QUALITY CHARACTERISTICS OF RING AND O.E. YARNS SPUN FROM EGYPTIAN AND UPLAND COTTON BLENDS

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Abstract

An important and target aspect of the fiber-to-yarn production process is the quality and price of the resulting yarn. The yarn should have optimal product characteristics, while maintaining as low a price as possible. To meet this target, Giza 85 Egyptian cotton variety, was chosen and blended with Sudanese Upland cotton (Acala) and also, with Greek Upland cotton. Ten different combinations of blend levels including the 100 % fiber types were performed for two different spinning systems, open-end yarn counts of 25 Ne and 35 Ne and also, 30 Ne and 40Ne for ring spinning, at constant twist multiplier 4.0.

Giza 85, Egyptian cotton variety is of higher quality than the two upland cotton varieties especially in fiber strength, length uniformity, fiber fineness, and elongation while of low spinning waste. The addition of different ratios of Giza 85 cotton fiber improved the mechanical properties of the Greek and Sudanese cotton yarns. The Uster provisional 5%, 25% and 50% yarn strength quality levels were suggested for using the Egyptian/Greek or Sudanese cotton blending, in order to achieve optimum yarn quality properties and to reduce and control the raw material cost. The spinner's cost could be reduced by trying different combinations of cotton qualities until matching the one that still allows for the required yarn properties is found.

INTRODUCTION

An important and target aspect of the fiber-to-yarn production process is the quality and price of the resulting yarn. The yarn should have optimal product characteristics, while maintaining as low a price as possible.

Cotton yarns classed internationally into three categories: (1) coarse yarns: of count up to 24s. Such counts could be spun from MS and MLS cottons, to be used for manufacturing cheap fabrics, towels, upholstery fabrics, etc.; (2) Medium yarns: of count 24 up to 42s. Such count could be spun from MLS cottons, to be used for manufacturing cheap poplins, knitting fabrics, etc.; (3) Fine yarns: of count 42 up to 60s and above. Such counts could be spun from LS and ELS cottons, to be used for manufacturing high quality poplins and clothes, Abdel-Salam (1998). Blending of two or more different fiber types is of crucial significance to the textile industry, Cookson

(2000) reported that several interrelated factors might contribute to the decision to replace a homogeneous textile material by a blend:

- Economy: The decrease of an expensive fiber by blending with a cheaper one.
- Durability: The incorporation of a more durable component to extend the useful life of a less durable fiber.
- Physical properties: A compromise to take advantage of desirable performance characteristics contributed by both fiber components.
- Color: The ability to develop novel designs incorporating multi-color effects.
- Appearance: The attainment of attractive appearance and tactile qualities using combinations of yarns with, for example, different luster.

Fiber blending is the process of combining different fiber components, together either of the same fiber type or of different fiber types to produce a fiber strand (sliver or yarn) of consistent desirable characteristics. The economical impact of fiber blending is well recognized. The cost of raw material is the most important economical factor in the make of a spun yarn. The smallest saving in the cost of raw material could mean a substantial increase in the company's profit. Proper fiber blending can lead to a substantial reduction in the cost of yarn manufacturing. A textile process may use different types of cotton with different quality attributes and prices. The process of fiber blending should aim at optimizing the cost of the cotton mix with respect to the desired levels of fiber properties and inventory constraints, El Mogahzy (2000).

One of the important production processes in the textile industry is the spinning process. Starting with cotton fibers, yarns are (usually) created on a rotor or ring-spinning machine. The quality of the resulting yarn is very important in determining their possible applications. The three most important characteristics of a yarn are: tenacity, elongation and corresponding price. The first two characteristics are physical yarn characteristics, while the third is the price of producing the yarn. The price depends on the blend of fiber qualities used in the fiber-to-yarn production process, van Langenhove (2002).

Karapinar and Erdem (2003) reported that the rapid development in the textile industry has also caused some of the physical properties of cotton fibers to become more important. It could be stated that the following main factors affect the yarn properties: Fiber properties, and Process parameters: yarn count and yarn twist; blend ratio (1st fibre/2nd fiber); re-used waste fibers; waste that is removed (short fiber ratio), preparation processes: machinery (types and adjustments); spinning systems (types and adjustments)

According to the international cotton yarn classification, both Long Staple and Extra-Long Staple Egyptian cottons fall in the category of Extra-Fine count, i.e. that group of cottons that could be spun into yarn count of 45s and higher. Mohamed et al (2005) reported that the major problem and challenge facing the Egyptian cotton textile industry is that Egyptian cotton has two distinct markets: the international market for producing fine and extra fine yarns and the domestic market for producing mainly coarse and medium count yarns.

The textile industry in Egypt, needs cheaper cotton to cover the demand of the domestic market i.e. coarse and medium yarn counts. So, there is a cotton gab especially MLS cottons in this respect, the Textile Industries Holding Company in Egypt supply Greek and Sudanese MLS cottons to close this gab to produce coarse and medium counts for local consumptions. Furthermore, the produced and exported yarn count level in the Egyptian spinning mills is around 28.5s, as much as 10-15 percent higher or lower using the Long-staple cotton varieties, Table 1 (Textile Industries Holding Co.(2006) and Textile consolidation fund, 2006).

Table 1. Development of exported cotton yarn count-wise from 1994: 2006

Count-wise	Average from 1994 - 1996			Average from 2004 - 2006		
	Ton	Count average	%	Ton	Count average	%
Less than 20s	14093	16.6	21.4	7227	14.57	23.3
21s – 30s	30112	29	45.9	9117	29	29.7
31s – 40s	13169	37	19.4	4663	37.7	15.1
41s – 50	1896	49	3.0	2177	48.7	7.0
Total L S cotton	59270	28.2	89.7	23185	28.2	75.1
51s – 60s	13000	58.7	4.9	2343	58.3	7.6
61s – 70s	1030	68	1.7	653	68.7	2.2
71s – 80s	1777	77.7	2.5	2184	76.9	7.2
81s – 90	267	85	0.4	622	85.2	2.1
From 91s and above	376	95.7	0.58	1715	100.4	5.8
Total E L S cotton	6449	68.3	10.3	7553	76.3	24.9
Total exported cotton yarns	65719		100			100

The objective of this investigation was to study the quality characteristics of yarn spun from Egyptian cotton and its blends with Upland cottons to create an optimum quality yarns, and the usefulness of blending Egyptian/Upland cottons as a potential way of reducing the costs of popular fabrics.

MATERIALS AND METHODS

The present study was carried out in Kom-Hamada, El Mahmoudia and Mit Ghamr spinning and weaving companies and Cotton Research Institute. Giza 85 Egyptian cotton variety (A) was chosen due to its color parameters and fiber length, and blended at different ten blend ratios for both Greek upland cotton (E) and Sudanese cotton (J). Cottons A, E and J were processed individually and carded at 3.54 g/m card sliver. Different Blend ratios were made at drawing frame with eight doubling to form six batches of second-drawing sliver of 3.20 g/m. The slivers of ten different blendes were supplied to the Schlafhorst Auotocoro 288 OE rotor spinning at rotor speed of 110,000 rpm for producing 25Ne and 35Ne and for producing 1.2 Ne roving for ring spinning at yarn size of 30 Ne and 40Ne. both OE and ring yarns were spun at constant twist multiplier 4.0.

Table 2. Processing outline

	Blending ratios and symbols							
Blends	A 100% G. 85 / 0% Gr. cotton				F 100% G. 85 / 0% Acala cotton			
	B 75% G. 85 / 25% Gr. cotton				G 75%G. 85 / 25% Acala cotton			
	C 50% G. 85 / 50% Gr. cotton				H 50%G. 85 / 50% Acala cotton			
	D 25% G. 85 / 75% Gr. cotton				I 25%G. 85 / 75% Acala cotton			
	E 0% G. 85 / 100%Gr. cotton				J 0% G. 85 / 100%Acala cotton			
Spinning system	Ring		Open-End		Ring		Open-End	
Yarn count	30s	40s	25s	35s	30s	40s	25s	35s
Twist multiplier	4.0							

Cotton fiber and yarn properties were determined according to ASTM method by using HVI Spectrum and Micromat. Yarn strength expressed in terms of Lea Count Strength Product (LCSP) was measured by using the Good-Brand Lea Tester. Single yarn properties and yarn uniformity, imperfections and hairiness were measured on Textechno Statimat Me tensile tester and Uster Tester III, respectively. The results were compared with the Uster provisional 5%, 25% and 50% quality levels (Zellweger Uster, 2001). Fiber and yarn properties were determined at the Cotton Technology Research Laboratories, Cotton Research Institute, Giza, Egypt.

RESULTS AND DISCUSSION

Fiber properties

Table 3 shows the quality properties of Egyptian cotton Giza 85, Upland Greek cotton and Acala Sudanese cottons. Naturally, the fiber quality of Egyptian cotton variety is higher than the two upland cotton varieties mainly, in fiber strength, fiber length, length uniformity, fiber fineness, fiber elongation and especially in short fiber index which reached in some samples of Greek and Acala cottons reached to 18.0 % accompanied by the lowest length uniformity, being 79%.

Table 3. Fiber quality properties of Giza 85, Greek and Acala cottons

	Giza 85	Greek Cotton	Acala Cotton
Upper Half Mean mm.	30.2	27.8	26.5
Uniformity Index (%)	86.5	82.3	82.1
Short fiber index	7.8	13.8	15.5
Strength cN/Tex)	40.8	31.7	28.8
Elongation (%)	6.7	6.4	5.8
Micronaire value	4.0	4.0	4.1
Maturity	93	91	91
Fineness	141	172	175
Reflectance Rd%	74.4	73.4	74.2
Yellowness +b	9.3	9.3	9.5

Mechanical properties

The lea count strength product, single yarn strength and elongation of open-end and ring yarns spun from Giza 85 and its blends with Greek and Sudanese cottons are given in Tables 4, 5, 6 and 7. The results indicated statistical significant difference in lea count strength product and single yarn strength means of all blended open-end and ring yarns. Giza 85 cotton variety recorded the highest and superior quality of lea count strength product and single yarn strength (cN/Tex), while as, Greek and Sudanese cottons showed the lowest yarn quality. In both spinning systems and yarn counts, the addition of different ratio of Giza 85 cotton fiber improved the mechanical properties of the Greek and Sudanese cottons. The fact that long and strong fiber produced strong yarn held true for the two spinning systems used in this study.

In all cases, LCSP and single yarn strength decreased linearly as yarn numbers become finer, this is clear in both open end and ring spun yarns, for instance yarn tenacity of 25s open end and 30s ring yarns were significantly higher compared to 35s open end yarns and 40s ring yarns respectively.

In open-end yarns, the variation analysis, a statistical difference revealed between the tenacity values of 25s and 35 yarns. Therefore, the tenacity values of the 25s yarns were higher than those of the 35s yarns. On the other hand, the tenacity values of the 30s ring spun yarns were higher than those of the 40s yarns.

For a given cotton blend, the ring yarns were stronger than the open-end yarns. Comparing yarn strength of the different blends of Giza 85 with Greek and Sudanese cottons, cotton B produced the strongest yarns, followed by cotton C, D, G, H and then cotton I regardless the spinning system used. The same trend was found among the combinations of Giza 85 and Sudanese cottons, indicating that yarn strength increased as the percentage of Giza 85 increased in the blend with both Greek and Sudanese cottons.

The study of the effect of short fiber index on processing efficiency and yarn quality indicated that the increases in short fiber contents have a detrimental effect on spinning performance (end breakage) and product quality. Even though it is well known that the long fibered, stronger and more uniform (Giza 85) cotton has a definite advantage over short fibered (Greek and Acala cottons), the high price of the longer cotton prohibits its indiscriminate usage.

Since cottons of longer staple length usually have less short fiber content than the shorter ones. Short fibers are generally immature, and weak fibers, it would appear that blending long cotton with short ones would reduce the short fiber content, resulting in increased spinning performance.

Coarse and medium yarns produced from Egyptian cotton are not economical due to high cost of raw material used in such cases. Regarding to the data mentioned above, the spinning industry in Egypt should blend high and low quality cottons to reduce and control the cost, as well as to meet functional use requirements.

Regarding to yarn strength which is the most important yarn character and determines the yarn quality and price in all markets, the spinning mills or the yarn consumers can determine the yarn quality level which they need according to the Uster provisional yarn quality levels, consequently yarn strength of the different blends of Egyptian cotton and Upland cottons as shown in figures 1, 2, 3, 4,5,6,7 and 8 could be helpful to determine the required blend. Any spinning mill primarily thinking in input "raw material cost and price" / output "yarn quality and price" system. In this regard, the best input (raw material cost and quality) situation is achieved when quality is at is highest possible level and price is at its lowest possible level. On the other hand, the best output (yarn quality and price) is achieved when quality is at its highest possible level and price is correspondingly high (from a spinner viewpoint). This is the only way to accomplish profit in the spinning industry.

Unevenness and imperfections properties

Regarding yarn C.V. %, the obtained data indicated that the yarns produced from 100% Giza 85 are more uniform than those produced from Upland cottons. The different blends of Giza 85 and Upland Greek and Sudanese cottons produced more uniform yarns than 100% Upland cottons and less uniform yarns than Giza 85. Moreover, yarn C.V. % increased as the percentage of Upland cotton increased in the blend regardless the spinning system. On the other hand yarn C.V.% for the blends obtained from Sudanese cotton was lower (more uniform) than for the Greek cotton blends regardless yarn count and spinning system. However, the open end yarns were more uniform than the ring ones regardless the blend ratio and yarn count. The unevenness of the Upland yarns and their blends could be due to its high short fiber content and lower length uniformity. It is already known that short fibers are poorly controlled by roller drafting at ring spinning and tend to stay in aggregates, which results in defects in the yarn. Such defects can be responsible for breaks at spinning and contribute to yarn unevenness. Thus, the decrease in unevenness of both Open-End and Ring blended with regard to a ratio increase in Upland in Egyptian cotton in the blend can be emphasize this parameter.

Abdel-salam 1972, in his research work noted that short fibers had a negative effect on the yarn unevenness values.

Yarn nep count showed inversed trend compared to yarn C.V.% being higher in Giza 85 yarns than in Upland cotton yarns. Moreover, nep count increased as the percentage of Giza 85 increased in the blend.

Open end yarns showed lower number of neps compared with ring spun yarns. Moreover, the coarse counts 25s open end and 30s ring showed lower number of neps compared to the finer ones, 35s open end and 40s ring yarns.

Generally, open-end spun yarns have a coefficient of variation value lower than that ring spun yarns. The improvement in unevenness of open-end spun yarns is generally ascribed to the higher number of doublings taking place inside the rotor.

The overall picture of the data presented in Tables 4-7, indicated that it is possible to blend up to 50% of Giza 85 lint with 50% Greek or Sudanese cottons without any pronounced decrease in lea count strength product, single yarn strength and unevenness values weather spun at open-end and ring spinning at different yarn counts under study.

Table 4. Mechanical properties for O-E yarns of Giza 85/Greek blends.

	25 Ne			35 Ne		
	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)
Egyptian cotton/Upland Greek blends						
A	2100	16.56	7.3	2015	15.74	7.1
B	1965	15.24	7.6	1940	14.92	6.8
C	1875	14.64	7.1	1830	14.33	6.6
D	1800	13.10	6.8	1795	13.00	6.8
E	1660	12.65	6.7	1650	12.23	6.5
L.S.D at 0.05% level	49.08	1.15	0.14	50.87	1.13	0.1

Table 5. Mechanical properties for O-E yarns of Giza 85/Acala blends.

	25 Ne			35 Ne		
	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)
Egyptian cotton/Acala Sudanese blends						
F	2100	16.57	7.3	2015	15.71	7.2
G	1935	14.45	7.1	1930	14.35	6.8
H	1855	13.43	6.5	1815	13.25	6.4
I	1750	13.00	6.1	1700	12.24	6.1
J	1600	12.17	6.7	1550	11.16	6.4
L.S.D at 0.05% level	56.18	1.42	0.12	49.88	1.65	0.13

Table 6. Mechanical properties for ring yarns Giza Giza 85/Greek blends.

	30 Ne			40 Ne		
	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)
Egyptian cotton/Upland Greek blends						
A	2880	20.65	6.4	2655	19.65	6.3
B	2685	19.10	6.3	2480	18.11	6.3
C	2535	17.65	6.3	2360	16.76	6.3
D	2310	16.15	6.3	2035	15.13	6.3
E	2135	14.64	6.2	1875	14.15	6.3
L.S.D at 0.05% level	65.12	1.37	N.S.*	64.43	2.15	N.S.

N.S. : non significant

Table 7. Mechanical properties for ring yarns Giza 85/Acala blends.

	30 Ne			40 Ne		
	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)	LCSP	Yarn tenacity (cN/Tex)	Yarn elongation (%)
Egyptian cotton/Acala Sudanese blends						
F	2880	20.15	6.4	2655	19.65	6.3
G	2655	18.87	6.4	2085	18.54	6.2
H	2465	17.74	6.4	1995	17.30	6.1
I	2245	15.33	6.4	2020	14.88	6.1
J	2090	14.65	6.4	1800	13.76	6.1
L.S.D at 0.05% level	65.45	1.54	N.S.*	63.34	2.11	N.S.

N.S. : non significant

Table 8. Unevenness and neppiness values for O-E yarns Giza 85/Greek blends.

	25 Ne		35 Ne	
	Unevenness (C.V.%)	No. of nep	Unevenness (C.V.%)	No. of nep
Egyptian cotton/Upland Greek blends				
A	11.21	44	11.90	68
B	12.75	36	13.70	50
C	13.09	30	13.70	38
D	13.02	23	14.12	33
E	13.18	22	14.42	22
L.S.D at 0.05% level	0.50	8.76	0.53	9.11

Table 9. Unevenness and neppiness for O-E yarns Giza 85/Acala blends.

	25 Ne		35 Ne	
	Unevenness (C.V.%)	No. of nep	Unevenness (C.V.%)	No. of nep
Egyptian cotton/Upland Greek blends				
F	11.21	44	11.90	68
G	13.21	36	13.88	62
H	13.71	28	14.86	50
I	13.60	27	14.72	46
J	13.83	19	14.90	37
L.S.D at 0.05% level	0.54	8.98	0.60	9.54

Table 10. Unevenness and neppiness for ring yarns Giza 85/Greek blends.

	30 Ne		40 Ne	
	Unevenness (C.V.%)	No. of Neps	Unevenness (C.V.%)	No. of Neps
Egyptian cotton/Upland Greek blends				
A	14.45	83	15.39	97
B	15.22	72	16.34	77
C	15.81	64	17.71	45
D	16.03	52	17.90	41
E	16.99	45	18.31	33
L.S.D at 0.05% level	0.53	10.22	0.47	11.43

Table 11. Unevenness and neppiness for ring yarns Giza 85/Acala blends.

	30 Ne		40 Ne	
	Unevenness (C.V.%)	No. of Neps	Unevenness (C.V.%)	No. of Neps
Egyptian cotton/Upland Greek blends				
F	14.45	88	15.39	97
G	15.48	78	16.56	73
H	16.38	77	17.75	48
I	16.99	64	17.92	43
J	17.63	45	18.55	36
L.S.D at 0.05% level	0.49	9.76	0.54	10.65

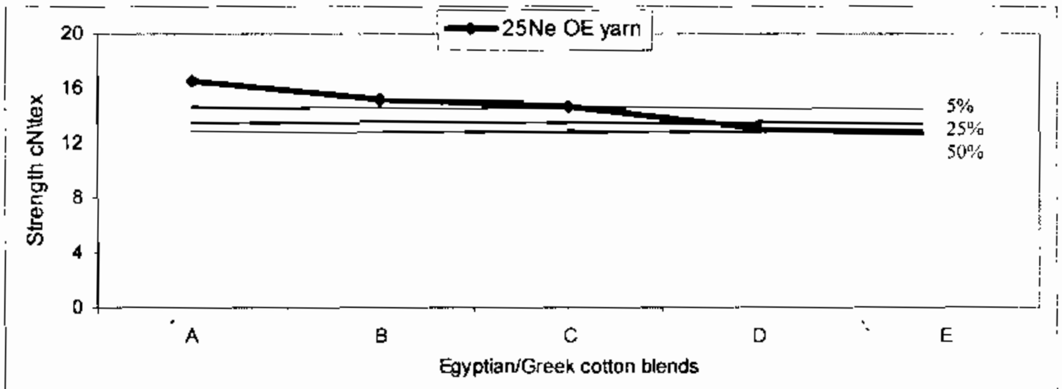

Fig 1: 25Ne OE yarn strength as compared with Uster provisional 5%, 25% and 50% levels

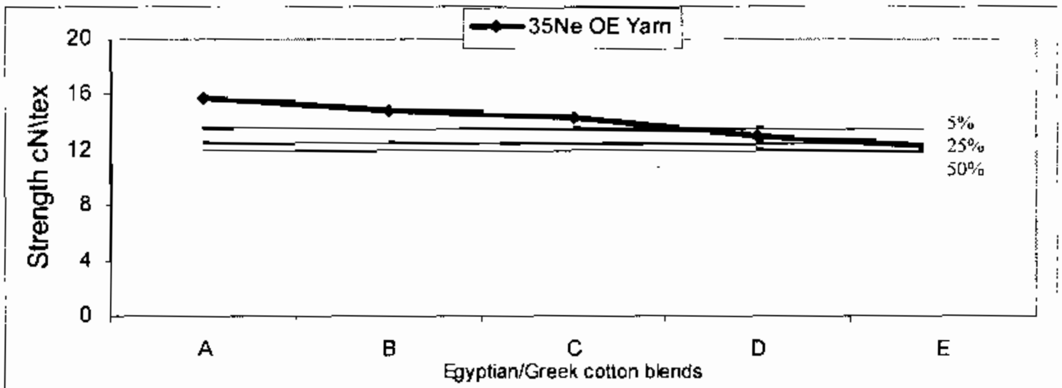

Fig 2: 35Ne OE yarn strength as compared with Uster provisional 5%, 25% and 50% levels

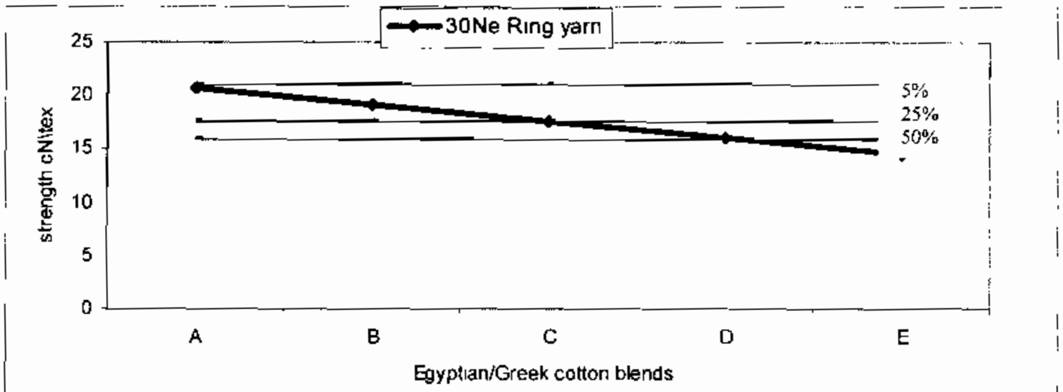

Fig 3: 30Ne ring yarn strength as compared with Uster provisional 5%, 25% and 50% levels

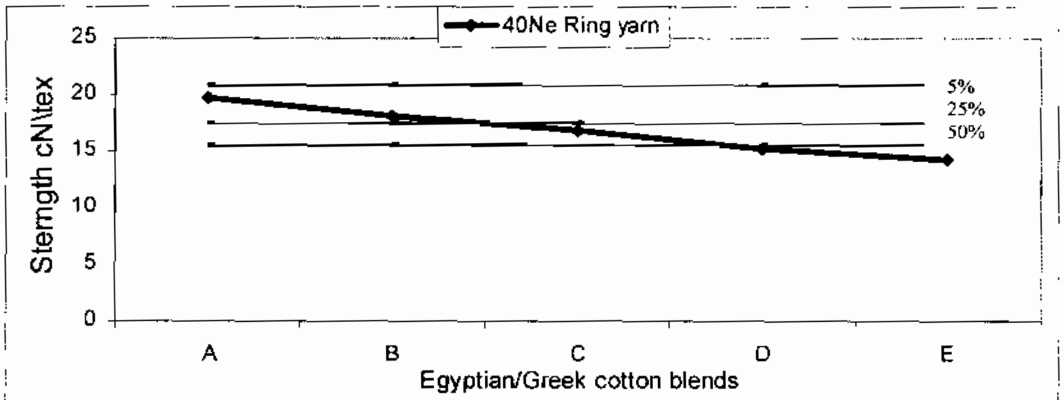

Fig 4: 40Ne ring yarn strength as compared with Uster provisional 5%, 25% and 50% levels

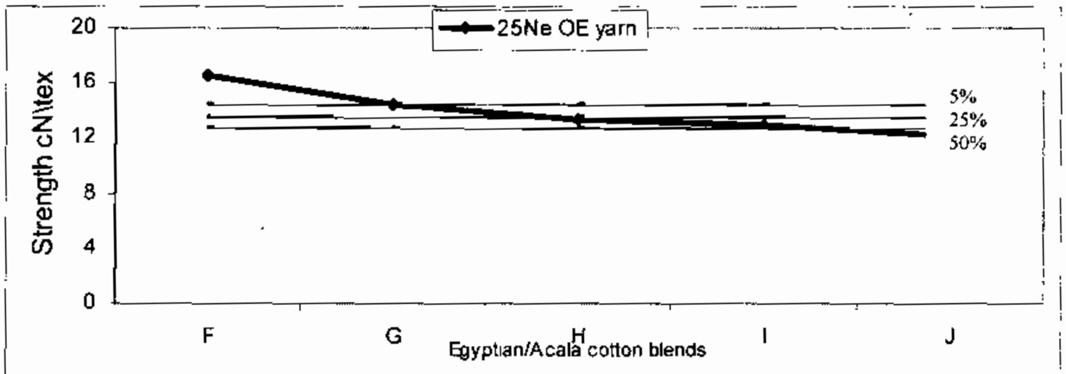

Fig 5: 25Ne OE yarn strength as compared with Uster provisional 5%, 25% and 50% levels

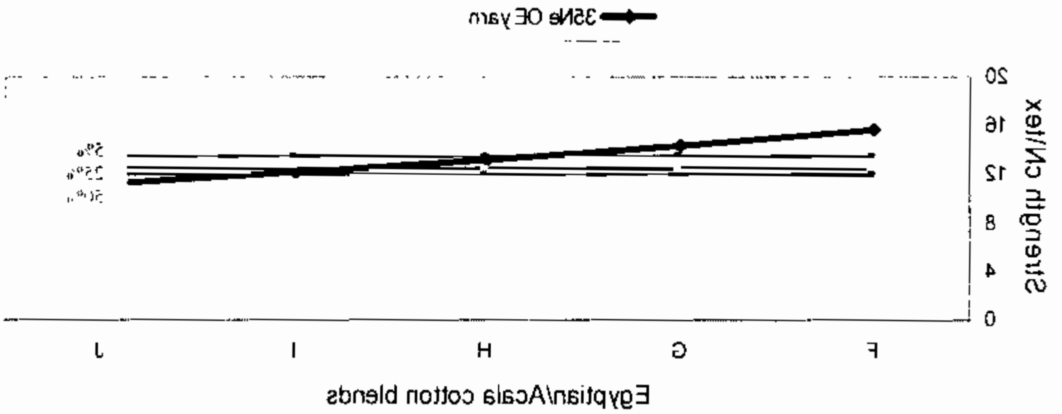

Fig 6: 35Ne OE yarn strength as compared with Uster provisional 5%, 25% and 50% levels

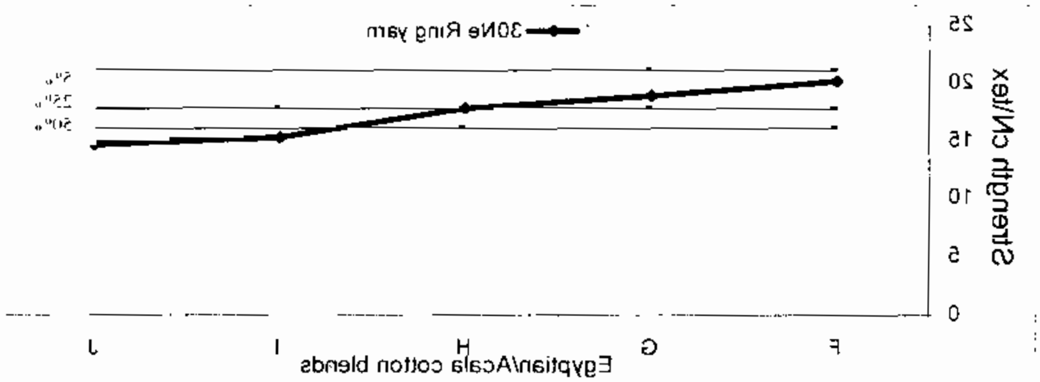

Fig 7: 30Ne ring yarn strength as compared with Uster provisional 5%, 25% and 50% levels

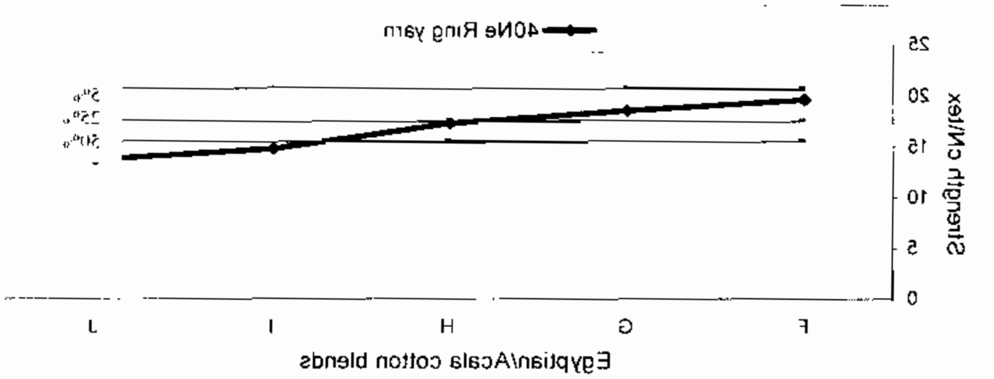

Fig 8: 40Ne ring yarn strength as compared with Uster provisional 5%, 25% and 50% levels

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خواص جودة خيوط غزل الطرف المفتوح والحلقى لخلطات الأقطان المصرية مع أقطان الأبلند

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١. *معهد بحوث القطن – مركز البحوث الزراعية – الجيزة*

٢. *الشركة المساهمة لتصدير الأقطان*

إن المحدد الرئيسي والهدف من عمليات تحويل شعيرات القطن إلي خيوط هى جودة وسعر الخيط الناتج. و يجب أن تشتمل الخيوط على خواص الجودة المطلوبة مع الحفاظ على اقل سعر ممكن. وحتى نصل لهذا الهدف تم إختيار صنف القطن جيزة ٨٥ لخلطه مع القطن السودانى (اكالا) وايضا خلطه مع القطن اليونانى. وقد تم إنتاج عشر خلطات بنسب مختلفة للقطن المصرى مع كلا من القطن السودانى واليونانى وتم غزلها على نظامى غزل الطرف المفتوح على نمرة ٢٥ و٣٥ انجليزى و على نظام الغزل الحلقى على نمرة ٣٠ و ٤٠ بمعامل برم ثابت "٤,٠" لكلا النظامين. كما تمت مقارنة النتائج المتحصل عليها بمستوى جودة يوستر العالمية لمتانة الخيط عند نسب ٥% ، ٢٥% و ٥٠%.

صنف القطن المصرى جيزة ٨٥ كان أعلى جودة من الصنفين الابلند وخاصة فى صفات متانة الشعيرات ونسبة انتظام طول الشعيرات والاستطالة كذلك نسبة العادم. بزيادة نسبة شعيرات الصنف جيزة ٨٥ فى الخلطات تم تحسين الخواص الميكانيكية والفزيائية لكل من خيوط القطن اليونانى والسودانى والخلطات المقترحة للاستخدام تبعا للجودة المثلى لجودة يوستر العالمية لخواص الخيوط هى التى تقابل متطلبات العميل من حيث الجودة وتقابل متطلبات المصنع من حيث التكلفة.