RESPONSE OF CARDED AND COMBED YARNS OF EGYPTIAN EXTRA-LONG STAPLE COTTONS TO MERCERIZATION UNDER TENSION

M.A. ABD EL-AZIZ

Cotton Research Institute, Agricultural Research Centre, Giza, Egypt.

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Abstract

The present investigation was carried out to study the response of six Egyptian extra long staple cotton varieties and three grades from each to mercerization under tension treatment. Samples were spun carded and combed (20%) to produce yarns of 60's count at 3.6 twist factor. Carded and combed slivers were tested to determine fiber properties before and combed slivers were tested to determine fiber properties before spinning and mercerization. Mercerization under tension was carried out by caustic soda solution (NaOH) 20% w/w.

The results showed significant differences in single yarn strength. The highest value of increase for carded yarns was obtained for Giza 45 variety grade FG (13.11%) while for combed yarns the highest value was obtained for Giza 76 variety grade FG (17.95%). Yarn elongation% decreased significantly after mercerization and the percentage of decrease ranged from -3.19 to -19.52%. It is concluded that the response of extra long staple Egyptian cottons to mercerization under tension is affected by carding and combing process as well as the cotton grade, thus these factors should be taken into consideration in the processing to produce high quality cotton products.

INTRODUCTION

Mercerization is well recognized as a commercial process for modifying cellulose of fibers, yarns and fabrics to induce many changes in cotton fiber properties. Of special interest is the effect of tension during mencerization treatments. Mercerization is usually carried out with sufficient tension on the textile product to provide yarns or fabrics with dimensions equivalent to those of the untreated. The reason often given for the tension is to prevent a loss in yardage. However, the high luster produced by mercerization with tension is still one of the main purposes of the treatment (Fourt et al., 1954).

Investigations have shown that variety and growth conditions affect the extent of change in physical properties of the fibers as a result of mercerization, Orr et al. (1952), and Warwicker et al. (1966) stated that mercerization under tension gives a larger gain in strength than slack mercerization, the increase in yarn strength, due to mercerization, is probably a combination of an increase in fiber strength and an increase in the co-operative action of the fibers in the yarn. Al-Ashwat (1974) showed that mercerization under tension nearly double the increase resulting from mercerization at a constant length, also mercerization under tension decreased yarn elongation by 26.7%.

The response of different cotton cultivars to mercerization has been widely discussed in the literature. Warwicker et al. (1966) stated that the differences in response among the cultivars would be expected because of the range in the orientation of cellulose molecules and in the intensity and distribution of weak points. Mercerization affects both these parameters. Moreover, the effect of any treatment modifying the properties of cotton fibers is greatly influenced by the original characteristics of the fibers. Therefore, the exlent of modification brought about by mercerization will be directly related to the physical properties of cotton fibers. Thus, it is expected that the different cotton varieties respond differently to mercerization (Hollen and Saddler, 1964 and Lawson and Ramey, 1977).

Fibers with low strength uniformity have a greater potential for improvement with mercerization because more weak places can be improved. Lawason et al. (1979), fond that both strength uniformity and fiber maturity are likely related to the change in tenacity with mercerization.

MATERIALS AND METHODS

This investigation was carried out at the laboratories of Cotton Res. Inst., Agric. Res. Center, Giza, Egypt. Three samples representing three lint grades namely; fully good, good/fully good and good were chosen from each of six extra long staple commercial Egyptian cotton varieties namely; Giza 45, Giza 76, Giza 87, Giza 77, Giza 70 and Giza 88. The samples were obtained from the commercial cotton samples of 1996 harvest which were delivered to Cotton Research Institute from cotton export companies.

The samples were processed through the experimental spinning mill of Cotton Res. Ints., at Giza, spun into carded and combed yarns at 60's count with 3.6 twist

factor. Second card and combed slivers were tesled to determine fiber properties. Three replicates from yarns were mercerized under tension at 25oC in 20% NaOH solution (w/w) containing 1% mercerol as a wetting agent, for 10 minutes. The treated yarns were washed in running water for 10 minutes, then neutralized in 2% acetic acid solution for 10 minutes, after which washed thoroughly in running water, then dried in the over at 50°C for 4 hours and left overnight at room temperature. On the other hand, one untreated sample from each was left as a control. The untreated and mercerized yarns were tested for the following characteristics.

Fiber properties: Tenacity (g/tex) and elongation % (E1) measured by stelometer at 1/8 inch (T1) according to ASTM (D, 1445-64), fineness and maturity (micronaire reading) according to ASTM (D, 1448), toughness (g/tex) [(T1xE1)/2] x 100, and stiffness (g/tex) T1/E1% according to Grover and Hamby (1960).

Yarn properties: Single yarn strength and elongation % at break were measured on the Uster automatic yarn strength tester according to the ASTM specification D-2256-66. The length of tested specimen was 50 centimeters and the time-to-break was that specified by ASTM i.e. 20±3 seconds.

All fiber and yarn tests were carried out at constant relative humidity of 65±2% and temperature of 20±1°C.

A completely randomized design with three replications were used to analyze the effect of lint grade, carding, combing, mercerization and varieties on single yarn strength and single yarn elongation. The data obtained were subjected to statistical analysis according to the procedure outlined by Snedecor (1956), LSD test was used for comparing the different means.

RESULTS AND DISCUSSION

I. Cotton fiber properties :

Values of fiber properties of different varieties and grades under investigation are shown in Table (1).

Combed fibers gave higher values of fiber tenacity than carded fibers. Elongation of both carded and combed fibers were more or less similar, and there was no consistent trend for the percentage of elongation among the varieties and grades.

Table 1. Physical properties of fibers of carded and combed slivers of six Egyptian extra-long staple cotton varieties.

Variety	Grades	Tenacity at (1/8 inch (g/tex)		Elongation %		Micronaire reading		Toughness (g/tex)		Stiffness (g/tex)	
		Carded	Combed	Carded	Combed	Carded	Combed	Carded	Combed	Carded	Combed
Giza 45	FG	32.04	33.26	6.00	5.16	2.8	3.0	0.961	0.858	534	644
	G/FG	31.71	33.46	5.60	5.46	2.8	3.1	0.887	0.913	566	612
	G	33.13	33.81	5.70	5.51	2.8	3.1	0.944	0.931	581	614
Giza 76	Average	32.29	333.51	5.76	5.37	2.8	3.1	0.930	0.900	560	623
	FG	31.95	33.16	5.23	5.01	33.4	3.7	0.835	0.830	611	661
	G/FG	31.77	33.81	5.21	5.25	33.4	3.8	0.827	0.887	609	644
	G	34.31	34.43	5.37	5.25	3.4	3.8	0.921	0.903	639	655
Giza 87	Average	32.67	33.80	5.27	5.11	3.4	3.8	0.861	0.873	619	653
	FG	32.86	33.60	5.15	5.17	3.3	3.6	0.846	0.868	638	649
	G/FG	33.13	35.11	5.337	5.17	3.5	3.8	0.89	0.907	617	679
	G	32.37	32.80	5.40	5.12	3.6	3.7	0.874	0.839	599	640
	Average	32.78	333.83	5.330	5.15	3.4	3.7	0.870	0.871	618	656
Giza 77	FG	32.80	33.43	5.95	5.332	3.6	3.6	0.976	0.889	551	628
	G/FG	32.80	33.51	5.89	5.06	3.7	3.7	0.965	0.848	557	662
	G	33.14	333.45	5.76	5.01	3.6	3.6	0.954	0.838	575	668
	Average	32.91	33.46	5.86	5.13	3.6	3.6	0.965	0.858	561	652
Giza 70	FG	32.45	35.30	5.39	5.23	3.6	3.6	0.374	0.923	602	674
	G/FG	32.89	34.87	5.34	5.50	3.6	3.6	0.878	0.958	616	634
	G	33.19	35.57	5.34	5.50	3.6	3.6	0.886	0.978	621	647
	Average	32.84	335.24	5.35	5.441	33.6	3.6	0.879	0.953	613	651
Giza 88	FG	32.29	33.40	5.15	5.58	3.4	3.4	0.877	0.931	627	598
	G/FG	31.68	31.95	5.54	6.09	3.3	3.3	0.848	0.972	572	524
	G	31.65	32.46	5.36	5.90	3.4	3.4	0.852	0.957	590	550
	Average	31.87	32.60	5.335	5.85	3.5	3.5	0.892	0.953	596	557
Average of varieties		32.56	33.74	5.48	5.34	3.5	3.5	0.887	0.901	594	632
Grades	FG	32.39	333.69	5.47	5.22	3.5	3.5	0.887	0.883	593	642
	G/FG	32.33	33.78	5.49	5.42	3.	3.5	0.887	0.914	589	625
	G	32.96	33.75	5.48	5.38	3.5	3.5	0.904	0.907	600	629

The range of micronaire reading of carded fibers was between 2.8 and 3.7, while for the combed fibers it was form 3.1 to 3.8, the values of combed fibers were higher than carded fibers. This could be explained by the fact that the combing process generally decreases the percentage of short fibers and immature fibers. Accordingly, the percentage of mature fibers could be slightly increased within the grade or variety this will increased the micronaire reading value.

Fiber toughness results indicated that carded and combed fibers showed different values for same grade and variety.

Fiber stiffness for both carded and combed fibers showed different values for some grade and variety, the values of combed fibers were generally higher than the carded ones.

2. Yarn properties:

From table (2), it could be seen that single yarn strength was affected by mereerization under tension, carding and combing for all varieties and grades. The results indicated that mercerization under tension increased yarn strength significantly for both carded and combed yarns. For combed yarns, the highest percentage increase was obtained by Giza 76 variety grade FG (17.95%), whereas for carded yarns the highest percentage of increase was obtained for Giza 45 variety grade FG (13.11%). Generally, combed yarns gave higer increases than carded yarns. The varieties differed in the percentage of increase as well as the grades which showed different response with a general for grade fully good to give higher increase than the other two grades.

It is worthy to mention that the combed yarns of Giza 70 variety gave higher percentage increase (14.13%) single yarn strength than the carded ones (4.87%). On the other hand, for the grades, grade FG was at the top followed by grade G/FG then grade G. This trend was constant for all varieties under investigation. These results are in agreement with those obtained by Lawson et al. (1974), and Al Ashwat et al. (1983) who found that mercerization under tension increased yarn tenacity and yarn stiffness, while it decreased yarn elongation and yarn toughness. Nomeir et al. (1985) concluded that the increase in strength due to mercerization could be attributed to straightening and realignment of the internal structure of yarns mercerized under tension. On the other hand, the increase in yarn tenacity by mercerized under tension was reported by several workers; Grant (1956), McDonald et al. (1957) and Murphy and Goldthwait (1958). This increase might be attrib-

Table 2. Averages and percentage increase in single yarn strength of carded and combed six Egyptian extra long staple cotton varieties as affected by mercerization under tension treatment.

Variety	Grades	Carded		Increase (%)	Combed		Increase (%)
		Untreated	Treated		Untreated	Treated	
Giza 45	FG	19.14	21.65	13.11	19.40	22.87	17.88
	G/FG	18.90	20.46	8.25	19.07	21.62	13.37
	G	18.08	19.19	6.13	18.96	21.14	11.49
	Average	18.70	20.43	9.16	19.14	21.87	14.24
Giza 76	FG	19.45	21.10	8.48	18.95	24.90	17.95
	G/FG	18.38	19.48	5.98	21.11	22.13	13.959
	G	18.23	19.05	4.49	18.71	20.54	.78
	Average	18.68	19.87	6.31	19.79	22.52	13.89
Giza 87	FG	18.87	20.19	6.99	20.35	23.19	13.95
	G/FG	18.65	19.58	4.98	19.94	22.31	11.88
	G	18.15	18.59	2.42	19.75	21.46	8.65
	Average	18.55	19.45	4.79	20.01	22.32	11.49
Giza 77	FG	19.49	20.86	7.02	19.90	23.08	15.97
	G/FG	18.56	19.16	3.23	19.70	22.26	12.99
	G	18.39	18.83	2.39	19.00	20.69	8.89
	Average	18.81	19.61	4.21	19.54	22.01	12.61
Giza 70	FG	17.79	18.89	6.18	19.99	23.28	16.45
	G/FG	17.65	18.49	4.75	19.60	22.34	13.97
	G	17.31	17.95	3.69	19.51	21.85	11.99
	Average	17.58	18.44	4.87	19.70	22.49	14.13
Giza 88	FG	19.04	20.42	7.24	19.41	21.89	12.77
	G/FG	18.10	19.14	5.74	18.34	20.35	10.95
	G	17.66	18.36	3.96	18.50	19.98	8.00
	Average	18.26	19.30	5.64	18.75	20.74	10.57
Average of varieties		18.26	19.51	5.83	19.48	21.99	12.82
Grades	FG	18.96	20.51	8.17	19.66	23.20	15.82
	G/FG	18.37	19.38	5.48	19.62	21.83	12.85
	G	17.97	18.66	3.84	19.07	20.94	9.80

L.S.D. at 5% for

Carding and combing	0.27	Lint grade	0.33
Mercerization	0.27	Varieties	0.47

uted to the factors concerning fiber structure and yarn construction: (a) Gradual increase in fibrillar orientation and fiber strength during mercerization (Rebenfeld. 1958 a and b; Radhakrshnan et al., 1959 and Orr et al., 1959; (b) Decrease in spiral angle of fiber, so its strength increased (DeBoer, 1973), (c) Higher moisture regain compared with the unmercerized yarn thus increased strength, Meredith (1956), and (d) Decrease in twist of the yarn which increases the strength.

B. Single yarn elongation %:

Single yarn elongation % of untreated and mercerized under tension yarns as well as the magnitude of change in the studied cottons spun into combed or carded yarns are shown in Table (3).

It is obvious from Table (3) that mercerization under tension decreased yarn elongation % in all varieties, either combed or carded. However, percentage of decrease varied from variety to another and from grade to another. The decrease of the elongation % due to mercerization treatment differed from grade to grade within each variety, and did not follow any constant trend. Generally the percentage of decrease in elongation % for varieties of carded and combed yarns were more or less similar (-9.56% and -9.15%, respectively). For grades, of both carded and combed yarns, the highest percentage of decrease was-12.81% for grade FG of carded yarns. Moreover, FG exhibited the highest value of decrease followed by grade G/FG and grade G, while for combed yarns, the loss did not follow any specific trend. For carded yarn, the highest percentage of decrease was for Giza 88 variety grade fully good -18.27, while the lowest percentage of decrease was found for Giza 77 variety grade grade G -3.5%. The percentage of decrease in elongation % of combed yarns ranged from 3.19 to 19.92%, obtained for both Giza 45 variety grade G/FG and Giza 87 variety grade G, respectively. The reduction in the elongation of tensioned mercerized with tension caused a low breaking extension and a high orientation. Also, warwicker et al. (1966) stated that the relation between orientation and extension at break is to be expected from structural considerations, whether the stretching during mercerization increased the orientation by adding the deconvolution, it could be stated that any restriction in the swelling force and alignment of fibers through strains on yarns during mercerization would cause a reduction in yarn elongation at break.

In conclusion, mercerization under tension decreased yarn elongation. These results agrees to a great extent with those found by Grant (1956), McDonld et al. (1957), Murphy and Goldthwait (1958), Orr et al. (1959). Ziifle et al. (1959 and 1965) and Al Ashwat (1974).

Table 3. Averages and percentage increase in single yarn elongation % of carded and combed six Egyptian extra long staple cotton varieties as affected by mercerization under tension treatment.

Variety	Grades	Carded		Increase (%)	Combed		Increase (%)
		Untreated	Treated		Untreated	Treated	
Giza 45	FG	7.52	6.70	-10.90	7.07	6.23	-11.88
	G/FG	6.96	5.98	-11.87	6.78	6.57	-3.19
	G	6.39	5.97	-7.03	7.27	6.50	-11.84
	Average	6.95	6.21	-9.93	7.04	6.43	-8.97
Giza 76	FG	7.27	6.32	-13.06	6.45	5.57	-13.64
	G/FG	6.27	5.70	-0.95	7.01	6.38	-8.98
	G	5.70	5.30	-7.01	6.85	6.50	-5.38
	Average	6.41	5.94	-7.00	6.77	6.15	-9.33
Giza 87	FG	6.68	6.14	-8.61	6.42	5.95	-7.89
	G/FG	6.32	5.77	-9.53	6.47	5.95	-8.73
	G	6.49	6.27	-3.50	6.68	5.57	-19.92
	Average	6.49	6.06	-7.21	6.52	5.82	-12.18
Giza 77	FG	6.80	5.82	-16.83	6.70	6.20	-8.06
	G/FG	6.70	5.95	-12.60	7.12	5.56	-8.53
	G	6.32	5.95	-6.21	6.24	5.60	-11.42
	Average	6.60	5.90	-11.88	6.68	6.12	-9.33
Giza 70	FG	6.39	5.85	-9.23	6.82	6.27	-8.77
	G/FG	5.93	5.45	-8.80	6.80	6.22	-9.32
	G	5.78	5.17	-11.79	6.52	6.03	-8.12
	Average	6.03	5.49	-9.94	6.71	6.17	-8.73
Giza 88	FG	5.89	5.50	-18.27	5.95	5.38	-10.59
	G/FG	6.20	5.61	-10.51	5.88	5.63	-4.44
	G	6.24	5.91	-5.58	5.62	5.40	-4.07
	Average	6.11	5.67	-11.45	5.81	5.47	-6.36
Average of varieties		6.43	5.87	-9.56	5.59	5.90	-9.15
Grades	FG	6.75	6.05	-12.81	6.56	5.93	-10.13
	G/FG	6.39	5.74	-9.04	6.67	6.21	-7.19
	G	6.15	5.76	-6.85	6.53	5.78	-10.12

L.S.D. at 5% for

Carding and combing	0.147	Lint grade	0.180
Mercerization	0.147	Varieties	0.250

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إستجابة خيوط غزل الأقطان المصرية فائقة الطول المسرحة والممشطة للمرسرة تحت شد

محمد عبد المجيد عبد العزيز

معهد بحوث القطن ، مركز البحوث الزراعية ، الجيزه .

أجرى هذا البحث بهدف دراسة مدى إستجابة ستة من أصناف القطن المصرى التجارية فائقة الطول وهى جيزة ٤٥ ، جيزة ٧٦ ، جيزة ٨٧ ، جيزة ٧٧، جيزة ٧٠، جيزة ٨٨ ومن ثلاث رتب لكل صنف وهى رتبة فولى جود وجود فولى جود والمنزرعة فى موسم ١٩٩٦ ، لعملية المرسوة تحت الشد، وذلك بعد إجراء عمليتى التسريح والتمشيط لإنتاج خيوط غزل على نمرة ٦٠ بمعامل برم ٣,٦ تمت عملية المرسرة تحت الشد بإستعمال محلول الصودا الكاوية طبقاً للطريقة القياسية والمتبعة بوحدة التحويرات الكيماوية بمعهد بحوث القطن بالجيزة. تشير النتائج المتحصل عليها إلى أن الأصناف أظهرت إختلافاً معنوياً فى متانة الخيط المفرد وكان لكل من الرتبة وعمليتى التسريح والتمشيط الأثر الواضح لهم فى هذا الإختلاف. وبصفة عامة فإن عملية المرسرة تحت الشد أدت إلى زيادة نسبة متانة الخيط المفرد لجميع الأصناف والرتب لكل من الخيوط المسرحة والممشطة وكانت نسبة الزيادة للخيوط الممشطة أعلا منها للخيوط المسرحة وتراوحت النسبة المئوية للزيادة ما بين ٢,٣٩ - ١٣,١١٪ للخيوط المسرحة وبين ٨ -١٧,٨٨٪ للخيوط الممشطة. وجد أن هناك إختلاف معنوى فى إستجابة الرتب داخل كل صنف وكذا بين الأصناف المختلفة لعملية المرسرة تحت الشد وكانت رتبة FG وهى الأعلى تليها رتبة G/F ثم رتبة G بينما كانت إستجابة رتبة G بينما كانت إستجابة رتبة G فى الخيوط الممشطة بعد التسريح أعلا من رتبتى G/FG ورتبة FG بالترتيب.

ولقد أدت عملية المرسرة تحت الشد إلى نقص نسبة الإستطالة ٪ للخيط المفرد ووجود إختلاف معنوى بين الأصناف والرتب وكذا للمعاملات سواء التسريح أو التمشيط وتراوحت نسبة النقص فى الإستطالة ما بين ٣,٥ إلى ١٨,٥٧ ٪ للخيوط المسرحة وبين - ٣,١٩٪ الى -١٩,٥٢٪ للخيوط الممشطة.