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POSSIBILITY OF SPINNING EGYPTIAN LONG-STAPLE COTTONS INTO FINE COUNTS ON ROTOR SPINNING MACHINE

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Abstract

This study was carried out to examine the possibility of spinning commercially grown Egyptian Long-Staple cottons on open-end rotor spinning machine into yarn counts finer than the ones regularly spun on these machines using Upland cottons, which could help in increasing demand on Long staple Egyptian cottons, besides helping cotton breeder in Cotton Research Institute in breeding new varieties more appropriate to open-end rotor spinning. The five long staple Egyptian cottons; Giza 83, Giza 90, Giza 85, Giza 89 and Giza 86 were spun into 20s, 25s, 30s, 35s and 40s yarn counts at 3.8, 4.0 and 4.2 twist multipliers. Yarn quality parameters were determined.

All the Egyptian cotton varieties under study exhibited the same trends in yarn properties as spinning parameters such as yarn count and twist multiplier were varied, understandably because they are of comparable fibers properties. All the tested Egyptian cotton varieties produced high yarn quality up to the maximum count of 40s. Depending on the yarn quality, particularly yarn strength, elongation % and unevenness, it could be recommended that the Egyptian Long-Staple cotton varieties could be used for the production of rotor yarns up to count 40s.

With increasing twist multiplier, yarn strength improved and spinning became more stable. Finer yarns required higher twist multiplier.

INTRODUCTION

When considering the development of spinning technologies and spinning machines since the beginning of the18th and 19th centuries it becomes obvious that priority has been given to lowering the manufacturing costs because of the constantly rising cost of labor. Commercial rotor spinning began in 1967 in Czechoslovakia. Since that time, many researchers have studied factors that affect rotor spinning of fine yarns. Sultan and El-Hawary (1974) found that the BD 200 open-end spinning machine could not be recommended for spinning fine yarns from long staple Egyptian cotton. Nikolic (1980) reported that the quantitative and economic indices for a 20 to 50 tex (Ne 12 to 30) yarn are significantly better if open-end spinning is used. However, the qualitative index is better and the range of application is wider if ring spinning is used. Brunk (1982) used combed long-staple cotton to spin fine yarns in a rotor spinner. Starting with fiber counts of 100 mtex, it was possible to spin yarns of 14 to 16 tex (Ne 37 to 42). Alston (1987) reported that fiber and machinery technologies are now available that permit the production of fine count yarns at rotor speeds equal to or greater than 95,000 rpm. Steadman *et al.* (1989) demonstrated that the most of the practical guidelines governing successful rotor spinning of fine rotor yarns are least qualitatively similar to those of ring spinning: selecting a fiber that is strong, clean, and fine without being too short or immature; avoiding excessive draft; combing the fiber; and matching the twist to the fiber length and fineness as well as to the end requirements. Nomeir *et al* (1990) emphasized that in ring spinning, the long and fine fibered cottons could be spun into stronger yarns than the coarse fibered ones. El-Sayed (1996) studying the effect of fiber fineness on spinning finer counts on open-end spinning, reported that there were some limitations on the spinning of the 80's yarn count on the open-end spinning, because it was either unspinnable or spinnable but with inferior yarn quality, depending on the interaction between fiber length and rotor diameter. Abdel Maalk *et al.* (2001) reported that the Open-End yarns were of less lea product values than their corresponding ring spun yarns. The percentage of decrease ranged from 20.1% to 24.1%.

The Cotton Research Institute, in its effort to continuously improve the Egyptian cotton competitiveness in world markets, and because of the expansion in open-end worldwide, installed a new open-end rotor machine to evaluate new Egyptian cottons strains to help the breeders in introducing new varieties that could compete with all other cottons in open-end sector of the spinning industry.

The purpose of this research was to study the possibility of spinning Egyptian cottons for the production of yarn counts finer than the ones regularly spun on these machines using Upland cottons which could help in increasing demand on Long staple Egyptian cottons besides helping cotton breeder in Cotton Research Institute in breeding new varieties more appropriate to open-end rotor spinning.

MATERIALS AND METHODS

Five Egyptian long-staple cotton varieties namely: G. 83, G. 90, G. 85, G. 89 and G. 86 were used in this study. The mean values of fiber length measurements; fiber strength, fiber elongation %, and micronaire value of the studied commercial long staple cottons, are presented in Table 1. The important differences between these cottons were noticed only for Giza 86, which is of longer and stronger fibers.

Table 1. Fiber data from tests carried out on sliver.

	Fiber 2.5% (mm)	lengh 50% (mm)	Parameters UR (%)	Strength (g/tex)	Elongation %	Micronaire Reading
Cotton						
G.83	28.9	14.5	50.0	27.4	6.7	4.2
G.90	29.2	14.7	50.3	28.8	7.0	4.1
G.85	29.5	14.7	49.8	29.5	6.8	3.9
G.89	30.7	15.5	50.4	29.3	6.8	3.9
G.86	32.3	16.5	51.0	31.2	6.7	4.0

With regard to fiber strength measurements, the five varieties could be arranged in descending order according to Stelometer strength as: Giza 86, Giza 85, Giza 89, Giza 90, and Giza 83. Also, Giza 86 showed the highest fiber length among the cotton varieties under study.

All of these cottons were sampled and tested for fiber properties at the sliver stage. The drawn slivers were spun on Auotocoro 288 OE spinning into five yarn numbers 20 Ne (29.5 tex), 25 Ne (23.6 tex), 30 Ne (19.7 tex), 35 Ne (16.8 tex) and 40Ne (14.7) with αe 3.8, 4.0 and 4.2 respectively. The spinning conditions for all cotton varieties included a 31 mm diameter rotor (cotton type) running at 100.000 rpm. The second card sliver (0.26 Hank slivers) was processed at opening roller speed for 8200 rpm. Giza 83 used for comparison, and spun into three ring spinning yarn numbers namely 20's, 30's and 40's with twist multiplier (αe) 3.6.

Fiber and yarn properties were determined according to ASTM method. Fiber length was measured by Fibrograph 630 (A.S.T.M., D-1440-67), and (A.S.T.M., D-1445-75, 1984) for the fiber strength by Stelometer and also micronaire reading of cotton fiber measured by Micronaire (A.S.T.M., D-1448-59, 1984) The single yarn tenacity and breaking extension were determined on Zwick 1511 Automatic Tensile Tester (ASTM, D-2256-84) and the yarn unevenness on the Uster tester III (A.S.T.M., D-1425-84). Fiber and yarn properties were determined under standard conditions of 65 ±2% relative humidity and 21±1° C temperature at the Cotton Technology Research Laboratories. For the statistical analyses, the trials were designed as a three-factor full factorial experiment with three replications. All samples were processed under similar conditions in the Open-end spinning section of the Cotton Research Institute, Giza, Egypt.

RESULTS AND DISCUSSION

Effect of yarn count on yarn quality:

The results shown in Tables 2 & 3 and illustrated in Figures 1 & 2 were compiled by averaging the data for yarn spun at different yarn counts under two spinning systems. The general trends revealed that the yarn strength decreased with increasing yarn count. In the open-end spinning, the strongest yarns were produced from Giza 86, followed by Giza 89 cotton variety. Yarns from Giza 85 and Giza 90 cotton varieties were of similar strength, while Giza 83 cotton variety showed the lowest strength. Comparing the single yarn strength of each of the 20's, 30's and 40's open-end spun yarns of cotton varieties with Giza 83 ring spun yarns, it was lower than their respective ring spun yarns. It was clear from Table 3 that the percentage decrease in the strength of the open-end yarns compared with ring spun yarns was 15.33, 23.5, and 28.9% for the 20's, 30's and 40's yarns respectively. Under normal conditions, these results reflected the well-known differences in yarn strength between the ring spinning and open-end spinning techniques. Generally, the strength of open-end yarns is less than that of comparable ring spun yarns due to lack of fiber migration in spinning. In addition, the fiber tends to be less well aligned with the yarn axis than those in ring-spun yarns.

Yarn strength data (figures 1 and 2) reflected the trend in fiber tenacity data. Besides yarn strength, the transmittable strength was calculated as the ratio of yarn strength to fiber strength (Abdel-Salam 1994). The transmittable strength was higher for the coarser 20''s yarns and decreased gradually as yarns become finer. The overall trend suggests that fiber strength, micronaire value and fiber length are responsible for yarn strength, respectively.

The elongation of open-end rotor spun yarns varied in the range of 5.8-6.5 % depending upon yarn count and cotton variety. As is evident from Table 2, all the yarns recorded a decrease in elongation % with the increase in yarn count.

Table 2. Effect of cotton varieties and yarn count on yarn quality properties of Open-End spun yarns.

Cotton variety	Yarn count	Yarn Strength (cN/tex)	Elongation at break %	Unevenness (c.v.%)
G.83	20	14.75	6.2	12.82
	25	13.21	5.8	13.28
	30	12.27	5.6	15.07
	35	11.5	5.6	15.46
	40	10.29	5.3	16.09
G.90	20	14.37	6.3	13.15
	25	13.55	6.3	13.18
	30	12.67	6.2	14.75
	35	12.79	6.1	14.97
	40	11.7	5.9	15.98
G.85	20	15.36	6.3	12.04
	25	13.86	6.3	12.49
	30	12.96	5.9	14.61
	35	12.83	5.7	15.37
	40	11.02	5.6	15.69
G.89	20	15.39	6.5	11.9
	25	14.58	6.2	12.44
	30	13.37	6.1	14.08
	35	12.39	6	15.17
	40	11.14	5.9	15.8
G.86	20	17.47	6.4	13.08
	25	15.89	6.1	13.66
	30	13.99	6	14.81
	35	13.09	5.9	15.5
	40	12.37	5.8	16.21
L.S.D at 0.05 level		0.49	0.15	0.32

Table 3. Comparison between yarn properties of open-end and ring spun Yarns of Giza 83 variety.

Yarn	Yarn strength (cN/tex)			Elongation at break%			Unevenness (c.v.%)		
count	Ring	OE	Diff.%	Ring	OE	Diff.%	Ring	OE	Diff.%
20Ne	18.26	15.5	15.3	7.7	6.3	18.1	16.3	12.6	22.7
30Ne	17.07	13.1	23.5	7	5.9	14.8	18.8	14.7	21.8
40Ne	15.91	11.3	28.9	6.6	5.7	13.6	19.5	16	18.2

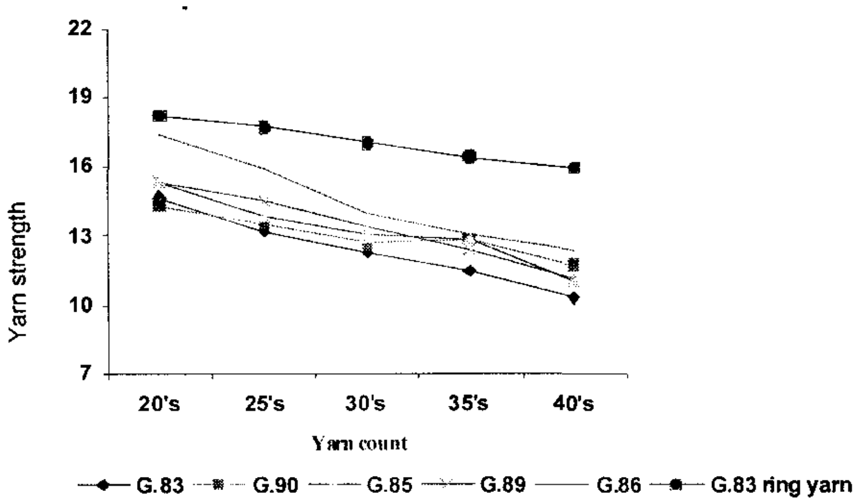

Fig 1. Yarn strength of five long-staple cottons spun at Open-End yarn different counts in comparison with G.83 ring spun yarns

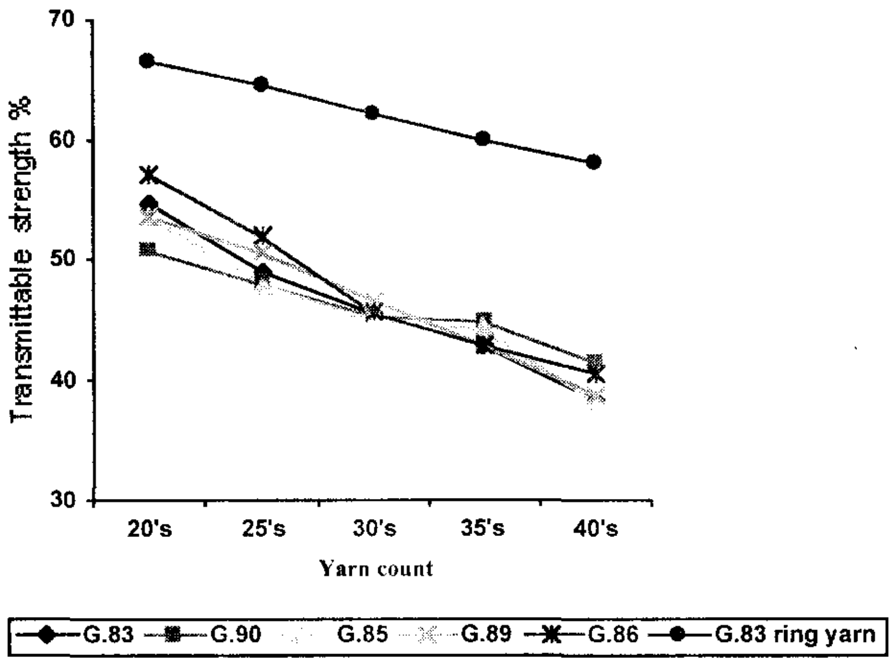

Fig 2. Transmittable fiber strength into yarn strength of long-staple cottons spun at Open-End different yarn counts

The change in yarn strength, elongation % and unevenness as yarn count is increased from 20s, to 40s varied according to cotton variety was calculated. The results are shown in Table 4. The variability in yarn strength, elongation and unevenness due to increasing yarn count from 20s to 40s were least for yarn spun from Giza 90. While, Giza 83 showed the highest value in both yarn strength and yarn elongation.

Table 4. The change in yarn properties as yarn count is increased from 20s to 40s.

	Yarn strength (cN/tex)	Elongation at break %	Unevenness (c.v.%)
Cotton variety			
G.83	-30.2	-14.5	20.32
G.90	-18.58	-6.3	17.7
G.85	-28.2	-11.1	23.26
G.89	-27.6	-9.2	24.6
G.86	-29.1	-9.3	14.86

Giza 89 cotton variety produced a more even yarn. It was clear from the mean values of unevenness illustrated in Fig. 3 that the open-end spun yarns were of lower level of unevenness than the ring spun yarns from Giza 83 cotton variety. It could be noted that the rotor spun yarns are more even than ring spun ones due to more doubling during the yarn assembly. The graphs also show that yarn strength and unevenness deteriorate as yarns become finer. Consequently, higher twist multipliers may be necessary when spinning finer yarns.

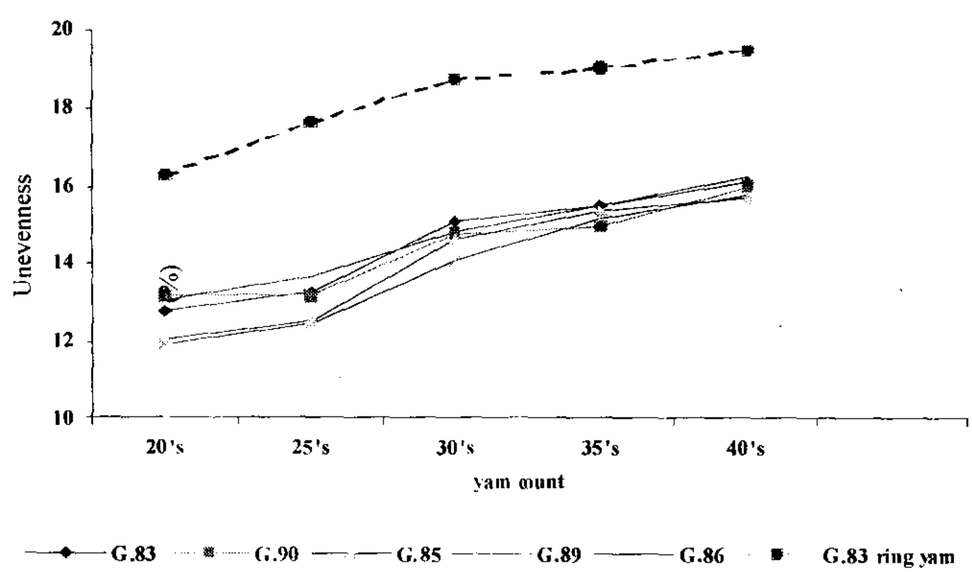

Fig 3. Effect of yarn count on yarn unevenness of Open-End spun yarn (4 cotons) and ring -spun Giza 83

Effect of twist multiplier on yarn quality.

Regarding twist multiplier, it was intended to spin each of five yarns from each cotton at three twist multipliers (αe) of about 3.8, 4.0, and 4.2 (αm 115, 121 and 127, respectively). The factorial analysis of variance revealed that each of yarn count and twist multiplier, individually, had a significant effect on yarn properties of the five cotton varieties under study. Results obtained emphasized the consistent trends of increase in yarn strength with increasing twist factor, Table 5.

Table 5. Effect of interaction between yarn count and twist multiplier on yarn quality properties of Open-End spun yarns.

Yarn count	Twist multiplier	Strength (cN/tex)	Elongation at break %	Unevenness (c.v.%)
20	3.8	15.15	6.2	12.11
	4	15.5	6.3	12.57
	4.2	15.98	6.5	13.1
25	3.8	13.86	6	12.94
	4	14.28	6.2	12.93
	4.2	14.52	6.3	13.15
30	3.8	12.72	5.8	14.63
	4	13.08	5.9	14.6
	4.2	13.35	6	14.75
35	3.8	11.99	5.8	15.39
	4	12.55	5.9	15.34
	4.2	12.83	6	15.15
40	3.8	10.67	5.6	15.87
	4	11.2	5.7	16.04
	4.2	12.04	5.8	15.95
L.S.D at 0.05 level		0.39	0.11	0.25

It was generally noticed that the variation in yarn strength accounted by count was apparently greater than that accounted by twist multiplier. However, it should be taken in consideration that the range of twist multiplier is very narrow (3.8 to 4.2) which does not allow a better evaluation. Generally, open-end rotor yarns have structures that are different from corresponding ring-spun yarns. However, higher twist values were found to be one answer to the reduction of yarn strength that characterized open-end rotor spinning. A further finding was that the higher twist multiplier increased yarn elongation and also, impaired unevenness (cv%).

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إمكانية غزل الأقطان المصرية طويلة التيلة على نمر رفيعة على ماكينة الغزل ذو الطرف المفتوح

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إستهدفت هذه الدراسة إختبار إمكانية غزل الأقطان المصرية التجارية طويلة التيلة على ماكينة الغزل ذو الطرف المفتوح على نمر غزلية أرفع من النمر العادية المغزولة على هذه الماكينات بإستخدام أقطان الابلند، والتي يمكن أن تساعد على زيادة الطلب على الأقطان المصرية طويلة التيلة بجانب مساعدة مربى القطن في معهد بحوث القطن في تربية اصناف جديدة اكثر ملائمة لنظام الغزل ذو الطرف المفتوح، استخدمت خمسة أصناف طويلة التيلة من القطن المصري هي جيزة ٨٣، وجيزة ٩٠ وجيزة ٨٥ وجيزة ٨٩ وجيزة ٨٦ تم غزلها على نمر ٢٠، ٢٥، ٣٠، ٣٥، ٤٠ بمعاملات برم ٣,٨، ٤,٠، ٤,٢.

وقد أجريت قياسات صفات التيلة والغزل. كل الأصناف المصرية المختبرة أعطت نفس الإتجاه في خواص الخيط تبعاً لإختلاف نمرة الخيط ومعامل البرم. كذلك أنتجت خيوط عالية الجودة حتى أعلى نمرة غزلية وهي ٤٠ إنجليزي. ومن ثم يتوقع إعتماداً على جودة الخيوط معبراً عنها بصفات المتانة والإستطالج وعدم الإنتظام أن الأقطان المصرية طويلة التيلة يمكن أن تستخدم لإنتاج خيوط غزل ذو طرف مفتوح حتى نمرة ٤٠ إنجليزي.

بزيادة البرم يحدث تحسن في متانة الخيط، كما أن الخيوط الأرفع تحتاج إلى برم أعلى.