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PROCESSING OF WASTE AND LOW QUALITY COTTONS ON THE OPEN-END ROTOR SPINNING

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Abstract

The present work has been done to study more closely the possibility of producing commercially accepted rotor yarns spun from waste and low quality cottons to give spinning value to the waste and low grade cottons. The influence of cotton type i.e. comber noils, export type, wati makhlout and two ordinary cottons "Giza 80 and Giza85" and yarn count 20Ne (29.5 tex), 25 Ne (23.6 tex), 30Ne (19.7 tex) and 35 Ne (16.8 tex) with two twist multipliers 3.8 (36) and 4.2 (40) on the properties of open-end rotor spun yarn has been studied. The multiple regression analysis indicated that the Short Fiber Index, Micronaire reading and Fiber strength showed the greatest influence upon Open-End yarn strength. It was found that the open-end rotor spinning offers the opportunity for viable spinning of cotton wastes (comber noils) and low quality cottons (Wati Makhlout and export type) prepared in a recycling process for end uses with adequate yarn quality.

INTRODUCTION

Egypt's ring spinning mills produce, each year between 1000 and 1500 tons of noils that are regarded as potential input material for an efficient rotor spinning operation. Also, waste material from elsewhere in the spinning preparation department, e.g. the blow room, cards, drawframes and roving frames, can be combined as feedstock for rotor spinning.

International Institute for Cotton (1974) estimated that about two-thirds of open end yarn currently being produced on the short staple system is of pure cotton. The system will accept very short staples or wide staple mixes, blends of short staple cotton and clean cotton waste can be spun successfully. Douglas and Mech (1975) showed that the waste fiber (fiber which is too short in its staple length to be processed via a normal roller drafting system, but in terms of cleanliness, fineness and strength, is in every way comparable with longer staple material) could be processed successfully on the rotor-spinning machine. Pillay (1975) stated that the strength deficiencies of open end rotor yarns are smaller for short staple cottons than for long staple ones, and that this coupled with the definite economic advantages of open end rotor spinning in the coarser count range, may open up new avenues for the use of short staple cottons and waste. Studies at Textile Research Center, Texas Tech University

(1975) showed that very good open-end yarn strength could be obtained with low micronaire, high strength cottons and that fiber length and uniformity of length played secondary roles. Aboul-fadl (1979) showed that the Egyptian cotton waste was spinnable on open-end rotor spinning, and the yarn obtained was of acceptable strength up to count 17Ne. He added that this limit may be raised by using the modern card machines to provide more even and clean sliver. Shcherbakova *et al* (1983), likewise, showed that lower grade cotton could be processed on the open end spinning, leading to fewer faults and a more regular yarn than those processed on the ring frame. Steadman *et al.* (1989) reported that the rapid extension of rotor spinning since its commercial introduction in 1967 has had limited influence at the fine end of the spectrum of coarse yarns. Tetzlaff and Wulfhorst (1992) emphasized that the economic benefits of open-end rotor spinning technology lie especially in the production of yarns of medium and coarse count. Rüger (1993) stated that the fibers of widely varying length, including extremely short fibers, could be processed on rotor spinning machines to produce yarns of outstanding uniformity. El-Sayed (1996) illustrated that the yarn strength of open end spinning decreased considerably with decreasing fiber length and increasing short fiber content, meaning that the long fibered cotton with lower short fiber content could be spun into yarns of higher strength than the shorter cotton containing higher percentage of short fibers.

The objective of this research was to study the possibility of producing commercially accepted rotor yarns spun from waste and low grade cottons to enhance the use value of these cottons.

MATERIALS AND METHODS

Two ordinary cottons and three low quality types were chosen for this study. The ordinary cottons were Giza 80 of grade 'Good', which is used largely for the production of coarse and medium counts ring spun yarns, and Giza 85, a long staple variety. The low quality types included; (a) Cotton waste; comber noils extracted from Giza 45, Giza 70 and Giza 88 cotton varieties, were blended and used. (b) The export type included a below grade cotton. (c) The off-grade types, included the low-mixed "Wati Makhlout" of the long staple varieties Giza 89 (30%), Giza 85 (30%), and Giza 86 (40%), respectively. The fiber properties are presented in Table 1.

As could be seen from Table 1, the important differences between these cotton types were noticed for the short fiber index, uniformity ratio and micronaire reading. Short fiber index of the comber noils, export type and Wati Makhlout type were lower than that of ordinary cotton. Uniformity ratio was substantially lower for low quality cottons than for the Giza 80 and Giza 85.

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

Material	Fiber length parameters 2.50% (mm)	50% (mm)	UR (%)	SFI	Tenacity T1 (g/tex)	EL%	Mic. Reading
G. 80	28.1	14.15	50.3	12.5	28.21	6.5	4.2
G. 85	29.5	14.70	49.8	10.6	29.5	6.6	3.8
Comber noils	27.95	12.77	45.0	28.4	28.73	6.6	3.4
Export type	28.70	12.31	42.9	27.32	26.1	6.6	3.6
Wati makhlout	29.18	13.00	44.5	20.2	27.75	5.8	3.8

Cotton samples were obtained from the Misr Cotton Export Company. Auotocoro 288 OE spinning was used to conduct the investigation using a 31 rotor diameter (cotton and cotton waste types rotors) running at 1667 rev/s with a cleaning device in the spinning heads. A second card sliver (0.26 Hank sliver) was processed at opening roller speed for 137 rev/s. All samples were processed into four yarn numbers, 20 Ne (29.5 tex), 25 Ne (23.6 tex), 30 Ne (19.7 tex) and 35 Ne (16.8 tex) with two twist multipliers 3.8 (36) and 4.2 (40). Fiber and yarn properties were determined according to ASTM method. (A.S.T.M., D-1440-67) for the fiber length by Fibrograph 630, 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 Zwick 1511 Automatic Tensile Tester (ASTM, D-2256-84). Toughness was calculated from the following expression: yarn toughness = $^{1}/_{2}$ Yarn strength X elongation %. Yarn uniformity and imperfections were measured on 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, Cotton Research Institute, Giza, Egypt. For the statistical analyses, the effect of three experimental variables viz. Cotton type, yarn linear density and twist factor on the yarn properties was evaluated with the help of ANOVA analysis, the confidence level used was 99%. Simple and multiple regression correlations analyses were carried out according to Draper and Smith (1966) to evaluate the relative contribution of five fiber properties on yarn strength. All samples were processed under similar conditions in the Open-end spinning section of the cotton research Institute.

RESULTS AND DISCUSSION

Yarn properties:

The effect of three experimental variables, viz. Cotton type, yarn count and twist level, on the yarn properties was tabulated. The different levels of the main effects shown in Table 2. indicated that the low quality cottons were of significantly lower yarn strength and elongation than the respective ordinary cotton due to increasing short fiber index (Table 1) meaning that the long fiber with lower short fiber index could be spun into yarns of higher strength than longer cotton containing higher percentage of short fibers. The comber noils were considerably more neppy while, Wati Makhlout type recorded high yarn toughness for all low quality and waste cottons because of its slightly higher yarn strength and elongation.

Table 2. Summary of main effects

	Strength (cN/tex)	Elongation (%)	C.V. (%)	Thin places 120/Yds	Thick places 120/Yds	Neps 120/Yds	Toughness
Cotton type effect							
G.80	12.62^{a}**	5.9^{b}**	14.27^{c}**	3^{bc}**	5^{b}**	44^{d}**	37.25^{a}**
G.85	12.77^{a}	6.0^{a}	13.55^{e}	1^{c}	2^{c}	27^{e}	38.20^{a}
Comber noils	10.82^{b}	5.1^{d}	14.07^{cd}	1^{c}	7^{a}	102^{a}	27.94^{b}
Export type	10.64^{b}	4.8^{e}	14.73^{a}	4^{b}	6^{ab}	56^{b}	25.60^{c}
Wati makhlout	10.93^{b}	5.2^{c}	14.62^{ab}	10^{a}	7^{a}	51^{c}	28.30^{b}
Yarn count effect							
20's	13.31^{a}**	5.7^{a}**	12.80^{c}**	1^{b}**	2^{d}**	13^{d}**	38.47^{a}**
25's	11.80^{b}	5.5^{b}	13.47^{b}	1^{b}	4^{c}	23^{c}	32.73^{b}
30's	10.90^{c}	5.3^{c}	15.16^{a}	6^{a}	7^{b}	88^{b}	28.72^{c}
35's	10.23^{d}	5.0^{d}	15.60^{a}	8^{a}	10^{a}	100^{a}	25.91^{d}
Twist level effect							
3.8	11.34^{b}**	5.5^{a}**	14.13	4	5	56	31.53
4.2	11.78^{a}	5.3^{b}	14.26	3	5	56	31.39

As yarn becomes finer, the yarn strength and elongation decreased, whereas their imperfections increased. The increase in yarn irregularity C.V.% with increasing yarn count could be explained by the lower number of fiber in the cross-section of fine yarns. The findings indicate that high twist improved yarn strength.

1-Yarn strength.

As shown from Table 3 and Figure 1, the yarn has a higher strength at coarse count (20's), and as the yarn gets finer, the strength significantly decreases. The differences in yarn strength could be attributed to the differences in the number of fibers in yarn cross-section of the different yarn counts. In general, good yarn strength was obtained from G.85 of ordinary cotton and from Wati Makhlout of low quality cottons. Figure 1 shows that ordinary cottons were of high yarn strength than their corresponding of waste and low quality cotton. The high twist gave high yarn strength in all the five cottons used in the study. For the waste and low quality cottons, results were generally good, near the Uster provisional 50% level (Zellweger Uster, 1997, P. 121).

As shown in the regression equation regarding fiber properties and yarn strength, it was important to state that the higher short fiber index reduced yarn strength, and both low micronaire reading and high fiber strength are the most important criterion for Open-End yarn strength.

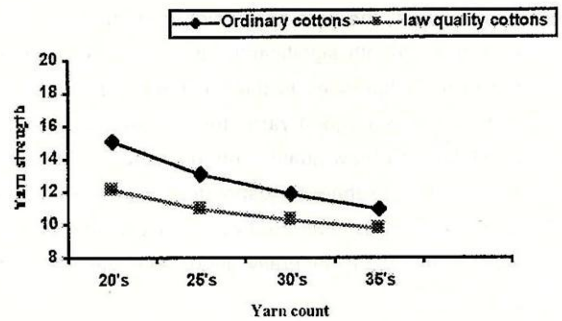
In this respect, Simpson and Murray (1978) reported that very good open-end yarn strength could be obtained with low micronaire, and high strength cottons.

Table 3. Measured yarn strength (cN/tex)

Yarn count	Twist level	G.80	G.85	Comber noils	Export type	Wati makhlout
20 s	3.8	14.4	15.09	11.55	11.7	12.5
	4.2	14.74	16.05	12.54	12.05	12.52
25 s	3.8	12.63	12.48	10.57	10.71	10.86
	4.2	13.45	13.56	11.28	11.3	11.27
30 s						
	3.8	11.91	11.4	10.18	9.92	10.03
	4.2	12.33	11.56	10.71	10.27	10.68
35 s	3.8	10.52	10.81	9.75	9.33	9.36
	4.2	11.13	11.22	10	9.91	10.27

L.S.D. = 1.14

Fig (1): Comparison between ordinary and low quality cottons on yarn strength



Regression equation to predict yarn strenght

Prediction equation	R^2
$Y_1 = 7.968 - 0.0982X_1 + 0.163X_2 + 0.251X_3$	0.956

Y_1 = yarn strenght. X_1 = Short Fiber Index X_2 = Micronaire value X_3 =Fiber Strenght

2-Yarn irregularity.

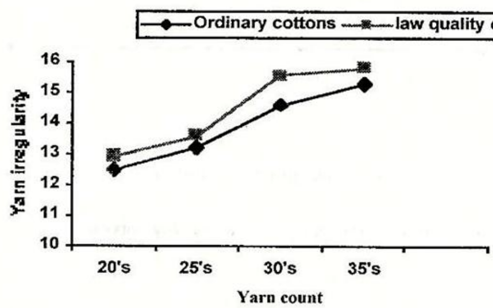
The effect of cotton type, yarn linear density and twist level on yarn irregularity is shown in Table 4. It is observed that yarn irregularity increase as the yarn increase from 20's to 35's. In general, yarn irregularity results were very good, near the Uster provisional 5% level (Zellweger Uster, 1997, P.118). Table 4 shows that coarse count (20's) gave the low yarn irregularity with G.85, Comber noils, Export type and G.80 but high in Wati Makhlout type. As shown in Figure 2, the ordinary cottons were of lower yarn irregularity compared with the low quality cottons. It could be shown that the yarn irregularity deteriorated steadily as the yarn become finer. Thus in general, the tendency for yarn irregularity c.v.% to improve at low twist (3.8) is more pronounced in coarse count and also, the higher twist impairs irregularity.

Table 4. Measured yarn irregularity c.v. %

Yarn count	Twist level	G.80	G.85	Comber noils	Export type	Wati makhlou
20 s	3.8	12.69	12.24	12.53	12.62	13.24
	4.2	13.14	12.17	13.05	13.03	13.26
25 s	3.8	13.43	12.61	13.6	13.34	14.18
	4.2	13.95	12.88	13.42	13.43	13.81
30 s	3.8	14.84	14.27	14.76	17.23	15.24
	4.2	14.85	14.48	14.75	16.02	15.11
35 s	3.8	15.64	14.76	15.44	16.08	16
	4.2	15.62	15.05	15.01	16.13	16.14

L.S.D. = 0.81

Fig (2): Comparison between ordinary and low quality cottons on yarn irregularity



3-Yarn neppiness

The interaction between Cotton type, yarn count and twist level was significant, Table 5. The lowest value of number of neps was obtained from the ordinary cottons (Figure 3), while the highest value was recorded from the Comber noils spun yarns. Undoubtedly, comber noils contain different amounts of short fiber and neps.

Yarn spun from Comber noils were more neppy than those spun from all cotton type due to combing process which is a controlled process intended to remove short fibers and neps. Therefore, it was evident that the number of neps was increased with increasing yarn count because it will be more visible in fine yarns than in coarse count.

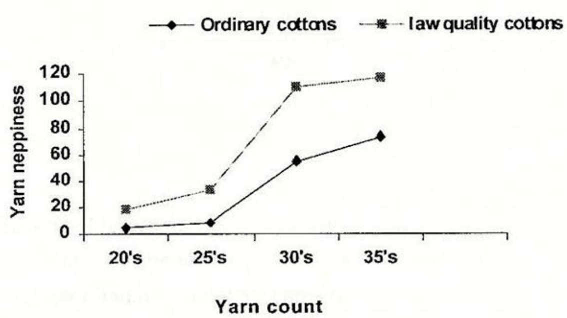
Within the limits of this study, according to Uster provisional (yarn strength at 50% level Zellweger Uster, 1997, P. 121 and yarn irregularity at 5% level Zellweger Uster, 1997, P.118), it seemed possible to spin waste (comber noils) and low quality cottons (Export type and Wati Makhlout) into yarn counts of acceptable quality level up to 35's.

Table 5. Measured number of Neps

		G.80	G.85	Comber noils	Export type	Wati makhlout
Yarn count	**Twist level**					
20 s	3.8	6	2	28	6	10
	4.2	10	2	39	13	13
25 s	3.8	7	5	61	27	19
	4.2	12	7	59	20	12
30 s	3.8	67	43	145	100	89
	4.2	69	43	147	100	80
35 s	3.8	89	57	180	82	91
	4.2	90	57	157	96	97

L.S.D. = 10.32

Fig (3): Comparison between ordinary and low quality cottons on yarn neppiness



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تشغيل العوادم والاقطان المنخفضة الجودة على نظام الغزل ذو الطرف المفتوح

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إستهدفت الدراسة مدى إمكانية انتاج خيوط مقبولة تجاريا باستخدام عوادم القطن والاقطان المنخفضة الجودة لإضافة قيمة غزلية لهذة النوعية من الاقطان. وقد ركزت الدراسة على مدى تأثير نوع القطن (عوادم تمشيط - نموذج مصدًر - واطى مخلوط بالاضافة الى صنفين أستخدما ككنترول هما جيزه ٨٥ و جيزه ٨٣ ونمرة الخيط ٢٠، ٢٥، ٣٠، ٣٥ إنجليزى ومستويين من البرم (٣,٨ و ٤,٢) على خواص خيط الغزل ذو الطرف المفتوح .. أظهر التحليل المتعدد المراحل أن الشعيرات القصيرة وقراءة الميكرونير ومتانة الخصلة هي أكثر الصفات التي تؤثر في متانة خيوط الغزل ذو الطرف المفتوح. ومن المهم أن نوضح أن نظام الغزل ذو الطرف المفتوح يوفر قيمة تطبيقية لغزل عوادم القطن (عوادم التمشيط) والاقطان المنخفضة الجودة (النموذج المصدر والواطى المخلوط) من حيث إعدادها وإعادة إستخدامها لإنتاج خيوط ذات جودة مناسبة .