Location	Fibre length
T_1	1.008a	V_3	1.004a	L_1	1.008a
T_2	0.998b	V_2	0.999a	L_2	0.994b
T_3	0.993b	V_4	0.999b	L_3	0.997c
T_4	0.975c	V_1	0.974c		

Table 3: Individual Comparison of Means for Fibre Strength

Treatments	Fibre strength	Varieties	Fibre strength	Location	Fibre strength
T_1	22.05a	V_4	21.96a	L_1	21.54a
T_2	21.25b	V_3	20.41b	L_2	20.48b
T_3	20.54c	V_2	20.03c	L_3	19.42c
T_4	18.08d	V_1	19.52d		

Table 4: Individual Comparison of Means for Fibre Fineness

Treatments	Fibre fineness	Varieties	Fibre fineness	Location	Fibre fineness
T_1	4.39a	V_3	4.61a	L_1	4.38a
T_2	4.39a	V_2	4.31b	L_2	4.35b
T_3	4.27b	V_1	4.27c	L_3	4.23c
T_4	4.23c	V_4	4.08d		

Any two means not sharing a letter in common differ significantly at 0.05% level of probability Note. a,b,c, and d are used separately for each column.

support from the results of Nasir (1998) who reported that average values for fibre strength raised from 23.03 to 23.059 and 24.39 g/tex under autoclave and washing treatments, respectively.

Statistically significant results are obtained under varietal effect. It is found that FH-634 variety has the highest average strength (21.96 g/tex) whereas CIM-448, CIM-1100 and SLS-1 ranked second, third and fourth with values 20.41, 20.03 and 19.52 g/tex, respectively.

Micronaire value: The differences in the mean values of the factors varieties, treatments locatio and their interactions, are highly significant Table-4.

The comparison of individual means indicates statistically no change in the fibre fineness under flash heating treatment. The average micronaire value for flash heating is 4.38 ìg/inch which is at par with the value 4.39 ìg/inch obtained after mechanical cleaning treatment. Rousselle *et al.* (1996) also recorded no change in micronaire values for cotton samples hated at temperature 250 to 252EC. Present results get support from the finding of Nasir (1998) who recorded that average value for micronaire changed from 4.67 to 4.66 ìg/inch.

Under Autoclave treatment statistically significant decrease in the mean micronaire value is recorded. The micronaire value decreased from 4.39 to 4.27 ìg/inch. Similarly, Nasir (1998) narrated that average micronaire value under autoclave treatment record a decrease from 4.68 to 4.63 ìg/inch.

Statistically significant decrease in mean values for micronaire is also noted under washing treatment. It is found that washing improved the micronaire from 4.39 to 4.23 ìg/inch. It is clear from these results that washing removed most of the water extractable non-lint substances. Similar are the findings of Nasir (1998) who recorded that average value for fineness decreased from 4.68 to 4.53 ìg/inch. Sasser (1980) endorsed that all washing treatments slightly decreased the micronaire value of cotton and this change was likely caused by the removal of small trash particles from the lint.

Varietal effect upon fineness for different varieties is significant. CIM-448 has the highest micronaire value as 4.61 ig/inch whereas SLS-1, CIM-1100 and FH-634 have 4.27, 4.31 and 4.08 ig/inch respectively. Similar results were reported by Naveed (1994).

Autoclave endotoxin deactivation technique proved the best for optimal detoxification of byssinogenic substances with minimum fibre damage risk. Flash heating showed significant decrease in fibre length and strength. Maximum fibre strength was recorded under Wash treatment while heating treatment caused strength loss. However, Mechanical-cleaning treatments remained inert. Washing and Autoclaving decreased micronaire value of the cotton significantly while Flash heating effect on fineness was non-significant. Comparison with respect to location showed maximum fibre length at Faisalabad station while strength was highest at Sargodha zone, moreover, the lowest endotoxin level was found in the raw cotton grown at Sargodha.

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