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YARN PROPERTIES OF COTTON AND RAYON AND THEIR BLENDS SPUN ON THE OPEN-END ROTOR SPINNING

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Abstract

Yarns of Giza 85 cotton and rayon and their blends were spun. The rayon fibers in cotton rayon blend ratios are 75 : 25, 50 : 50, 25 : 75, spun on the Schlafhorst Auotocoro 288 OE rotor spinning to produce yarn counts of 20Ne, 30Ne and 40Ne at three twist multipliers; 4.0, 4.4 and 4.8. The effect of blend ratio on yarn properties and yarn hairiness has been investigated to define the proper blended yarns.

Results indicated that the better yarn quality is obtained at higher percentage of cotton in the blend. 100% cotton yarns produced the strongest lea count strength product and single yarn tenacity. Blended yarn of 25:75 cotton/rayon recorded the lowest yarn strength. Yarn extension at break gradually and steadily increased with increasing the rayon percent. The increase of fiber length (38 mm for rayon fibers) has no effect on yarn unevenness of open-end rotor spinning. The optimum yarn quality has been obtained at 75:25 cotton/rayon blends.

INTRODUCTION

Today the majority of apparel textiles are manufactured from yarns spun from staple fibers. Population expansion and consumer growth increase demand for textiles. Open-end rotor spinning has succeeded in gaining some economic advantage over the conventional ring spinning method. So, there is considerable interest in replacing fine ring spun yarns with rotor spun yarns for uniforms and career apparel. Celluloses fibers make comfort fabrics for tropical countries.

Sultan (1977) stated that blending cotton with synthetic fibers has become an important trend in the spinning technology. The open-end spinning machine has become now very competitive to the ring spinning machine. Mittal *et al.* (1981) stated that there has been growing tendency to blend cotton with rayon and polynosic fibers. These fibers differ in their physical, mechanical and fine structural properties. Vinzanekar *et. al.* (1981) concluded that the strengths of blended yarns are considerably lower than one might expect from the strengths of component fibers due to the differences in breaking elongation of the constituent fibers. Ali (1993) showed that the yarn strength decreased gradually as rayon percentage increased, while the yarn extension at break was increased. Mansour *et al.* (1998) reported that the acceptable homogenous blend is achieved by bringing fiber together in finest possible subdivision to the processing line. The purposes of the blending are; improving yarn and fabric properties, compensating for the shortage in natural fibers, economizing on material cost and designing yarns to produce desired characteristics, vis, feel, appearance, novelty. They added that the yarn tenacity decreasing by increasing rayon percentage, while yarn extension at break improved with increase of rayon percentage.

The objective of the investigation was combining the aesthetic and comfort properties of the natural components in the spinning of cotton/rayon yarns, to overcome the lack of cotton production, and producing a relatively fine yarn on a rotor spinning machine.

MATERIALS AND METHODS

Fiber properties of Giza 85 Egyptian cotton variety rayon as involved in the present study are given in Table 1. The five different combinations of blend levels (Table 2) including the 100 % fiber types were processed through carding and drawing machines. The slivers with two passages of drawing were supplied to the Schlafhorst Auotocoro 288 OE spinning using a 31-rotor diameter running at 100,000 rpm. at opening roller speed of 8200 rpm according to EL-Sayed and Suzan (2003). The experiment was performed for three different yarn counts of 20 Ne (29.5 tex), 30 Ne (19.7 tex) and 40 Ne (14.7 tex) for three twist multipliers 4 (38), 4.4 (42) and 4.8 (45).

Cotton fiber and yarn properties were determined according to ASTM methods. (A.S.T.M., D-1440-67) for the fiber length by Fibrograph 530, 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 strength and elongation % were determined on Tensojet Automatic Tensile Tester (ASTM, D-2256-84). Yarn uniformity, imperfections and hairiness were measured on Uster Tester III (A.S.T.M., D-1425-84). Fiber properties and lea count strength product were determined at the Cotton Technology Research Laboratories, Cotton Research Institute, Giza, Egypt. Single yarn properties were determine at Textile Consolidation Fund, Alexandria, Egypt. All fiber and yarns were tested under standard conditions of 65 ± 2% relative humidity and 21± 1° C temperature.

Table 1. Fiber properties (from tests on sliver).

Fiber properties	Materials	
	Giza 85	Rayon
Fiber length parameters		
2.5% SL (mm.)	28.1	38
UR (%)	50.3	------
Tenacity (g/tex)	28.21	21.6
Elongation (%)	6.5	19.5
Micronaire reading	4.2	1.5 (d)
Denier	-	1.5
Micronaire reading	4.2	-
Millitex	145	139

Table 2. Blend ratios.

0 % Rayon/100% Giza 85
25% Rayon/75% Giza 85
50% Rayon/50% Giza 85
75% Rayon/25% Giza 85
100% Rayon/0% Giza 85

All samples were processed under similar conditions in the Open-end spinning section of the Cotton Research Institute.

RESULTS AND DISCUSSION

The effect of three experimental variables, viz. blend ratio, yarn count and twist multiplier, on yarn properties and hairiness was evaluated with help of ANOVA analysis (Table 3), the confidence level used was 95%.

Table 3. ANOVA test results.

Process parameters	L.C.S.P.	Yarn tenacity (cN/tex)	Yarn elongation (%)	Unevenness (C.V. %)	Neps	Hairiness
Main effect						
B	30.53*	0.005*	0.10*	0.13*	0.46*	0.005*
C	23.65*	0.004*	0.079*	0.10*	0.36*	0.004*
T	23.65*	0.004*	0.079	0.10*	0.36*	0.004*
First order interaction						
B X C	52.89*	0.079*	0.178*	0.23*	0.80*	0.009*
B X T	52.89*	0.079*	0.178*	0.23*	0.80*	0.009*
C X T	40.96*	0.060*	0.137*	0.17*	0.62*	0.007*
Second order interaction						
B X C X T	91.60*	0.13*	0.30*	0.39*	1.39*	0.017*

B: blend ratio. C: yarn count. T: Twist multiplier. *: Significant at 95% level.

Yarn tensile strength

The most important property that can be affected by blending is the tensile strength, which give better performance in mechanical processing of spinning and weaving. An analysis of variance shows that, for lea count strength product and single yarn tenacity, the main effect, first and second order terms are significant at the 5% level. Table 4 and figures 1-6 show the effect of on lea count strength product and single yarn tenacity. It is evident from this table and figures that the lea count strength and yarn tenacity decreases as the rayon component increases. It is obvious from the results that the cotton yarns have higher breaking strength as compared to the rayon yarns. It can be readily seen from the test results (Table 4) that cotton produced the strongest lea count strength product and single yarn tenacity. This is shown in figures 1-6. It will be noted that when only at 75% cotton in the blend, differ too much in the strengths of the yarns when the percentage was decreased to 25%. The strength of rayon yarns can be emphasized by the single fiber strength as well as fiber bundle strength. The difference gradually reduced as the percentage of rayon content increased, the decrease in yarn strengths can emphasize by the variability in strength/ elongation of the composite fibers. Lea count strength product and single yarn tenacity of blended yarns and the cotton and rayon component decrease gradually as yarn linear density becomes finer. As the twist increases, the influences of the yarn linear density on lea count strength product and yarn tenacity become more apparent.

Table 4. Properties of yarns from different blends with different counts and different twists.

	L.C.S.P.	Yarn tenacity (cN/tex)	Yarn elongation (%)	Unevenness (C.V. %)	Neps (km)	Hairiness
Cotton/Rayon blends						
100 / 0	2375	17.72	5.8	11.30	2	3.8
75 / 25	1825	15.62	6.1	14.35	5	4.0
50 / 50	1495	12.93	6.3	14.18	3	4.1
25 / 75	1465	11.72	7.1	14.29	3	4.1
0 /100	1645	12.55	11.03	14.75	3	4.1
Yarn count						
20s	2000	15.13	7.8	12.52	2	4.4
30s	1680	13.92	7.1	14.07	4	3.9
40s	1595	12.68	6.9	14.73	4	3.7
Twist multiplier						
4.0	1710	13.41	7.0	13.81	3	4.1
4.4	1755	13.94	7.4	13.90	4	4.0
4.8	1820	14.37	7.5	13.60	3	3.9

Yarn elongation

The effect of rayon percentage on the yarn elongation at break at different counts and twist multipliers is shown in Figures 7-9. It is evident from these Figures and Table 4 that the yarn elongation at break exhibited a gradual and steady increase with increasing rayon content. This is because the elongation of rayon fibers (19.5%) was about triple as much as that of cotton fiber (6.5%). Yarn elongation is influenced relatively little by either the yarn linear density or the twist level. The influence is more marked for coarser count and low twisted yarns. In this respect, Barella and Vigo (1980) concluded that an increase in twist leads to a parallel increase in elongation at break.

Yarn unevenness

The effect of blending ratio on yarn unevenness was shown in Table 4 and Figures 10-12. Since the structure and properties of open-end spun yarns are considerably different than the corresponding ring-yarns, these differences can be attributed to the way fibers are disposed in the body of the yarn, which is decided by the method of yarn formation. An increase in fiber length from 30mm (cotton fibers) to 38 mm (rayon fibers) offers no advantage to yarn unevenness in open-end rotor spinning. As can be observed in Table 4 and Figures 10-12, yarn unevenness is practically dependent of the yarn linear density. As the yarn linear density increases, the influence of the yarn unevenness become more apparent, such that, when the rayon percentage increases, an increase in yarn unevenness does not become evident. As can be observed in Figures 13-15, the effect rayon percentage and fiber type component, yarn linear density and twist multiplier on yarn neppiness/ 1000m. is very small.

Yarn hairiness

The hairiness attachment on an Uster Tester 3 detects the rays of scattered light caused by fibers protruding from the main body of the yarn, and the amount of scattered light provides a measure of the yarn hairiness (Zellweger Uster AG, 1987). This hairiness device is claimed to produce consistent hairiness results that are independent of the method of guiding the yarn and the test speed (Uster News Bull., 1988).

The mean values of yarn hairiness and its affected by rayon percentage, yarn linear density and twist multiplier were given in Table 4. and illustrated in Figures 16-18. The differences between cotton/rayon blended yarns and fiber type component were significant. The cotton yarns recorded low hairy than those respective cotton/rayon yarns and rayon yarns. According to yarn count, yarn hairiness decreased gradually as yarn become finer, this result due to the reduce the number of fiber per yarn cross-section.

Yarn unevenness (C.V.%) was found to be the only yarn property that correlated significantly with yarn hairiness, in agreement with the theoretical hypothesis, that the more protruding ends and loops, the more irregular is the number of fibers in the cross-section of the yarn, which causes unevenness to increase (Aboul-Fadl and Syiam 1983).

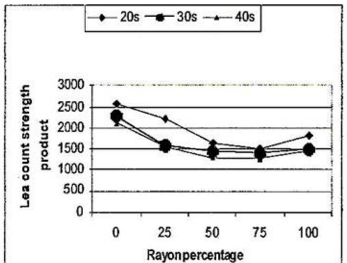

Figure (1): Lea count strength product of cotton /rayon blended yarns (4.0 TM.)

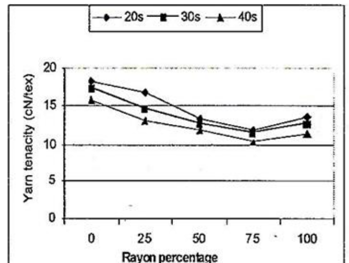

Figure (4): yarn tenacity (cN/tex) of cotton /rayon blended yarns (4.0 TM.)

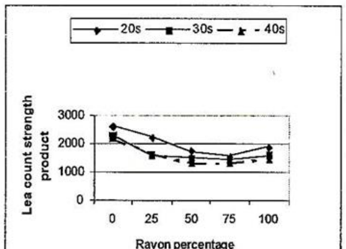

Figure (2): Lea count strength product of cotton /rayon blended yarns (4.4 TM.)

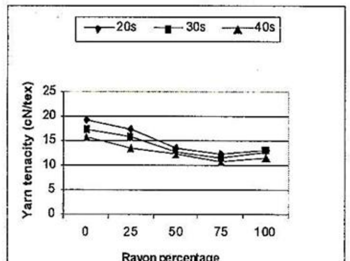

Figure (5): Yarn tenacity (cN/tex) of cotton /rayon blended yarns (4.4 TM.)

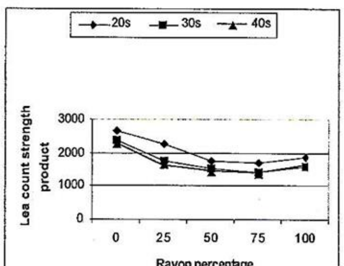

Figure (3): Lea count strength product of cotton /rayon blended yarns (4.8 TM.)

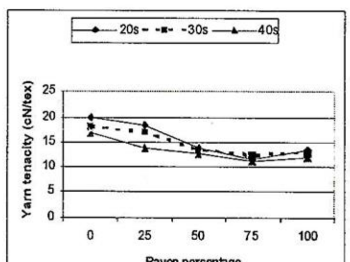

Figure (6): Yarn tenacity (cN/tex) of cotton /rayon blended yarns (4.8TM.)

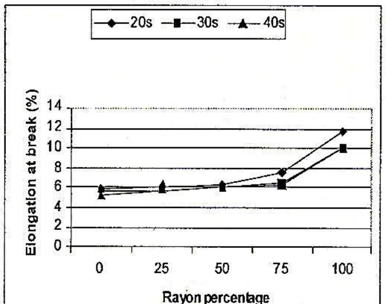

Figure (7): Elongation (%) of cotton /rayon blended yarns (4.0 TM.)

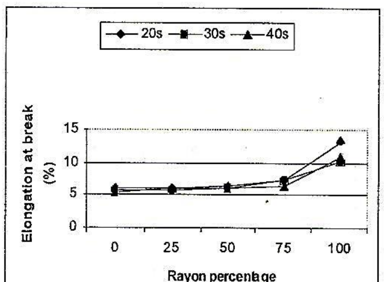

Figure (8): Elongation of cotton /rayon blended yarns (4.4 TM.)

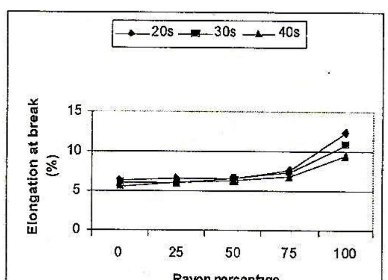

Figure (9): Elongation of cotton /rayon blended yarns (4.8 TM.)

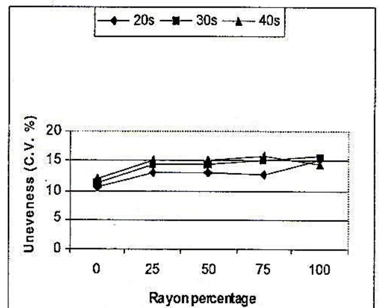

Figure (10): Uneveness of cotton /rayon blended yarns (4.0 TM.)

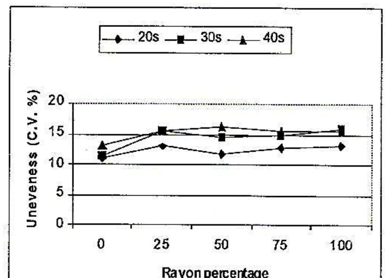

Figure (11): Uneveness of cotton /rayon blended yarna (4.4 TM.)

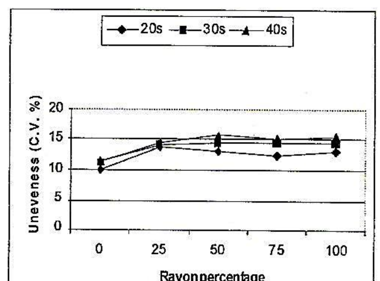

Figure (12): Uneveness of cotton /rayon blended yarns (4.8 TM.)

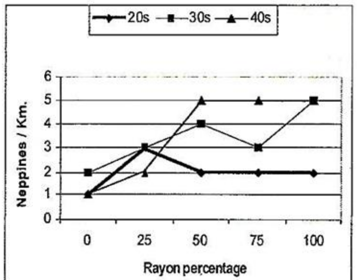

Figure (13): Neppiness of cotton /rayon blended yarns (4.0 TM.)

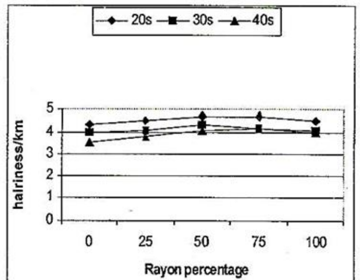

Figure (16): Hairinessof cotton /rayon blended yarns

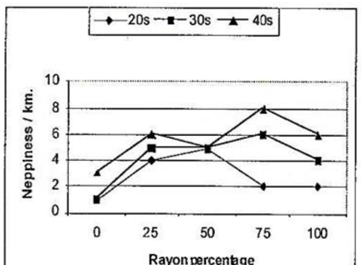

Figure (14): Neppiness of cotton /rayon blended yarns (4.4 TM.)

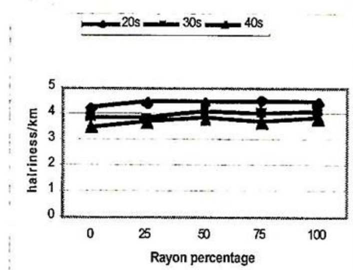

Figure (17): Hairiness of cotton/rayon blended yarns (4.4 TM.)

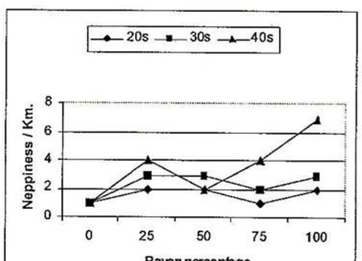

Figure (15): Neppiness of cotton /rayon blended yarns (4.8 TM.)

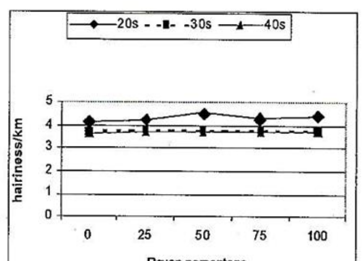

Figure (18): Hairiness of cotton /rayon blended yarns (4.8 TM.)

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خواص خيوط القطن والرايون وخلطاتهما المغزولة على غزل الطرف المفتوح

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معهد بحوث القطن – مركز البحوث الزراعية – الجيزة

أستخدم لهذه الدراسة صنف القطن جيزة ٨٥ وكذلك ألياف الرايون ومخلوطاتهما والمخلوط مع الياف الرايون بنسب خلط ٧٥ : ٢٥ ، ٥٠ : ٥٠ و ٢٥ : ٧٥ وتم غزل تلك الخامات على ماكينة غزل الطرف المفتوح لإنتاج خيوط بنمر ٢٠ ، ٣٠ و ٤٠ إنجليزى عند ثلاث معاملات برم هى ٤,٠ ، ٤,٤ و٤,٨ . وتمت دراسة تأثير نسبة الخلط على خواص الخيوط ومعدل التشعيرلتحديد نسبة الخلط التى تعطى خيوط متميزة الجودة.

أظهرت نتائج هذه الدراسة أنه بزيادة نسبة القطن فى الخلطة تتحسن خواص الخيوط . وأن الخيوط المغزولة من القطن أعطت أعلى متانة للشلة وكذلك للخيط المفرد، بينما سجلت الخلطة ٢٥٪ قطن و ٧٥ ٪ رايون أقل قيمة لمتانة الشلة و متانة الخيط المفرد. يرجع ذلك الى الإختلاف فى خواص المتانة والإستطالة لكل من مكونىَ الخلطة. وتزداد إستطالة الخيط عند القطع بزيادة نسبة الياف الرايون فى الخلطة . إن زيادة طول شعيرات الياف الرايون الى ٣٨ مللى عن شعيرات القطن (٣٠ مللى) لم يحسن من صفة عدم إنتظام خيط غزل الطرف المفتوح. و قد أعطت الخلطة ٧٥٪ قطن و ٢٥٪ رايون أفضل خواص جودة.