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Comparison of Quality Characteristics of Yarns Spun from Aegean Cotton Fibres and Their Mixtures with South-East Anatolian Cotton Fibres

Abstract
Cotton fibre properties show differences according to their region of cultivation, which are caused by the use of various kinds of cottonseeds as well as differing climate conditions. Therefore, the blending and yarn spinning processes of cotton fibres from crops harvested in different regions should be carried out under control, and the blend ratios should be selected in order to ensure the optimum yarn quality properties. Otherwise, the variations existing in fibre properties will also cause variations in yarn properties. In Turkey, some South-East Anatolian (GAP) cotton fibres are transported to the Aegean region and are blended with cotton fibres from this region. Such a situation causes some problems for textile manufacturers. In this study, the differences between the properties of Aegean and GAP cotton fibres and the changes in yarn quality as an effect of blending these two sorts have been estimated. As a result, the quality characteristics of produced yarns such as the structural properties (yarn count, yarn twist), the unevenness properties (CV% values, thin and thick places, neps, hairiness) and the physico-mechanical properties (tenacity and elongation at break) have been determined, and the results obtained statistically evaluated. We wish to draw this study to the attention of producers and textile manufacturers.

Key words: *yarn quality, blending, fibre properties, Aegean cotton, South-East Anatolian cotton.*

Introduction

The Turkish textile industry has developed quickly, especially during the 1950s and 1960s, and has made Turkey one of the most powerful textile countries in the world market. With the effect of GAP[1], Turkey became the sixth biggest cotton producing country in the world [1]. In Turkey, cotton is mostly produced in the Cukurova, South-East Anatolian, Antalya and Aegean regions. With the development of the GAP project, the cotton-planting area in South-East Anatolian has demonstrated the highest increase in Turkey. For this reason, the cotton fibres produced in the GAP Region are of great importance. In recent years, as a result of this development, investments in this region have been made especially into cotton yarn spinning, and more and more new plants are beginning to process cotton yarn.

The quality of raw material is the most important feature in obtaining high-quality yarns. The raw material costs constitute over 50% of the unit cost of cotton yarn, and the yarn properties have changed with regard to raw material properties [2]. The conditions for growing cotton have a significant effect on the raw material quality. When cotton types with different fibre characteristics are grown in various regions, the fibre quality properties also show differences with regard to growing conditions. The differences between regions, as well as the differences between cotton types, cause significant problems in producing the end-use products.

The main cotton fibre properties are length, fineness, strength and elongation. In addition to these properties, maturity and number of convolutions are also important. Furthermore, colour, the amount of trash and the humidity that the cotton fibre retains are properties which affect the cotton quality. These properties should be known in order to produce yarns and fabrics of appropriately high quality. Yarn properties change not only with respect to the raw material properties but also to the machinery that is used.

The main yarn properties which are important for yarn production are as follows:
- structural properties (yarn count, yarn twist),
- unevenness properties (CV% values of unevenness, thin and thick places, neps, hairiness), and
- physical and mechanical properties (strength, elongation).

The rapid development in the textile industry has also caused some of the physical properties of cotton fibres to become more important. It can be stated that the following main factors affect the yarn properties:
- fibre properties,
- process parameters: yarn count and yarn twist; blend ratio (1st fibre/2nd fibre); re-used waste fibres; waste that is removed (short fibre ratio),

Table 1. *Production properties of cotton fibres.*

Type	Class	Region	Ginning type	Production date
Aegean	St Beyaz (I)	Menemen	Rollergin	2001
GAP	Urfa St (I)	Sanliurfa	Rollergin	2001

Table 2. *Test methods and machinery used in determining quality properties of yarns (* Turkish Standards Institution).*

Yarn quality properties	Test method	Machinery/Equipment
Yarn count	TSE* 244	Yarn reel + USTER AutoSorter III
Yarn twist	TSE* 247	Officine Brustio Electronic Twisttester
Unevenness CV% values	TSE* 628	USTER Tester III
Number of thin places		
Number of thick places		
Number of neps		
Hairiness		
Tenacity	TSE* 245 (5 m/min)	USTER Tensorapid 3
Elongation		

Table 3. *Quality properties of Aegean and GAP cotton fibres.*

Property	Unit	Aegean cotton fibre	GAP cotton fibre
SCI	-	148	137
Micronaire	-	4.4	4.6
Bundle tenacity	cN/tex	29.8	28.6
Length	mm	29.9	30.3
Uniformity	-	84.7	84.2
Short fibre index (SFI)	-	4.1	4.5
Elongation	%	5.8	5.2
Trash (T)	-	4	5
Trash area	%	1.1	3.8
Colour degree (CG)	-	31-4	51-1
Reflexion (Rd)	-	75.1	69.2
Yellowness (+b)	-	8.9	7.3

Table 4. *Yarn count results.*

Blend		Average yarn count, tex	Standard deviation Sd	Variation CV, %
100% GAP	29.5 tex	29.2	0.223	1.11
	19.7 tex	19.7	0.493	1.64
50% Aegean-50% GAP	29.5 tex	28.9	0.209	1.03
	19.7 tex	19.4	0.543	1.78
75% Aegean-25% GAP	29.5 tex	29.7	0.250	1.25
	19.7 tex	19.6	0.441	1.46
85% Aegean-15% GAP	29.5 tex	29.2	0.194	0.96
	19.7 tex	19.6	0.340	1.13
100% Aegean	29.5 tex	29.1	0.234	1.15
	19.7 tex	19.7	0.752	2.52

- preparation processes: machinery (types and adjustments); spinning systems (types and adjustments),
- environmental factors.

The preparation processes are determined while the plant is being established, and these processes have an influence of almost the same degree throughout the production period. For example, the numbers of passages and the structure of the combed spinning process are preparation processes. Environmental factors such as temperature and humidity, as well as machinery adjustments, can also be chosen to suit the production. Yarn count and yarn twist values can also be adjusted according to our target and wish. On the other hand, the raw material properties show differences caused by growing conditions and various kinds of cotton seed, and cannot be changed in the given plant. However, variations in fibre properties cause variations in yarn properties. So, some raw material properties should be known in order to produce yarn of sufficiently high quality. If possible, the raw material should be chosen according to the end-use product [3].

Keeping these conditions in mind, the goal of this study is to determine the differences between the properties of Aegean cotton fibre and GAP cotton fibre, and to evaluate statistically the changes in yarn quality by blending these two kinds of cotton fibres. The considerations presented are intended for the benefit of yarn producers and textile manufacturers.

Material and Method

In this study, Aegean and the GAP Region cotton fibres of the 2000/01 season were used. The GAP cotton fibres included a mixture of ST 453 and Carmen cotton types, and the Aegean cotton fibres included a mixture of Nazilli 84 S, Sahin 2000 and Carmen cotton types [4].

The Aegean Region cotton fibres were provided by the Genel Cotton Ginning Plant in Izmir, and the GAP Region cotton fibres were provided by the Pure Cotton Company in Gaziantep. The classes, growing regions, ginning types and production dates of cotton fibres are given in Table 1.

Four samples were taken from each bale with respect to TS EN 12751 (Turkish Standards) to measure and evaluate the fibre quality properties. These measurements were carried out with the use of an Uster HVI 900 A apparatus.

The yarns were spun in two different counts [29.5 tex (Ne 20) and 19.7 tex (Ne 30)] and at five different blend ratios (100% Aegean, 100% GAP, 50% Aegean - 50% GAP, 75% Aegean - 25% GAP, 85% Aegean - 15% GAP) in the Izmir TARIS Yarn Spinning Plant. The analyses shown in Table 2 were made to determine the quality properties of carded yarns.

A total number of 200 yarn samples (bobbins) were evaluated in this study. Yarn twists were measured under standard atmospheric conditions by the Untwist-Retwist method. The α_e value was determined as 3.6 for both 29.5 tex (Ne 20) and 19.7 tex (Ne 30) yarns produced within the range of this research.

$$T / inch = \alpha_e \sqrt{Ne}, \text{ and}$$

$$T / m = T / inch \times [100/2.54]$$

The experiments for determining yarn properties were carried out in the laboratory of the TARIS Yarn Spinning Plant and in the Physical Testing Laboratory of the Department of Textile Engineering of Dokuz Eylul University. The results obtained after test evaluation were then compared with each other and were statistically analysed.

Results and Discussions

Fibre properties

Table 3 shows the quality properties of Aegean and GAP cotton fibres that were used in this study.

Yarn count and variation

Yarn count is an important parameter that above all affects the physical properties of yarns such as strength, elongation, unevenness and hairiness. Thus the variation in yarn count changes, the yarn cross section, yarn strength and elongation are also directly affected. The results of yarn count measurements are shown in Table 4 for 29.5 tex and 19.7 tex yarns.

Yarn twist

The measurement of result twist per metre of the yarns produced from Aegean and GAP cotton fibres and the variations in twist values are given in Table 5. Twist variation (CV%) in blended yarns of 29.5 tex and 19.7 tex was statistically the same with regard to the variation analysis of the twist variation of yarns.

Unevenness properties

Yarn unevenness is a periodical and short-term variation in yarn thickness along the yarn. Unevenness is the most important parameter that affects yarn quality [5]. Yarn unevenness is determined by unevenness (CV%) value, the number of thin (-50%) and thick places (+50%) per 1000 m of yarn, the number of neps (+200%) and hairiness. The yarn unevenness values for 19.7 tex and 29.5 tex yarns are given in Tables 6 and 7.

As a result of variation analysis, it was achieved that the unevenness CV% values of 100% GAP and 50/50% blended yarns of 19.7 tex were smaller than the others. Regarding correlations between fibre and yarn properties in cotton yarn spinning, Bozkurt [3] in his research noted that short fibres had a negative effect on the yarn unevenness values. In fact, it was measured that the GAP cottons used in our study had a higher short fibre ratio than the Aegean cotton fibres. Thus, the decrease in unevenness of the 19.7 tex blended yarns with regard to a ratio increase in Aegean cotton in the blend can be described by this parameter. The smallest unevenness value of the 29.5 tex yarn was achieved for 75/25% blended yarns, and no linear relation was found between unevenness values and the kind of blend.

In 19.7 tex yarns, the number of thin places for 100% Aegean, 100% GAP and 50/50% blended yarns was higher than the number of thin places for the other blended yarns. The number of thin places was acceptable in 19.7 tex yarns in accordance to TSE 262. In the case of 29.5 tex yarns, no statistical difference was noted among the blends considering the number of thin places.

In 19.7 tex yarns, the number of thick places for 100% GAP and 50/50% blended yarns were higher than the number of thick places for other blended yarns. According to these results, the number of thick places increases with the increase in the ratio of the GAP cotton in blends. In 19.7 tex yarns (except for 100% GAP yarns), the number of thick places was acceptable in accordance to TSE 262. In 29.5 tex yarns, the number of thick places for 100% GAP and 50/50% blended yarns were higher when compared with the number of thick places for other blended yarns. Thus, according to these results, the number of thick places in

Table 5. *Twist results of yarns.*

Blends	29.5 tex		19.7 tex	
	twist, T/m	variation CV, %	twist, T/m	Variation CV, %
100% GAP	632	3.10	788	3.09
50% Aegean-50% GAP	633	2.97	780	3.49
75% Aegean-25% GAP	638	3.11	787	2.83
85% Aegean-15% GAP	635	2.99	781	3.33
100% Aegean	630	2.67	776	3.33

Table 6. *Yarn unevenness values for 19.7 tex.*

Blends	CV, %	Thin places per 1000 m	Thick places per 1000 m	Neps per 1000 m	Hairiness
100% GAP	17.03	30.0	468.4	499.1	5.87
50% Aegean-50% GAP	17.21	31.0	441.6	488.9	6.00
75% Aegean-25% GAP	16.59	22.7	352.7	375.4	6.29
85% Aegean-15% GAP	16.72	22.6	357.7	378.7	6.01
100% Aegean	16.59	28.6	333.1	272.4	5.80

Table 7. *Yarn unevenness values for 29.5 tex.*

Blends	CV, %	Thin places per 1000 m	Thick places per 1000 m	Neps per 1000 m	Hairiness
100% GAP	14.11	1.6	145.0	155.4	7.23
50% Aegean-50% GAP	14.40	1.8	145.5	138.2	7.22
75% Aegean-25% GAP	13.68	1.2	104.7	114.1	7.16
85% Aegean-15% GAP	14.05	1.8	103.2	94.4	7.13
100% Aegean	14.27	2.8	114.6	54.5	6.76

Table 8. *The tenacity and elongation values.*

Blends	19.7 tex		29.5 tex	
	tenacity, cN/tex	elongation at break, %	tenacity, cN/tex	elongation at break, %
100% GAP	13.47	5.25	14.07	5.87
50% Aegean-50% GAP	13.31	5.40	13.91	6.17
75% Aegean-25% GAP	13.66	5.42	14.49	6.58
85% Aegean-15% GAP	13.41	5.10	14.49	6.19
100% Aegean	13.42	5.44	14.02	5.47

29.5 tex yarns increases with an increase in the ratio of the GAP cotton in blend.

In 19.7 tex yarns, the highest number of neps was achieved in 100% GAP and 50/50% blended yarns, whereas the smallest number of neps was achieved in yarns produced from 100% Aegean cotton fibres. It was seen that in 19.7 tex yarns an increase occurred in the number of neps with an increase in the ratio of the GAP cotton fibres. In the case of 29.5 tex yarns, the highest number of neps was obtained in 100% GAP yarns, whereas the smallest number of neps was in 100% Aegean yarns. In 29.5 tex yarns, the number of neps increases with an increase in the ratio of the GAP cotton fibres.

In his study, Furter [6] noted regarding the relationship between neps of roving/sliver and yarn that the number of neps decreased as the thickness of yarns increased, and that the number of neps in yarns increased as the yarns which were produced from roving including a certain amount of neps became thinner.

In 19.7 tex yarns, the smallest hairiness values were obtained from yarns produced from 100% Aegean cotton fibres. In the case of 29.5 tex yarns, the highest hairiness values were achieved in blended yarns, whereas the smallest hairiness values were achieved in 100% Aegean yarns. In 29.5 tex yarns, the GAP cotton fibres which were blended with Aegean cotton fibres negatively affected the yarn hairiness values.

One of the most important fibre parameters that affects hairiness is the amount of trash. In their study about estimation of functional relations between yarn and fibre properties, Bozkurt & Kadoğlu [7] noted that the amount of trash was the most important parameter in determining yarn hairiness following the yarn count. In this study, from the experiments carried out we established that the GAP cotton included a higher amount of trash in comparison with Aegean cotton fibres. For this reason, yarns produced from GAP cotton fibres had higher hairiness values when compared with those produced from Aegean cotton fibres.

When 19.7 tex and 29.5 tex yarns were compared with each other, the unevenness, number of thin and thick places, number of neps, and hairiness values of 29.5 tex yarns were better than those of 19.7 tex yarns.

Physical and mechanical properties

The tenacity and elongation of Aegean and GAP yarns in percent are given in Table 8. No statistical difference among the tenacity values of all blended yarns in both 19.7 tex and 29.5 tex yarns was noted with regard to variation analysis. In both yarn counts, blending the Aegean cotton with the GAP cotton had no effect on the yarn tenacity. The 75%/25% blended yarns yield the highest tenacity values for both the 19.7 tex and the 29.5 tex yarns.

At the end of the variation analysis, a statistical difference was found between the tenacity values of 19.7 tex and 29.5 tex yarns. So, the tenacity values of the 29.5 tex yarns were higher than those of the 19.7 tex yarns. Koç & Ogulata [8] noted that the number of fibres in the yarn cross-section decreases as yarn count increases (when yarns become finer), and so yarn tenacity decreases.

In 19.7 tex yarns, the elongation of 85/15% blended yarns was found to be the smallest of all the blended yarns. In the case of 29.5 tex yarns, a statistical difference among all blends by means of elongation values was stated. The highest elongation was achieved in 75/25% blended yarns, whereas the smallest was achieved in 100% Aegean yarns. However, no linear relation was found between elongation and the kind of blend.

A statistical difference was obtained in the elongation values of 19.7 tex and 29.5 tex yarns. The elongation in 29.5 tex yarns was found to be higher than the elongation in 19.7 tex yarns. Variations in yarn count affects yarn tenacity directly, since yarn count changes the yarn cross-section. In fact, the yarn tenacity value is closely related to yarn elongation. As an increase in yarn count means a decrease in yarn fineness and also a decrease in the number of fibres in the yarn cross-section, the elongation value of yarn also decreases, just like the decrease in yarn tenacity.

Conclusion

The addition of different ratios of GAP cotton fibres to Aegean cotton fibres negatively affects the yarn properties such as thin places, thick places, neps, and hairiness. This is the reason why in Turkey, although it is illegal, the GAP cotton fibres are transported from the GAP Region to the Aegean Region and blended with Aegean cotton fibres. Thus, this blending causes problems in either textile processing or in the textile end products, and in fact causes problems in exporting these textile goods. Moreover, the blending ratios of GAP cotton fibres to Aegean cotton fibres during the ginning process show differences from bale to bale. This results in yarn quality not remaining constant in the yarn spinning plants, and causes inefficiency during production.

According to the data obtained at the end of this research, if Aegean and GAP cotton fibres are to be blended during yarn spinning, the 75% Aegean/25% GAP blending is suggested for use, in ord to achieve optimum yarn quality properties.

Editorial note

1. *The South-East Anatolia Project (GAP) is a multi-sector and integrated regional development effort approached in the context of sustainable development. Its basic objectives include the improvement of the inhabitants' living standards and income levels so as to eliminate regional development disparities and contribute to such national goals as social stability and economic growth by enhancing productivity and employment opportunities in the rural sector.*

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