INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2000/02–1-2–66–68

Effect of Various Endotoxin Eradication Techniques upon Physical Properties of Cotton

SH. MUHAMMAD NAWAZ, IFTIKHAR AHMAD AND MUHAMMAD NASIR
Department of Fibre Technology, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

The toxic agents in raw cotton were eliminated by adopting four different techniques i.e. mechanical, washing, steaming and flash heating. The effect of these treatments upon fibre length, fibre fineness and fibre strength was recorded individually for the choice of the most suitable treatment. Autoclave method was found as the best and harmless to the treated cotton characteristics.

Key Words: Endotoxin eradication; Techniques; Physical properties; Cotton

INTRODUCTION

Endotoxins (Lipopolysaccharides, LPS) produced by gram-negative bacteria are considered as the main cause of respiratory disease Byssinosis in textile workers. These bacteria colonize cotton plants in the field and are carried on harvested cotton bolls. When ginned cotton fibre is opened and processed in textile mills, these endotoxins are released in the air, contributing to pulmonary disfunction.

It is generally agreed that these causatives are water soluble materials that can be removed from cotton fibre by hot water extraction. So the initial proposal for reducing byssinogenic potential of cotton suggested washing with water, which lowered the endotoxin content by 78-84%. Washing treatment reduced fibre length and micronaire value, whereas, fibre strength was increased under this technique. Similarly, Sasser (1980) noted that washing slightly decreased the micronaire value of the cotton. This change was caused by the removal of small trash particles from the lint. It was further observed that washing increases cotton fibre strength due to the removal of natural waxes.

Flash-heating treatment eradicate the endotoxin level in cotton lint upto 63%, when cotton samples were heated at 250°C for a time period of 25 seconds. However, this treatment adversly effected the length and strength of cotton fibres. Rousselle and Price (1996) observed that heating reduces the tensile and length parameters of cotton fibre.

Steaming lowers the endotoxin content upto 75% without disturbing the physical properties of cotton lint, when autoclave treatment was performed at temperature 121°C keeping pressure as 18 pound for half an hour. The objective of the study was to eliminate the causative of the respiratory disease by the best suitable endotoxin eradication technique.

MATERIALS AND METHODS

The present project was undertaken in the Department of Fibre Technology, University of Agriculture, Faisalabad and Mustafa Spinning Mills Ltd. Faisalabad. Cotton samples of NIAB-78 (V_1), NIAB-Karishma (V_2), FH-682 (V_3) and FH-634 (V_4) were collected from Ayub Agricultural Research Institute, Faisalabad.

Four treatments were given to eliminate the toxic agents from cotton according to the following procedure.

Mechanical cleaning (T_1). Cotton samples were mechanically cleaned with the help of "Shirley Analyzer MK-2" according to the instruction laid down in its operational manual.

Flash-heating (T_2). Cotton samples were heated in an "Electric Furnace" at temperature 250°C for a time period of 25-30 seconds.

Steaming (T_3). Cotton samples were autoclaved at temperature 121°C under pressure of 18 pounds for half an hour.

Washing (T_4). Washing was done according to the method suggested by Rousselle and Domelsmith, (1993). Cotton samples were washed with water at a temperature of 60-65°C. Water: cotton ratio was 50:1, using a wetting agent Kieralon-CD and then washed samples were air dried. To over come the static charge problem in spinning process, fibre finish Silligen-AFN was applied.

Physical characteristics of the cotton samples before and after treatments were determined by the High Volume Instrument "HVI-900" developed by M/S Spin Lab. according to the Procedure suggested by ASTM (1997).

RESULTS AND DISCUSSION

Fibre length. The statistical analysis of data in respect of fibre length for different varieties under different treatments is presented in Table I which indicates that differences in the mean values for varieties as well as for treatments are highly significant. Whereas, their interactions show non-significant effect for fibre length.

Least Significant Difference (LSD) test for comparison of individual means indicates that mechanical cleaning (T_1) slightly increases the fibre length as 1.153 to 1.157 inches for V_1, 1.133 to 1.137 inches for V_2, 1.153 to 1.160 for V_3 and 1.080 to 1.087 for V_4. It is obvious from the results that mechanical cleaning induces growth in fibre length which may be due to the straightening of the fibres through beating and pulling action . Similar finding are reported by Leifeld (1993) who lamented that fibre straightening in blow room occurs at points where held beats occur.

Table I. Individual comparison of treatment means for fibre length

Treatment	V_1	V_2	V_3	V_4
T_0	1.153ab	1.133ab	1.153ab	1.080ab
T_1	1.157a	1.137a	1.160a	1.087a
T_2	1.127c	1.113c	1.127c	1.057c
T_3	1.147b	1.127b	1.147b	1.077b
T_4	1.147b	1.125b	1.147b	1.077b

V_1 = NIAB-78; V_2 = NIAB KARISHMA; V_3 = FH-682; V_4 = FH-634;
Note: a, b, c are used separately for each column

Statistically non-significant differences in the mean value for fibre length are observed under autoclave (T_3) as well as washing (T_4) treatments. However, the impact of these treatments have shown some shorting in staple length values. Similar views were expressed by Sasser (1980) who stated that none of the washing treatments significantly affected the fibre length and all washed treatments had slightly shorter fibre length on the average. Perkins (1981) stresed that more severe washing conditions adversely affect fibre length. Whereas, Rousselle and Price (1996) suggested that fibre length and strength were generally not affected by the most washing treatments if an effective finish was applied.

Statistically significant higher decrease in fibre length was observed in flash heated (T_2) cotton samples. It was found that T_2 caused reduction in the fibre length from 1.153 to 1.127 inches for V_1, 1.133 to 1.113 inches for V_2, 1.153 to 1.127 inches for V_3 and 1.080 to 1.057 inches for V_4, respectively. These findings are conformed by the results of Rousselle and Price (1996) who reported that cotton fibres heated at 255°C showed an appreciable reduction in fibre length. Similarly, Brushwood (1988) noted that the fibre length decreased slightly at temperature below 180°C for cottons that did not receive mechanical working after heating and at temperature 200°C, the fibre lengths decreased in an average of 0.3% per minute for 2.5% span length. 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 250°C in a forced draft oven.

Fibre fineness. The statistical analysis of data produced in respect of fibre fineness for different varieties under different treatments is presented in Table II, which narrates that differences in the mean values for varieties as well as treatments are highly significant whereas their interactions show non significant effect for fibre fineness.

It was found that mechanical cleaning (T_1) reduced micronaire from 4.83 to 4.73 µg/inch for V_1, 4.87 to 4.77 µg/inch for V_2, 4.90 to 4.80 µg/inch for V_3 and 4.10 to 4.00 µg/inch for V_4. This reduction in micronaire values is because of the removal of foreign matter from cotton lint during mechanical cleaning. These observations get support from the results of Sasser (1980) who noted reduction in micronaire value of cotton samples from 4.22 to 4.08 µg/inch after mechanical cleaning.

Statistically no significant change in the mean values for fibre fineness is observed under flash heating (T_2) treatment. However, the fibre fineness 4.80, 4.87, 4.90 and 4.07 µg/inch for varieties V_1, V_2, V_3 and V_4, respectively, was noted for T_2 treatment. Identical observations were put forward by Rousselle and Price (1996) who recorded no change in micronaire value for cotton samples heated at temperature 250-252°C.

Table II. Individual comparison of treatment means for fibre fineness

Treatment	V_1	V_2	V_3	V_4
T_0	4.83a	4.86a	4.90a	4.10a
T_1	4.733bc	4.76bc	4.80bc	4.00bc
T_2	4.800ab	4.86a	4.90a	4.06ab
T_3	4.767abc	4.83ab	4.86ab	4.03ab
T_4	4.700c	4.73c	4.76c	3.93c

V_1 = NIAB-78; V_2 = NIAB KARISHMA; V_3 = FH-682; V_4 = FH-634;
Note: a, b, c are used separately for each column

Under autoclave (T_3) treatment, non-significant decrease in the mean values of fibre fineness is recorded. The decrease in micronaire value of variety V_1 is from 4.83 to 4.77 µg/inch, 4.87 to 4.83 µg/inch for V_2, 4.90 to 4.87 µg/inch for V_3 and 4.10 to 4.03 µg/inch for V_4. The slight decrease in micronaire might be due to the removal of some fine trash particles attached with cotton fibre during autoclave treatment.

Statistically significant decrease in the mean values for micronaire is noted under washing treatment (T_4). It is found that washing improves micronaire value from 4.83 to 4.70 µg/inch for V_1, 4.87 to 4.73 µg/inch for V_2,

4.90 to 4.77 µg/inch for V_3 and 4.10 to 3.93 µg/inch for V_4 respectively. It is clear from these results that washing removed most of the water extractable non-lint substances. Identically, Sasser (1980) found that all washing treatments slightly decreased the micronaire of cotton and this change was likely caused by the removal of small trash particles from the lint and observed a change from 4.22 to 4.05 in micronaire units under washing at 333°K.

Fibre strength. Statistical analysis of fibre strength of different cotton varieties under different treatments is presented in Table III, which shows that the differences in the mean values for varieties as well as for treatments are highly significant. Where as their interaction shows non-significant effect for fibre strength.

Least Significant Difference (LSD) test for comparison of individual means indicates that statistically no change in fibre strength is observed after mechanical cleaning (T_1). Sasser (1980) expressed similar views and reported that mechanical cleaning through the cleaning equipment did not significantly change the length, length uniformity and strength of cotton.

Table III. Individual comparison of treatment means for fibre strength

Treatment	V_1	V_2	V_3	V_4
T_0	23.47c	22.50c	24.83c	21.33c
T_1	23.27c	22.33c	24.67c	21.20c
T_2	21.20d	20.07d	22.03d	19.13d
T_3	24.03b	23.10b	25.33b	21.93b
T_4	24.77a	23.93a	26.07a	22.77a

V_1 = NIAB-78; V_2 = NIAB KARISHMA; V_3 = FH-682; V_4 = FH-634;
Note: a, b, c are used separately for each column

Significant differences in the mean values for fibre strength are observed under flash-heating (T_2) treatment. It was found that fibre strength decreases from 23.47 to 21.20 gm/tex for V_1, 22.50 to 20.07 gm/tex for V_2, 24.83 to 22.03 gm/tex for V_3 and 21.33 to 19.13 gm/tex for V_4 respectively. These findings are in close agreement to the views reported by Rousselle and Price (1996) who expressed that heating reduces all tensile and length parameters of cotton fibres. Similarly, Brushwood (1988) observed that cotton samples when heated without mechanical processing caused little loss in strength upto 160°C for 20 minutes, but rapid deterioration in strength occurred above this temperature. Whereas Rousselle and Domelsmith (1993) stated that fibre bundle tenacity and elongation decreased 12% when cotton samples were heated in a forced draft oven for 60 seconds at 250°C. However, later on, Rousselle and Chun (1995) noted a 24% reduction in fibre strength when cotton was heated in a gas fired pilot plant dryer at 255°C for 20 seconds.

Statistically significant increase in the mean values of fibre strength are recorded under autoclave (T_3) treatment. It was found that at T_3 the fibre strength was 23.47 to 24.03 gm/tex for V_1, 22.50 to 23.10 gm/tex for V_2, 24.83 to 25.33 gm/tex for V_3, and 21.33 to 21.93 gm/tex for V_4 respectively. The gain in strength noted might be due to the removal of the natural lubricants on the fibre surface during Autoclave (T_3) treatment thereby reducing the fibre slippage effect.

Significant increase in the mean values for fibre strength is also observed under washing (T_4) treatment. The strength from 23.47 to 24.77 gm/tex for V_1, 22.50 to 23.93 gm/tex for V_2, 24.83 to 26.07 gm/tex for V_3 and 21.33 to 22.77 gm/tex for V_4, respectively for washed cotton samples. Sasser (1980) observed similar changes, and expressed that fibre strength reading for all washed treatments were higher than those for all unwashed samples.

CONCLUSION

Washing treatment lowered fibre length and micronaire value, whereas fibre strength was increased under this treatment. Flash heating also adversly affected fibre length and fibre strength of cotton fibres. However, autoclave (steaming) treatment was emerged as be the most suitable method because of its minimum effect upon fibre properties.

REFERENCES

ASTM Committee, 1997. Standard test method for the measurement of cotton fibres by HVI. ASTM Designation D 4605-86. ASTM Standard on textile materials. Amer. Soc. for testing and materials, Philadelphia, USA.

Brushwood, D.E., 1988. Effect of heating on chemical and physical properties and processing quality of cotton. *Text. Res. J.,* 58: 309.

Leifeld, F., 1993. Blow room and carding machines, systematically correlated. Modern spinning system. German Technology Symposium and Exhibition, Bangkok, Thailand.

Perkins, H.H., 1981. Effect of washing on fibre properties, dust generation, and processing quality of cotton. *Text. Res. J.,* 51: 123–4.

Rousselle, M.A. and D.T.W. Chun. 1995. Endotoxin reduction in dust from heated cotton fibres. *Text. Res. J.,* 65: 501–5.

Rousselle, M.A. and J.B. Price. 1996. Heat treatment of cotton. Effect on endotoxin content, fibre and yarn properties, and processability. *Text. Res. J.,* 66: 727–38.

Rousselle, M.A. and L.N. Domelsmith., 1993. Endotoxin reduction in cotton fibre: Effect of washing and flash heating on endotoxin content, fibre physical properties, and processability. *Text. Res. J.,* 63: 595–603.

Sasser, P.E., 1980. Evaluation of cleaning and washing process for cotton fibre. Part I. Introduction and Cotton properties. *Text. Res.*

J., 50: 60–3.

(Received 15 November 2000; Accepted 13 January 2000)