

PRODUCING YARNS FROM BLENDS OF CARD WASTES, RECYCLED FABRIC AND MEDIUM QUALITY COTTON

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ABSTRACT

This investigation was conducted to produce open end rotor yarns from blends of card wastes, recycled fabrics and Giza 90 low grade FGF cotton in the spinning mill of North Africa Spinning Company El Sadat city, El Menoufea Governorate, Egypt. The card waste and recycled fibers couldn't be spun to 6 Ne rotor yarns. Five blends of Giza 90 virgin fibers and these waste and recycled materials, at different blending ratios, were spun successfully to 8 Ne, 10 Ne and 12 Ne open-end rotor yarns. Fiber and yarn quality measurements were determined. Giza 90 virgin fibers showed better length, length uniformity and tenacity with lower short fiber content compared to card waste and recycled materials although of its low grade. The results indicated that blending Giza 90 virgin fibers improved fiber and yarn quality of the blend specially when the ratio of Giza 90 increased in the blend. 75% Giza 90/ 25% card waste or recycled fibers blends showed higher yarn strength and lower yarn CV% and lower number of imperfections compared to the other blends while 33% Giza 90/ 33% card waste/ 33% recycled fibers showed the lowest level of these yarn quality levels.

Key words: *recycled fabric, blends of card wastes, cotton.*

1.INTRODUCTION

Recycling is a way to process the used materials (waste) into new products to prevent waste of potentially useful materials. It reduces the consumption of fresh raw materials, energy usage, air pollution, water pollution, and land pollution Sharma and Joel (2017). Recycling textile waste can be further converted into the form of fiber for filling, recycled yarns, recycled woven and non woven fabrics (Yukesekkaya *et al.* 2016). Textile waste can arise at different production stages such as fibers, sliver, yarn and fabrics. Moreover, the used fabrics can be opened into fibers that could be used to produce products such as Knitwear, woven fabric and yarns cover clothes, blankets, towels, shirting, underwear, carpet, industrial roller cloth, electric cabling and in manufacturing of asbestos yarns and regenerated fibers (Saravanan ,2011).

Textile waste recycling becomes more important due to the continuously rising costs of natural and synthetic fibers, energy, and labor. As natural resources decrease, public awareness of recycling increases rapidly. The textile industry generates large amounts of waste with high potential for recycling therefore; a special

market has formed for recycling of textile materials (Tereschenko,2012).

During the recycling procedure, harsh mechanical and / or chemical processes are applied to textile materials .In mechanical processing, fabric wastes are torn into individual fibers in tearing machines by harsh mechanical effects, while in case of chemical processing; thermoplastic waste materials are melted at high temperature. Both mechanical and chemical recycling could cause deterioration in physical and chemical properties of recycled materials (Bartolome *et al.*, 2012 and Cornier, 2003).

The studies about blending recycled (recovered) fibers quality, cleaning behavior and processing of these materials are essential to deal with textile waste. In this concern, Babak and Safdar (2013) indicated that blending is used as a means of substituting a less expensive fiber for a highly priced one and to produce yarns with qualities that cannot be obtained by using one type of materials alone. Recovered raw materials can be blended with virgin cotton fibers either at blowroom or at draw frame. Generally, it is said that the earlier blending of fibers gives better blending. Furthermore, Stephan and Kuschel (1995) stated that

recovered fibers from cotton waste can be used to produce blended yarns (cotton waste/ virgin fibers) in different portions. They added that the evaluation of recovered fibers characteristics enables the spinner to determine the optimum blend of (cotton waste/ virgin fibers), how to optimize machine setting in view of fiber/machine interaction and how to eliminate quality problems before they appear in the final product. Wulfhorst (1984) concluded that up to 20% of recycled fibers can be blended with primary raw material without noticeable changes in the tenacity of the produced yarns. It is common in rotor spinning system to produce useful yarns from recycled fibers in different blend ratios with virgin materials. The blend ratio depends on the targeted yarn quality, raw material quality, machine running conditions and the total cost of the spun yarns (Nityanand ,1984). El nouby and Kamel (2007) reported that yarn tenacity, yarn elongation and yarn regularity of the recycled spun yarns decreased as the percentage of recycled fibers increased in the blend. Furthermore, Halimi *et al.* (2009) and Khan *et al.* (2015) found that higher percentage of virgin cotton in the blend always increase yarn strength, they added that homogeneity in blending is necessary to get higher yarn strength and low yarn imperfections.

Therefore, the main objectives of this research work was to study producing cheap open end rotor spun yarns from blends of recovered fibers, textile waste and virgin cotton fibers and studying the effect of blending ratio, and yarn count on the produced yarn strength, elongation, irregularity and imperfections

2. MATERIALS AND METHODS

The present study was carried out in the spinning mill of North Africa Spinning Company at El-Sadat city, Elmenofea Governorate, Egypt, using samples of fully good fair (FGF) lint grade of Giza 90 Egyptian cotton variety, card waste (flat strips from carding machines during processing in the spinning mill) and fibers obtained from recycled fabrics. Card waste and recycled fibers were obtained from the aforementioned company.

Giza 90 is used as virgin cotton to be a carrier and improving fiber and yarn quality when blending with card waste and fibers from the recycled fabrics under the following levels of blend proportions:

50% Giza 90 / 50 % card waste

50% Giza 90 / 50 % fibers from recycled fabrics

75 % Giza 90 / 25% card waste

75% Giza 90 / 25% fibers from recycled fabrics

33.3 % Giza 90 / 33.3% card waste / 33.3 fibers from recycled fabrics

100 % Giza 90 FGF (control)

Fiber quality properties of samples from the different raw materials and their blends were tested using Uster HVI Spectrum system at the labs of Fiber Research Department, Cotton, research Institute according to ASTM standard test method (D 5867 – 05) to obtain the following fiber quality measurements: upper half mean length (UHML) in mm., length uniformity index % (UI %), short fiber index % (SFI%), the tensile strength (g/tex), fiber elongation %, micronaire value (Mike), maturity ratio (MR) and trash area %.

Blending of the different materials was carried on the drawing frame in the first passage by using number of card slivers of each material to get the targeted blending ratio. Another drawing passage was used to improve the homogeneity of the blend. The linear density of card and draw slivers was 5.5 ktex. The second draw slivers were used to produce the rotor spun yarns. Ritter rotor spinning machine was used to produce 8s, 10s and 12s yarn counts from the different blends. Rotor diameter was 55 mm, rotor speed was 77000 rpm at 5.5 twist multiplier.

Yarn strength and elongation % of the spun yarns were tested by the USTER TENSORAPID according to Uster Manual (2001). Yarn irregularity and imperfections (neps, thin places and thick places) were determined using USTER tester 3 according to Uster Manual (2001). All yarn tests were carried out at the labs of El Seouf Spinning & Weaving Company in Alexandria. All fiber and yarn tests were carried under controlled temperature ($20\text{ C} \pm 2$) and relative humidity ($65\% \pm 2$).

The obtained data were computed and subjected to statistical analysis as proposed by Snedecor and Cochran (1981) using SAS anova statistical analysis in completely randomized design with four replications. The LSD test at 5% level was employed to compare the different means.

3. RESULTS AND DISCUSSION

3.1. Fiber quality of the different materials and blends

Subjecting the data of fiber quality measurements represent the different materials and blends to ANOVA statistical analysis

revealed significant differences at 5% level between means of fiber quality measurements of Giza 90 (FGF), card waste, recycled fabric fibers and their blends. Data in Table (1) and Fig. (1) illustrates the different means of fiber quality measurements.

Although of its low grade, Giza 90 (virgin fibers) showed longer fibers (28.2 mm), more length uniformity (83.5 %) having lower short fiber index (8.5 %), having higher fiber tenacity (33.1 g / tex) and elongation (8.1 %) compared to card waste, recycled fabric fibers and their blends. Card waste recorded the least fiber length (18.4 mm), the least length uniformity (70.1 %) and the lowest tenacity (22.0 g / tex), while showed the highest short fiber Index (17.8 %) and the highest trash area as well (1.41 %). Recycled fabric fibers showed longer fibers than the card waste (21.5mm), higher length uniformity (73.5 %) and higher tenacity (24.6 g/tex) with lower short fiber index and fiber elongation than card waste but lower in all of these traits than Giza 90. These results indicated that card waste showed the lowest level of fiber quality among the studied materials.

Regarding the different blends, the results cleared that; fiber length, length uniformity and fiber tenacity increased and short fiber index

decreased when the portion of Giza 90 fibers increased in the blend. Moreover, the blends contain Giza 90 and recycled fabric fibers were higher fiber quality than those consisted of Giza 90 and card waste under the same blending ratio. On the other hand, the blend 33% Giza 90/ 33% card waste and 33% recycled fabric fibers exhibited the lowest levels of fiber quality compared to the other blends. Elnouby and Kamal 2007, Halimi *et al.*, (2009) and Khan *et al.* (2015) reported similar conclusions.

Since the objective of this research work was to study producing cheap open end rotor spun yarns from blends of recovered fibers, textile waste and low grade virgin cotton fibers (FGF). Besides studying the effect of blending ratio, and yarn count on the produced yarn strength, elongation, irregularity and imperfections, it is worthy to report that 8 Ne, 10 Ne and 12 Ne blended yarns were successfully spun from these blends, which could be considered a successful attempt to get more added values to these materials. Whilst, card waste and recycled fabric fibers failed to be spun to open end yarns even when processed to 6 Ne yarn count, it led to very high number of ends down and could not run smoothly during processing.

Table (1): Means of fiber quality measurements for the different materials and their blends.

Fiber properties Materials & blends	Mike	MR	UHM mm	UI%	SFI%	Tenacity g/tex	Elonga- tion %	Tras h area
Giza 90 (FGF)	3.80	0.88	28.20	83.5	8.5	33.1	8.1	0.96
Card waste	3.70	0.86	18.40	70.1	17.8	22.0	7.8	1.41
Recycled fabric fibers	4.20	0.90	21.50	73.5	14.9	24.6	6.8	0.52
50% G90 / 50% Card waste	3.80	0.87	24.10	77.5	13.7	27.5	8.0	1.30
50% G90/ 50% Recycled fabric	4.00	0.90	25.00	80.0	12.5	28.5	7.3	0.76
75% G90/ 25% Card waste	3.80	0.88	26.10	80.5	10.1	30	7.9	1.00
75% G90 / 25% Recycled fibers	3.90	0.90	26.50	81.1	9.8	31.0	7.5	0.80
33% G90 / 33% Card waste / 33% recycled fibers	3.90	0.88	23.10	77.0	13.0	28.0	7.70	0.98
LSD 5%	0.12	0.04	0.46	1.12	0.73	0.88	0.53	0.16

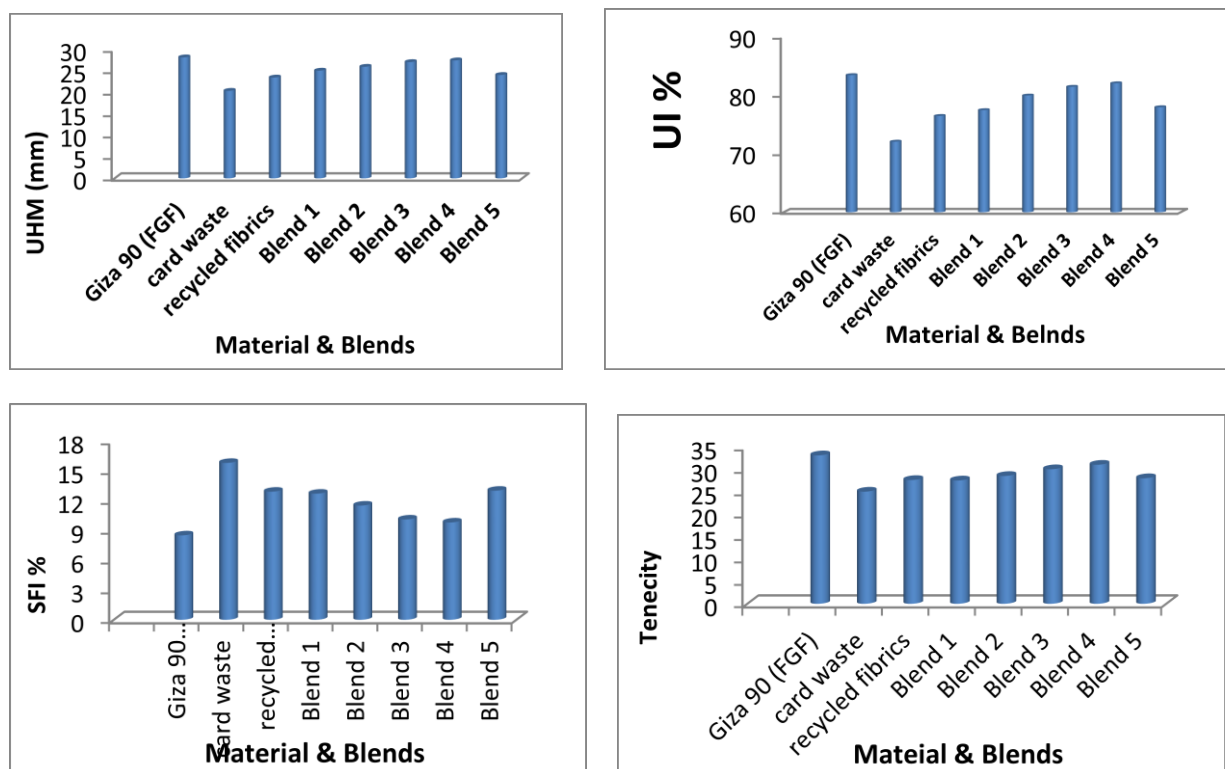


Fig.(1): Fiber quality measurements for the different materials and their blends.

3.2. Effect of blend ratio and components on yarn quality of the spun yarns

Data concerning the effect of blending ratio and its components on yarn quality properties are shown in Table (2) and 3 and illustrated in Fig. (2). The analysis of variance indicated that blend ratio and its components affected significantly most of the studied yarn quality properties. The obtained results led to the following conclusions:

The virgin fibers of Giza 90 produced yarns having higher strength, elongation and lower yarn cv% (more uniform) and contain lower numbers of yarn imperfections; neps, thin and thick places than all the blends although of its low grade (FGF).

Comparing yarn quality properties of the different blends of Giza 90 / card waste and / or recycled fabric fibers, data in Tables (2 and ,3) illustrated in Fig.(2) cleared that 75% Giza 90/ 25% card waste and 75% Giza 90/ 25% recycled fabric fibers showed insignificant differences in yarn strength, yarn elongation, yarn CV% but both of them produced yarns of higher quality levels as compared to the other blends. The recorded means of these yarn properties for the two mentioned blends were:

10.6 and 11.0 g/tex for yarn strength, 8.07 and 7.8% for yarn elongation and 14.23% and 14.07 for yarn CV%. Moreover, the blends 50% Giza 90 / 50% card waste and 50% Giza 90 / 50% recycled fabric fibers showed significant differences in yarn strength being 8.94 and 9.64 g/tex, respectively, while, showed insignificant differences in yarn elongation and yarn CV% to be, 7.47 and 7.27% for elongation and being, 16.07 and 15.57% for yarn CV%.

The blend of 33% Giza 90/ 33% card waste/ 33% recycled fabric fibers showed the least yarn strength, the least yarn elongation and the highest yarn CV% to be 8.81 g/tex , 6.40% and 16.57% for the three yarn properties respectively. Concerning yarn imperfections; neps, thin and thick places, data in Table (3) and Fig. (2) revealed that all the blends of card waste and recycled fibers with Giza 90 virgin fibers showed significant high number of yarn imperfections, furthermore, the number of these imperfections increased as the ratio of the card waste and/or the recycled fabric fibers increased in the blend. Giza 90 virgin fibers showed the least number of these yarn imperfections, regardless of its low grade, it averaged 179.3,

Table (2): Strength, elongation and CV% for the yarns spun from blends of Giza 90, card waste and recycled fabric fibers.

Yarn qualit Materials and Blends	Yarn tenacity g/tex			Mean	Yarn elongation %			Mean	Yarn unevenness (C.V%)			Mean
	Ne 8	Ne 10	Ne 12		Ne 8	Ne 10	Ne 12		Ne 8	Ne 10	Ne 12	
50% G90 / 50% Card waste	9.4	8.8	8.6	8.94	7.6	7.4	7.4	7.47	15.8	16.1	16.3	16.07
50% G90 / 50% Recycled fibers	10.2	9.9	8.9	9.64	7.4	7.2	7.2	7.27	15.3	15.6	15.8	15.57
75% G90 / 25% Card waste	11.2	10.7	9.9	10.60	8.3	8.1	7.8	8.07	14.0	14.2	14.5	14.23
75% G90 / 25% Recycled fibers	11.6	10.9	10.5	11.00	8.0	7.8	7.8	7.87	13.8	14.1	14.3	14.07
33% G90 / 33% Card waste / 33% Recycled fibers	9.1	8.7	8.6	8.81	6.6	6.3	6.3	6.40	16.2	16.8	16.7	16.57
Giza 90 (FGF)	13.4	12.8	12.6	13.02	8.2	8.0	7.9	8.03	13.2	13.6	13.6	13.47
Mean	10.8	10.3	9.86	10.34	7.68	7.47	7.40	7.52	14.7	15.07	15.2	14.99
LSD% Blends				0.48				0.38				0.55
LSD% Count				0.42				0.32				051
LSD% Blends x count				0.61				0.57				077

Table (3): Number of imperfections; neps, thin and thick places for the yarns spun from blends of Giza 90, card waste and recycled fabric fibers.

Yarn properties Materials & blends	Neps / 1000m			Mean	Thin places / 1000m			Mean	Thick places / 1000m			Mean
	Ne 8	Ne 10	Ne 12		Ne 8	Ne 10	Ne 12		Ne 8	Ne 10	Ne 12	
50% G90 / 50% Card waste	340	396	285	340.3	86	91	90	89.0	231	243	248	240.7
50% G90 / 50% Recycled	293	289	299	293.7	81	88	85	84.7	220	231	240	230.3
75% G90 / 25% Card waste	229	235	268	244.0	65	70	70.	68.3	196	210	207	204.3
75% G90 / 25% Recycled	216	227	245	229.3	60	64	66	63.3	178	180	180	179.3
33% G90 / 33% Card waste / 33% Recycled fibrics	354	378	360	364.0	100	100	110	103.3	240	271	273	261.3
Giza 90 (FGF)	190	173	175	179.3	44	50	50	48.0	131	135	135	133.7
Mean	270.3	283	272	275.1	72.7	77.2	78.5	76.1	199	211.7	213.8	208.8
LSD% Blends				17.1				6.6				18.7
LSD% Count				12.4				5.7				15.8
LSD% Blends x Count				21.5				8.8				22.6

,48.0 and 133.7 for the number of neps, thin places and thick places whereas the highest number of these imperfections was shown by the yarns of the blend 33% Giza 90/ 33% card waste/ 33% recycled fabric fibers, being 364, 103.3 and 258.3 for the number of neps, thin and thick places respectively.

Percentage of decrease in yarn quality spun from the different blends compared to Giza 90 ranged from 15 % to 35% in yarn strength, while

ranged in yarn elongation from 0 to 20% while the increase in yarn CV% (more unevenness) ranged from 4 to 15%. The highest decrease in percentage of decrease in yarn quality was obtained from the blend of 33% Giza 90/ 33% card waste/ 33% recycled fabric fibers, whereas the least decrease in yarn quality was obtained from 75% Giza 90 / 25% recycled fabric fibers regardless the yarn count. It is clear that adding different portions of Giza 90 low grade virgin

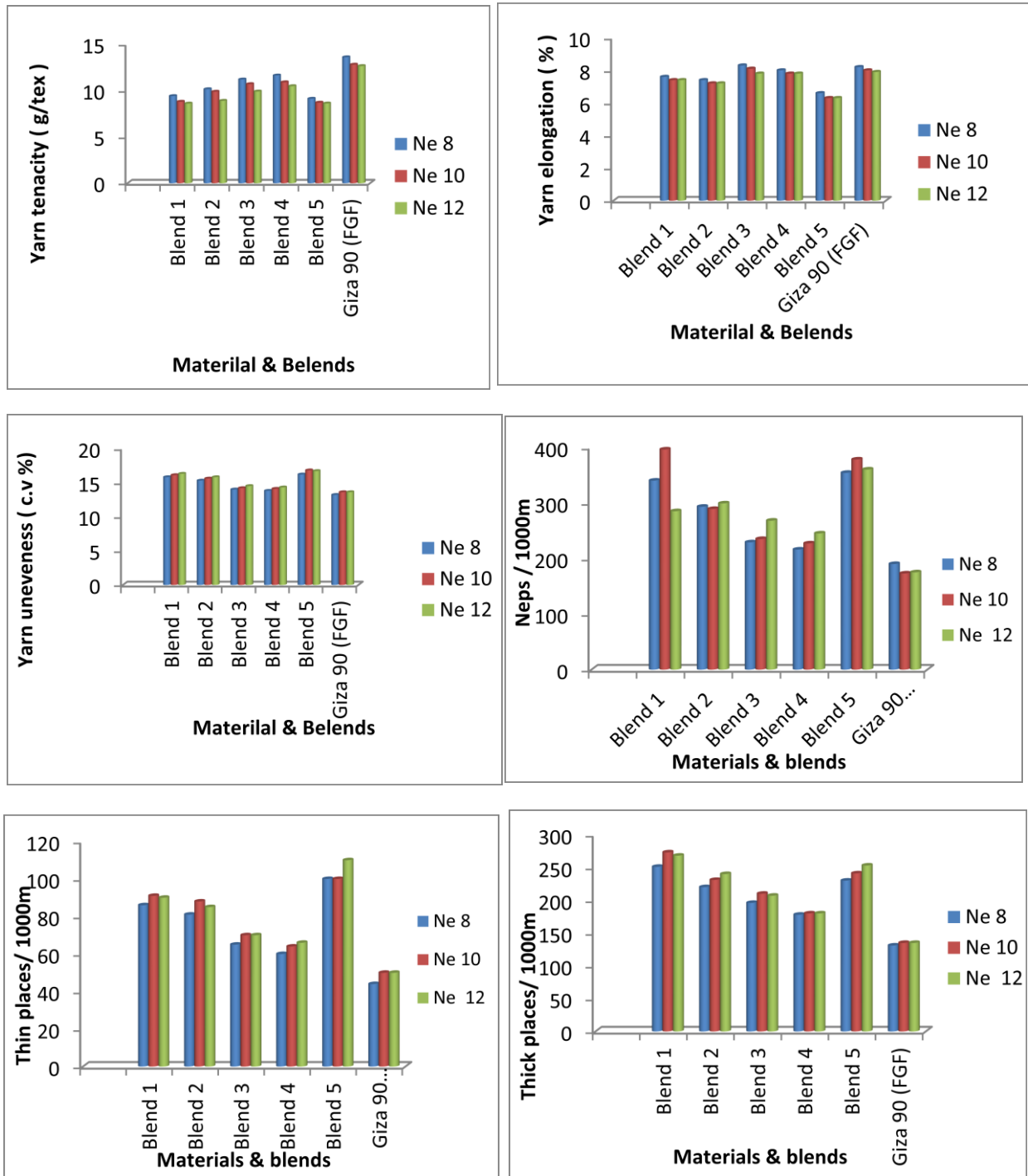


Fig.(2): Strength, Elongation, Yarn C.V%, Neps, Thin and Thick places for the yarns spun from blends of Giza 90, card waste and recycled fabric fibers.

fibers improved fiber quality and enabled producing coarse open end rotor yarns from these low quality materials with acceptable quality specially when the portion of the virgin fibers increased in the blend which could be considered a successful attempt to get more added value to these waste materials and to decrease the costs of the produced yarns since the wastes and recycled fibers are cheaper compared to the virgin fibers. Nityanand (1984), Stephan and Kuschel (1995), Elnouby and Kamal (2007), Halimi *et al* (2009) and Khan *et al.*(2015) came to similar findings and conclusions.

3.3. Effect of yarn count on the quality of Giza 90, waste and recycled blended yarns

It is well known that yarn strength, elongation and regularity decreases as the yarn count goes finer due to many factors specially the number of fibers in yarn cross section, twist, the setting of processing machines and fiber quality of the processed materials, in this concern data of yarn quality shown in Table (2) revealed that yarn strength, showed significant difference between 8 Ne yarn count and 12 Ne count only whereas the differences in yarn strength between 8 Ne and 10 Ne and between 10 Ne and 12 Ne were not significant in most cases. Yarn elongation % did not show a specific trend to be high or low according to yarn count. On the other hand the differences in Yarn CV% and yarn imperfections number were not statistically significant in most cases which could be due to the narrow range in the spun yarn counts being 8, 10 and 12 Ne. Sief (1984) and Arafa (2009) reported that yarn count affected significantly most of yarn quality.

Conclusion

Card waste and recycled fabric fibers could not be spun successfully to open end yarns even when decreasing the yarn count to 6 Ne, while adding portions of Giza 90 low grade virgin fibers (FGF) to form blends with these waste and recycled fibers enabled producing 8 Ne, 10 Ne and 12 Ne open end rotor yarns with acceptable quality levels specially when the portion of Giza 90 was higher in the blend. The spun yarns are suitable to be used in manufacturing jeans and medium quality products. Fiber and yarn quality of the blends increased as the ratio of the virgin fibers of Giza 90 increased in the blend.

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إنتاج خيوط من خلطات من عوادم التسريح وخامات معاد تدويرها مع قطن متوسط الجودة

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معهد بحوث القطن – مركز البحوث الزراعية – الجيزة – مصر

ملخص

أجري هذا البحث لدراسة إنتاج خيوط غزل من عوادم التسريح وألياف من أقمشة معاد تدويرها بخلطها بنسب مختلفة بالألياف متوسطة الجودة من رتبة فوللي جود فير من الصنف جيزة 90. تم اعداد خمسة خلطات بنسب مختلفة من الخامات المذكورة وإنتاج خيوط علي عدود 8 ، 10 ، 12 انجليزي بمصنع الغزل ذو الطرف المفتوح بشركة شمال أفريقيا للغزل بمدينة السادات – محافظة المنوفية في عام 2017. وقد تم تقدير صفات جودة التيلة للخامات المختلفة وخطاتها بجهاز HVI بمعامل معهد بحوث القطن بالجيزة كما تم تقدير صفات جودة خيوط الغزل بمعامل شركة السيوف للغزل والنسيج بالأسكندرية .

■ لم يمكن غزل عوادم التسريح والألياف المعاد تدويرها حتي عندما نقص العد الي 6 إنجليزي
■ كانت ألياف جيزة 90، رغم إنخفاض رتبتهأ أعلي في طول التيلة 28.4 مم وانتظام الطول 83,5% ومثانة التيلة 33.1 جم/تسك وأقل في معامل الشعيرات القصيرة 8.5% من عوادم التسريح التي سجلت 18.4 مم ، 70.1% ، 22.0 جم/تسك ، 17.8% لهذه الصفات. بينما سجلت الألياف المعاد تدويرها 21.5 مم ، 73.5% ، 24.6 جم/تسك ، 14.9% للصفات المذكورة علي الترتيب .

■ ترتب علي وجود ألياف جيزة 90 في الخلطات تحسين واضح في كل صفات جودة التيلة والخيوط المغزولة منها وقد زاد مقدار هذا التحسين بزيادة نسبة ألياف جيزة 90 في الخلطات.

■ تميزت الخلطتان 75% جيزة 90 / 25% عوادم تسريح ، 75% جيزة 90 / 25% ألياف معاد تدويرها بأعلي صفات جودة التيلة وأعلي مائة غزل (10.6 ، 11.0 جم/تسك) وأقل معامل إختلاف للخيوط (14.2 ، 14.1%) وأقل في عدد العيوب بالخيوط (المناطق الرفيعة والسميكة والعقد) بالمقارنة بباقي الخلطات، بينما كانت الخلطة 33% جيزة 90 / 33% عوادم تسريح / 33% ألياف معاد تدويرها الأقل في صفات جودة الخيوط الناتجة منها

■ زادت مثانة الغزل وانتظامية الخيوط وقل عدد العيوب في العد الأخشن 8 إنجليزي عنها في العد الأنعم 12 لأنه نظرا لضيق المدى بين العدود المغزولة فإن الفروق في معظم صفات جودة الخيوط لم تكن معنوية بين خيوط العد 8 والعد 10 وبين خيوط العد 10 والعد 12.

■ أمكن بعملية خلط ألياف الرتبة المنخفضة من جيزة 90 مع عوادم التسريح وألياف الأقمشة المعاد تدويرها إنتاج خيوط غزل بصفات جودة مقبولة تناسب الكثير من المنتجات والمنسوجات كالجينز وغيرها مما يعد تعظيما لإستخدام هذه الخامات وتقليل تكلفة إنتاج هذه الخيوط.

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