(REFEREED RESEARCH)

A RESEARCH ON YARN AND FABRIC CHARACTERISTICS OF ACRYLIC/WOOL/ANGORA BLENDS

AKRİLİK/YÜN/ANGORA LİFİ KARIŞIMLARINDAN ÜRETİLEN İPLİK VE KUMAŞLARIN ÖZELLİKLERİ ÜZERİNE BİR ARAŞTIRMA

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ABSTRACT

Acrylic fibers are one of the most commonly used synthetic fibers and due to its low thermal conductivity, good shape retention and durability properties, they have a large application area in knitted garment industry. Acrylic fibers are also used in blends to benefit from more prominent features of other fibers. Wool with having good wrinkle resistance, moisture absorption and warmth is a good blend material for acrylic. In order to get superior tactile properties, luxury animal fibers can also be used in acrylic blends, despite there are spinning difficulties and production limitations for these fibers. In this study, acrylic fiber and its blends with wool and Angora rabbit fiber were investigated for their yarn and fabric properties. According to the experimental results and the statistical analyses, it was concluded that, blending acrylic fiber with wool and Angora rabbit fiber, increases the CVm, thin/thick places and neps of the yarn. Yarns containing 100% acrylic and 70% acrylic/10% wool/20% angora have the highest tensile strength. In case of yarn friction coefficients, 70% acrylic /20% wool /10% angora containing yarn has the highest coefficient of yarn to pin and yarn to yarn friction values. However, 70% acrylic/30% angora and 100% acrylic yarns have lower values, supplying smoother yarn surface. 100% acrylic yarn and 70% acrylic/10% wool/20% angora yarn have the highest breaking strength values, similarly, the fabrics of these yarns have the highest bursting strength values. 70%acrylic/10% wool/20% angora fabric and 70% acrylic/30% angora fabric have the lowest circular bending rigidity, which mean that they have the softest handle.

Keywords: Acrylic fiber, Wool fiber, Angora rabbit fiber, Yarn to pin friction, Yarn to yarn friction, Bursting strength, Surface properties.

ÖZET

Akrilik lifleri yaygın olarak kullanılan liflerden birisi olup, düşük ısıl iletkenlik, iyi şekil koruma ve dayanıklılık özellikleri sebebiyle örme giysi endüstrisinde büyük bir uygulama alanına sahiptir. Farklı liflerle birlikte karışım halinde kullanılabilen akrilik lifleri için, buruşmazlık, iyi nem absorbsiyonu ve ısı tutuculuğa sahip olan yün lifi oldukça iyi bir karışım malzemesidir. Eğirme esnasında yaşanan bazı zorluklara rağmen, tekstil ürünlerine daha iyi duyusal özellikler kazandırabilmek adına lüks lifler de akrilik lifleri ile karıştırılarak kullanılmaktadır. Bu çalışmada, akrilik lifleri ile bu liflerin yün ve angora lifleri ile karışımlarından elde edilen iplik ve kumaşların özellikleri incelenmiştir. Elde edilen sonuçlar ve istatistiksel değerlendirmeler doğrultusunda akrilik lifleri yün ve Angora tavşanı lifi ile karıştırıldığında elde edilen ipliklerin CVm,, ince-kalın yer ve neps değerleri yükselmektedir. %100 akrilik ve %70 akrilik/%10 yün/%20 angora içeren iplikler en yüksek kopma mukavemeti değerine sahiptir. İplik sürtünme katsayıları açısından incelendiğinde, %70 akrilik/%20 yün/%10 angora içeren iplikler en yüksek iplik-metal ve iplik-iplik sürtünme katsayısı değerlerine sahiptir. Bununla birlikte, %70 akrilik/%30 angora ve %100 akrilik içeren iplikler, daha pürüzsüz iplik yüzeyi oluşumunu sağlayan, daha düşük değerlere sahiptir. %100 akrilik ve %70 akrilik/%10 yün/%20 angora içeren iplikler en yüksek kopma dayanımı değerlerine sahiptir. Benzer şekilde bu ipliklerden üretilmiş kumaşlarda da en yüksek patlama mukavemeti değerleri gözlenmiştir. %70 akrilik/%10 yün/%20 angora ve %70 akrilik/%30 angora içeren kumaşlar, en düşük eğilme dayanımı değerlerine sahiptir. Dolayısıyla bu kumaşlar, en yumuşak tutuma sahiptir.

Anahtar Kelimeler: Akrilik lifi, Yün lifi, Angora tavşanı lifi, İplik-metal sürtünmesi, İplik-iplik sürtünmesi, Patlama mukavemeti, Yüzey özellikleri.

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1.INTRODUCTION

Acrylic fibers are wool like synthetic fibers, which were first produced by DuPont under the trade name of “Orlon” in 1944. Other acrylic fibers developed shortly after include Acrilan (Monsanto), Dolan (Hoechst) and Dalon (Bayer). Due to the increase of application areas of these fibers, they became one of the most commonly used synthetic fibers all over the world [1,2].

75% of acrylic fibers are used in apparel, 20% in home furnishings, and 5% in industrial uses. For apparel, these fibers are used in jumpers, waistcoats, cardigans, jackets, socks, knee-high stockings, and training and jogging suits [3]. They have low thermal conductivity, good shape retention, durability, and easy-care properties. Its softness of touch and bulk makes it attractive for use in the knitwear sector. They are quick drying, resilient, retaining shape and resistant to moths, sunlight, oil and chemicals. The positive features of acrylic fibers are also apparent in blends with wool or other natural fibers [3,4].

The use of wool for clothing dates back to antiquity. Outstanding properties of it are wrinkle resistance, moisture absorption and warmth. A remarkable feature of wool is its ability to recover from deformation over a time, and this gives apparel made from these fibers attractive creaseshedding properties. Also, the rate at which the fiber takes up and disperses moisture is such that it gives clothes made from wool good comfort properties [5]. On the other hand, there are various other animal fibers, which contribute to the handle of the fabric more than wool fibers. One of the world's softest fibers comes from an animal called as "Angora rabbit" that have been used in fiber harvest for hundreds of years, and are originated in Turkey [6]. Angora rabbit fibers possess the high heat retention and best moisture-wicking properties of any natural fiber. The hairs are all medullated (hollow) which decrease their weight and increase their insulating properties [7,8].

Angora fiber has a low density of about 1.15 to 1.18 g/cm^3 compared to 1.33 g/cm^3 for wool, therefore it is very light. In addition to this, it is extremely warm, soft and silky to touch. However, since the height of the scales on fiber is very low as compared to other animal fibers, spinnability of the fibers is very poor and it is difficult to produce a fine spun yarn [6,9,10,11,12]. In addition to this, there is a constant risk of fiber shedding, since there is lack of fiber to fiber friction. Therefore, Angora rabbit fiber is usually blended with another fiber such as wool to improve its performance both in processing and fabric wearability [6].

As the literature was reviewed, it can be seen that there are several studies related to the properties of acrylic/animal fiber blends.

In the study of Mishra and Goel (2004), Angora rabbit fiber and merino wool blends were researched. According to the results, the evenness of yarn decreased with increasing proportion of Angora rabbit hair. Pure Angora rabbit yarn showed more neps and other irregularities compared to that of pure merino wool yarn. Less irregularity was found in the yarn, which has 35:65 (rabbit fiber/merino wool) blend ratio and this combination gave better performance, aesthetic appeal, appearance and low cost [13].

Marsal et al. (2009) investigated the evenness of 4 different blend yarns including acrylic /wool/mohair, acrylic/ polyamide, wool/acrylic, wool/acrylic/angora and they found the CV values as 16.95,15.27, 18.6 and 16.33 respectively [14].

In a study conducted by Park (2005) mechanical and handle properties of wool/acrylic blend knits were examined before and after repeated washing to get the optimum wool/acrylic ratio. For this purpose, 100/0, 70/30, 50/50, 30/70 and 0/100 blend ratios were used in the study. The yarns were knitted and than washed. According to the results, it was pointed out that before washing the handle properties did not change, however after washing, as the blend ratio of acrylic in the blend increased, bending property decreased proportionally, while the friction coefficient increased [15].

Onal and Korkmaz (2006) investigated the Angora rabbit fiber damages within knitted fabric structure under rubbing forces generated during Martindale pilling and abrasion tests. Lyocell and cotton fibers were blended with Angora rabbit fibers and polyamide fibers. The samples were prepared with two different twist multipliers and fiber blends. Cotton blended Angora fabrics have higher resistance to pilling than lyocell blended fabric [16].

Candan (2000) studied the effects of different yarn blends (100% wool, 50% wool-50% acrylic, 88% angora-12% nylon) and fabric constructions on the pilling tendency and other physical properties of fabrics. No significant difference was found between the pilling tendency of 100% wool fabrics and that of wool/acrylic fabrics [17].

Tvarijonavičienė et al (2004) performed a study on the yarns produced from 50% merino wool/50% acrylic and 50% cotton/50% acrylic. The tested yarns obtained after deknitting fabrics differed in their compactness. They analyzed and discussed the effect of knitting, washing procedures and tumbling in Pilling box tester on the changes in tensile characteristics of blended yarns. The washing conditions influence the tensile characteristics of tested blended yarns. After washing the elongation at break of cotton / acrylic yarns decreases in all cases of knitting conditions. The tumbling process in Pilling box tester causes deterioration in the tensile characteristics of tested wool / acrylic yarns as in washed and unwashed states [18].

As it can be seen from the literature review, there are limited studies on the blend properties of acrylic/wool/angora fibers. The aim of this study is to investigate the yarn and fabric properties of acrylic, acrylic/wool, acrylic/wool/angora and acrylic/angora blends comprehensively.

2. MATERIALS AND METHODS

The effect of blend on the yarn and fabric properties of acrylic/animal fiber compositions was searched in this study. For this purpose, acrylic, wool and angora fibers were obtained from Italy, Australia and China respectively. Properties of the fibers are summarized in Table 1.

Table 1. Measured Fiber Characteristics

Fiber Characteristics	Acrylic	Wool	Angora
Mean Fiber Length (mm)	41	38	60
CV (Fiber Length) (%)	11	15	21
Mean Fiber Diameter (μm)	12.6	21	16
CV (Fiber Diameter) (%)	11.0	18.7	29.5
Fiber Fineness (dtex)	1.24	4.46	3.50
Elongation (%)	40.5	38.4	40.4
Tenacity (cN/tex)	40.9	14.8	29.0
Density (g/cm^3)	1.18	1.30	1.12

Acrylic and animal fibers were processed together and blended in blow room and they were spun in ring spinning system (Ne 0.9 roving with 38 T/m twist, Ne 30 ring spun yarn with 800 T/m twist, spindle speed: 15.000 rpm). A special blending lubricant needed to be used to increase fiber to fiber friction and to avoid static electric problem, especially for the angora fibers, which was suggested by various researchers in the literature [10,11,12]. Since different types of lubricants give different friction values [3], a constant type of lubricant was used for all types of yarns. Blend ratios of the yarns were adjusted as given in Table 2.

Table 2. Blend Ratios of the Yarns

Yarn Code	Yarn Content
1	100% Acrylic
2	70% Acrylic/30% Wool
3	70% Acrylic/20% Wool/10% Angora
4	70% Acrylic/10% Wool/20% Angora
5	70% Acrylic/30% Angora

At the end of yarn production process, spun yarns were knitted in single jersey structures on a 28 gauge and 32" diameter circular knitting machine in the same tightness value. The knitting process was completed with constant machine settings and the samples were kept under the standard atmospheric conditions for 24 hours.

Yarn samples were tested for the following important quality characteristics. Tensile properties were measured by Zwick Z010 instrument according to ISO 2062 Standard. Yarn evenness and hairiness were measured by USTER Tester 5 according to ISO 16549. Frictional properties of the yarns were tested by Lawson-Hemphill CTT (Constant Tension Transport) tester (Figure 1a). CTT instrument is a dynamic yarn transport system with the ability to maintain a specific yarn tension and let the yarn run at any selected speed up to 360 m/min. It simulates the product performance in the testing laboratory and reduces the need to test products in the production line [19].

Yarns are in constant contact with various machine parts such as guides, tension bars, needles, reed during textile processes. During the friction test, the machine applies constant input tension and measures the change in the tension as a result of yarn to machine part interaction [20,22].

In Yarn-to-Pin Friction Test (Figure 2a), yarn is allowed to run at a certain test speed over friction surfaces such as stainless steel or ceramic pin with a specified wrap angle. The pins used in the experiment were selected as metal (steel) and the wrap angle was selected as 180° in the experiment. The test relative speed was adjusted as 100 m/min. The yarn input and output tensions are measured, and the coefficient of friction is calculated by means of Amontons'law given in equation 1 [23,24].

$$e^{\mu\theta} = \frac{T_2}{T_1} \qquad \mu = \frac{\ln (T_2/T_1)}{\theta} \qquad \text{(Equ.1)}$$

Where: μ is the coefficient of friction, T_1 is mean input tension, T_2 is mean output tension, θ=wrap angle (180°).

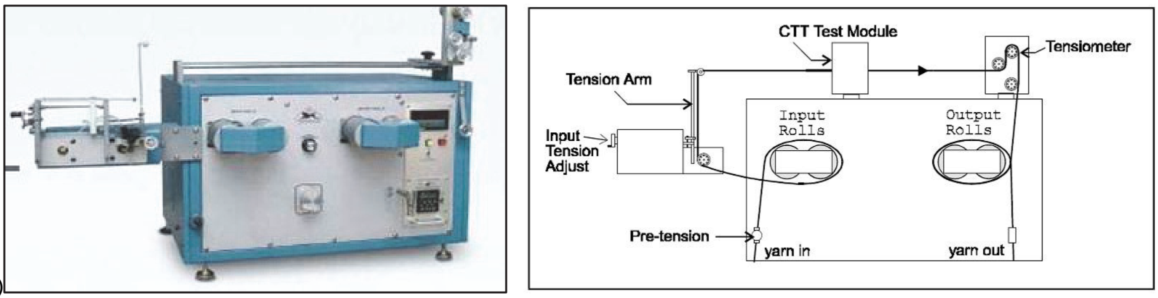
In Yarn-to-Yarn Friction test (Figure 2b), test yarn is wrapped around itself. As a result of this contact, the output tension on the yarn changes. The software calculates the coefficient of yarn friction using the input and output tension values as well as the number of wraps and Apex Angle, which is given in equation 2. Test speed was again adjusted as 100 m/min in the experiment [20,25].

$$\mu = \frac{\ln \dfrac{T_2 - \Delta T/2}{T_1 + \Delta T/2}}{2.\pi.n_\alpha} \qquad \text{(Equ.2)}$$

$$\text{where } \alpha = 2.\ \arctan\left(\frac{U}{V-W}\right)$$

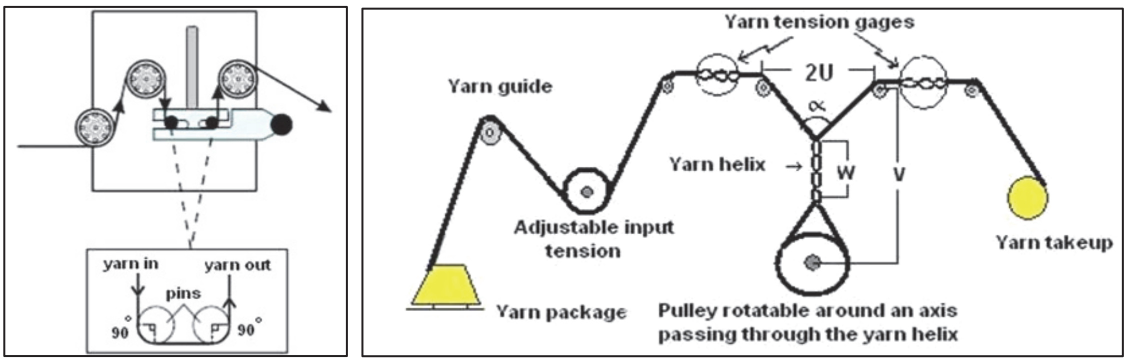
ΔT: zero twist tension (the difference value between input and output tensions with no yarn friction), n: number of wraps (2 turns), and α: apex angle (35°), W: inter twisted portion of yarn, U: the distance between the upper pulley axes, V: the distance between the lower pulley axis and a line connecting the upper pulley axes [24,25].

Fabric samples were tested for the physical properties. Thickness value was determined according to BS EN ISO 5084:1997. In order to determine the kinetic friction coefficient of the experimental fabrics, Frictorq instrument that uses the torq principle was used. Air permeability was measured according to EN ISO 9237 by using Textest FX 3300 instrument (in 20 cm^2 measurement area and 100 Pa pressure difference). Bursting strength was measured according to EN ISO 13938-1 and circular bending rigidity of the fabrics was measured according to ASTM D 4032.



(a) (b)

Figure 1.CTT Instrument (a) and its Elements (b) [20,21]



(a) (b)

Figure 2. Yarn to Pin Friction Test (a) and Yarn to Yarn Friction test (b) [23,24,25,]

3. RESULTS AND DISCUSSION

Test results were evaluated statistically by variance analysis, with the significance level of α= 0.05 to determine whether the effect of material composition has a significant effect on yarn and fabric properties. Both yarn and fabric results are given in Table 3 and Table 4. In the tables, the mean values were marked with the letters "a", "b", "c", "d" and "e". Each letter indicates a different group as subset, according to the statistical results, "a" refers to the lowest value.

3.1. RESULTS OF YARN TESTS

CV_m, USTER H (Hairiness), number of thin/thick places and neps results are given in Figure 3, Figure 4 and Figure 5 respectively. As the test results were analyzed, it can be stated that, 70% acrylic/30%wool yarn and 70% acrylic/20% wool/10% angora yarn have relatively higher CV_m value and thin/thick places and neps. This result could be related with the mean fiber diameter of wool fibers, which is higher than acrylic and angora fibers. In case of hairiness, 100% acrylic yarn has the lowest H value, while all blended yarns have more hairiness. Since fiber length variation (CV%) of angora and wool fibers are higher than acrylic fiber, animal fiber usage in the structure increases the yarn hairiness.

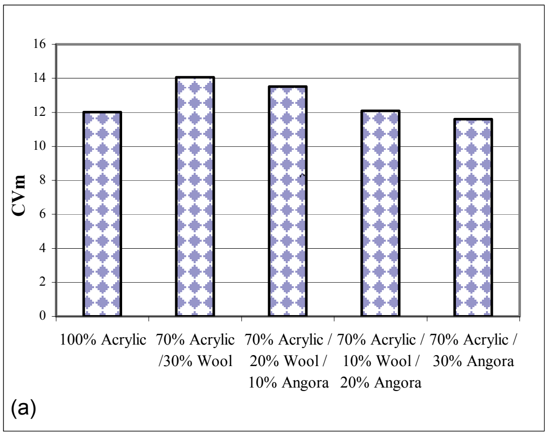
Tensile strength of the yarns are given in Figure 5b. As the results were analyzed, it can be seen that 100% acrylic and 70% acrylic/10% wool/20% angora yarns have the highest strength value, whereas 70% acrylic/30% angora and 70% acrylic/30% wool yarns have the lowest. It is thought that, this result could be mostly related with the CV_m value of the yarns. 100% acrylic and 70% acrylic/10% wool/20% angora yarns have lower CV_m value than the 70% acrylic/30% wool and 70% acrylic/20% wool/10% angora yarns, which supplied higher tensile strength. However, in case of 70% acrylic/30% angora yarn, although it has lowest CV_m, it also has the lowest tensile strength, due to the low breaking load of angora fibers, which is given in Table 1.

Table 3. Properties of the Yarns

BLEND RATIOS	CV_m	USTER Hairiness (H)	Thin Places /1000 m (-40%)	Thick Places /1000 m (+35%)	Neps /1000 m	Breaking Strength (N)	Coefficient of Yarn to Pin Friction (μ)	Coefficient of Yarn to Yarn Friction (μ)
100% acrylic	12.00 a	5.82 a	20.0 a	67.5 a	1.0 a	2.83c	0.5093 a	0.3283 a
70% acrylic-30% wool	14.05 b	6.59 b	132.50c	350.0 c	34.5 b	1.97 a	0.5470 c	0.3390 c
70% acrylic-20% wool-10% angora	13.51 b	6.40 b	85.5 b	426.5 d	60.0 c	2.17 b	0.5613 e	0.3473 e
70% acrylic-10% wool-20% angora	12.09 a	6.42 b	12.5 a	113.9 b	37.5 b	2.72 c	0.5537 d	0.3403 d
70% acrylic-30% angora	11.60 a	6.81 b	13.5 a	113.5 b	27.5 b	1.85 a	0.5130 b	0.3327 b

Table 4. Properties of the Fabrics

BLEND RATIOS	Mass per Unit Area (g/m^2)	Thickness (mm)	Air Permeability (l/m^2 s)	Bursting Strength (kPa)	Kinetic Friction Coefficient (μ)	Circular Bending Rigidity (N)
100% acrylic	149.48 a	0.55 a	843.8 c	660.84 c	0.3094 a	1.09 c
70% acrylic-30% wool	156.31 b	0.60 b	783.2 b	617.54 b	0.3328 b	0.96 b
70% acrylic-20% wool-10% angora	158.20 bc	0.64 c	760.1 b	595.02 b	0.3536 c	0.91 b
70% acrylic-10% wool-20% angora	160.11 cd	0.65 c	735.2 b	642.52 c	0.3497 c	0.76 a
70% acrylic-30% angora	162.16 d	0.65 c	643.0 a	489.28 a	0.3317 b	0.71 a



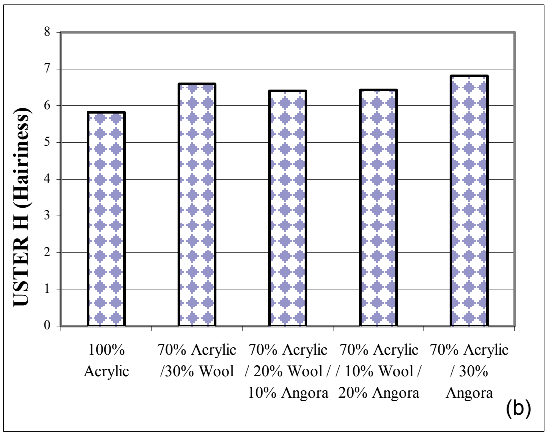


Figure 3. Uster Tester 5 CV_m Values (a) and Hairiness (b) Values of the Yarns

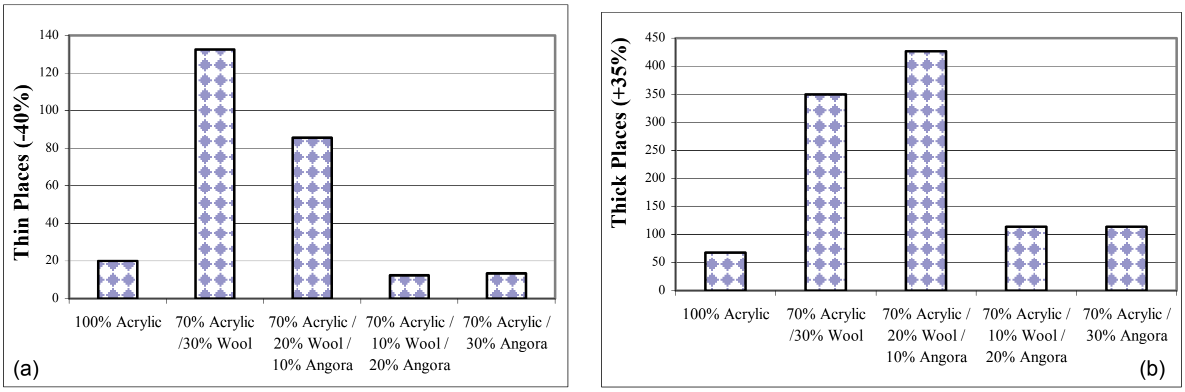


Figure 4. Uster Tester 5 Thin Places (-40%) (a) and Thick Places (+35%) (b) Values of the Yarns

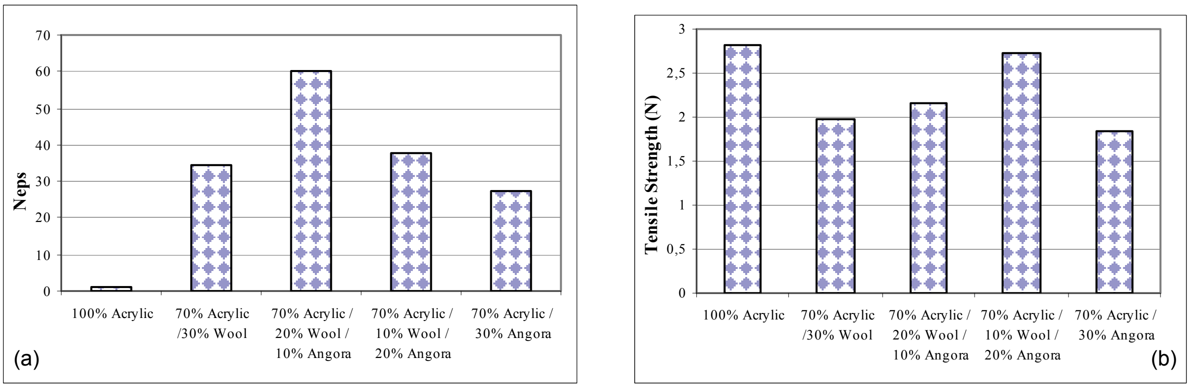


Figure 5. Uster Tester 5 Neps (a) and Tensile Strength (b) Values of the Yarns

Yarn friction is an important property with respect to the running behavior of a yarn in post-spinning processes. In addition to this, it affects the surface structure of yarn and fabrics, which is also related to the tactile characteristics of the fabric [3].

As the yarn to pin and yarn to yarn friction coefficient values, which are given in Figure 6 were evaluated, it was determined that they change in the same tendency. 70% acrylic /20% wool /10% angora yarn has the highest pin friction and yarn to yarn friction coefficient values, due to its high CV_m, number of thick places and neps. 70% acrylic/30% angora and 100% acrylic yarns, having lower CV_m values have relatively lower pin and yarn to yarn friction coefficients, which supply smoother yarn surfaces. The relationships between the results of the USTER Tester 5 and yarn friction coefficients were examined. Pearson correlation coefficients were calculated and given in Table 5.

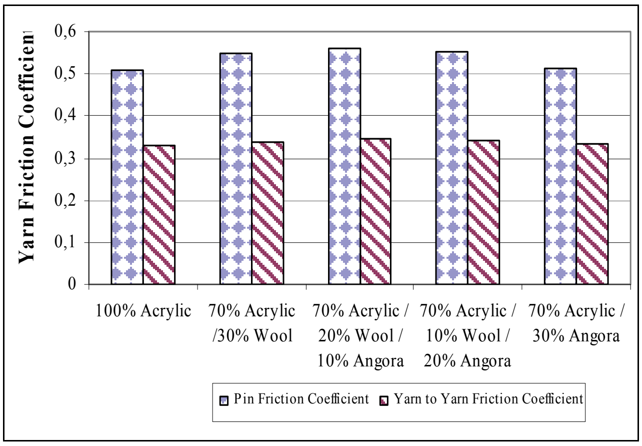


Figure 6. Coefficients of Yarn to Pin and Yarn to Yarn Friction

Table 5. Pearson Correlation Coefficients between USTER Tester Variables and Pin and Yarn to Yarn Friction Values of the Yarns

	Coefficient of Yarn to Pin Friction	**Coefficient of Yarn to Yarn Friction Coefficient**
YARN PROPERTIES		
CVm	0.627*	0.508*
USTER H (Hairiness)	0.136	0.191
Thick Places /1000 m	0.700*	0.667*
Neps/1000 m	0.802*	0.846*
Thin Places /1000 m	0.539*	0.410**
FABRIC PROPERTIES		
Fabric Kinetic Friction Coefficient	0.785*	0.787*

** Correlation is significant at the 0.01 level (2-tailed), **Correlation is significant at the 0.05 level (2-tailed).*

According to the results, it can be seen that, there are correlations between yarn friction coefficients and USTER variables, such as CV_m, thin-thick places and neps. The highest correlation coefficient was calculated for the number of neps. Although it was defined that the protruding yarn hairs prevent full contact between yarn and metal surface and caused lower friction coefficients, the correlations between friction coefficients and hairiness were found insignificant for the investigated yarns [3].

3.2. RESULTS OF FABRIC TESTS

Results for the dimensional properties of the fabrics are given in Figure 7a. According to the values, it can be deduced that, blending acrylic fiber with animal fibers increases the thickness and weight of the fabrics. It is due to the increased yarn hairiness depending on the increased animal fiber content.

Bursting strength values are given in Figure 7b. As it can be seen from the results, bursting strength of the fabrics generally change in the same tendency with yarn breaking strength values given in Figure 5b. 100% acrylic and 70% acrylic/10% wool/ 20% angora containing yarn have the highest breaking strength values; similarly the fabrics of these yarns have the highest bursting strength values. The correlation between these parameters is significant and the correlation coefficient which was found as "0.751" indicates the high correlation (Table 6).

As the air permeability results were analyzed, it was observed that, 100% acrylic fabric has the highest air permeability value, while 70% acrylics/30% angora containing fabric has the lowest. Air permeability decreases, with the increasing thickness and fabric weight (Figure 8a).

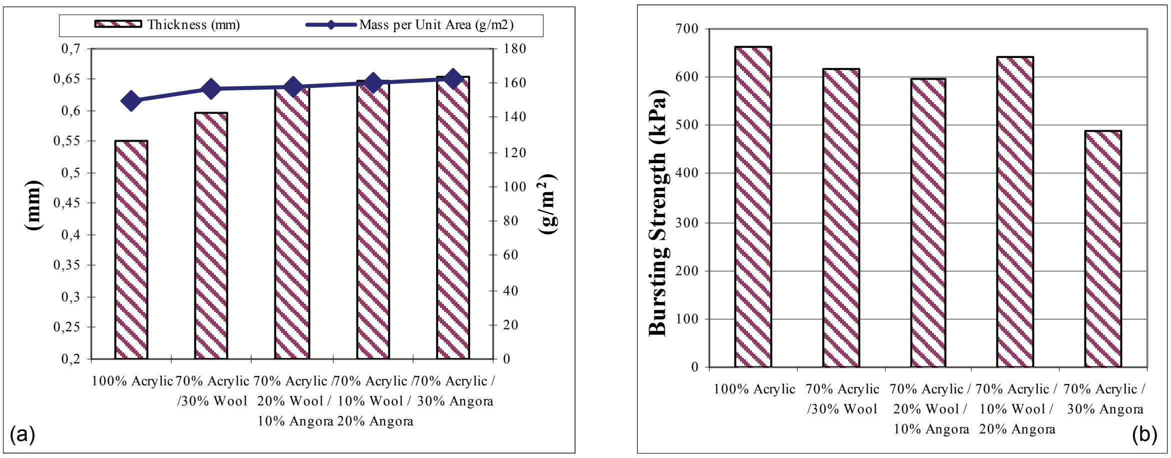


Figure 7. Dimensional Properties (a) and Bursting Strength (b) of the Fabrics

Table 6. Pearson Correlation Coefficients between Yarn Breaking Strength and Fabric Bursting Strength

PARAMETER	Fabric Bursting Strength
Yarn Breaking Strength	0.751*

**Correlation is significant at the 0.01 level (2-tailed)*

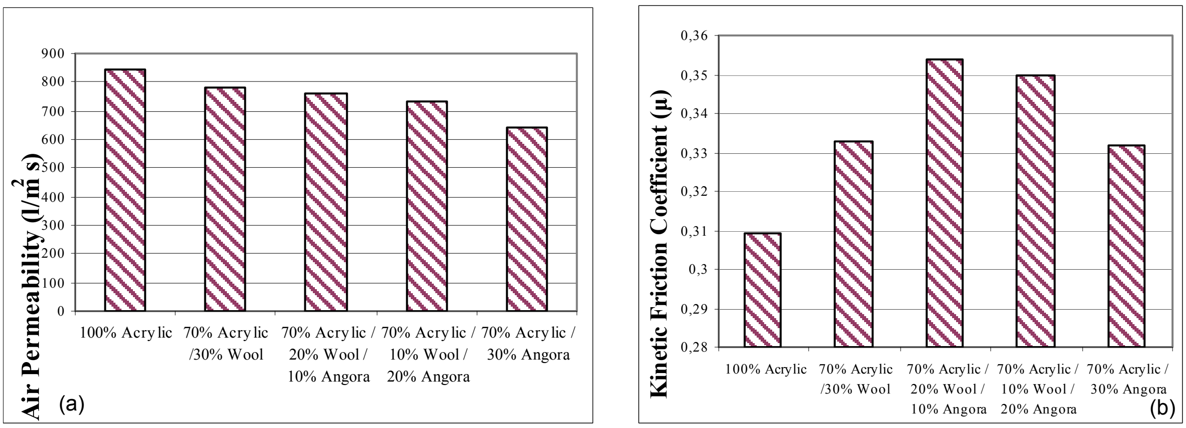


Figure 8. Air Permeability (a) and Kinetic Friction Coefficient (b) of the Fabrics

In case of fabric kinetic friction coefficient, fabrics containing triple blends have the highest kinetic friction coefficients (Figure 8b), which also have the highest yarn to pin and yarn to yarn friction coefficients. However, 100% acrylic fabric has a significantly lower kinetic friction coefficient, which was knitted from a yarn having the lowest pin and yarn to yarn friction coefficients. Pearson correlation analysis also confirmed this result. Correlation coefficient between yarn and fabric friction coefficients was found statistically significant at the 99% confidence level and the high correlation coefficient (>0.78), given in Table 5 indicate the strong relationship between yarn and fabric friction coefficients.

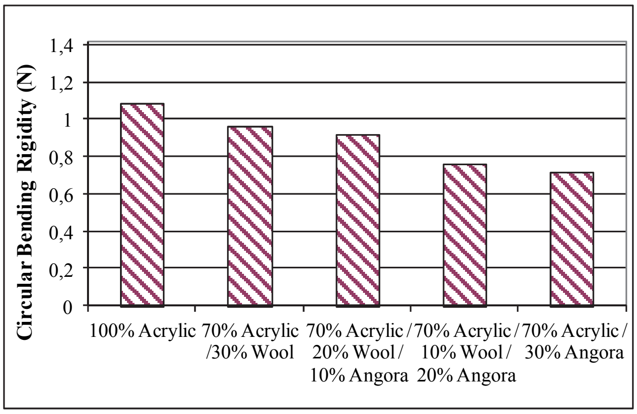


Figure 9. Circular Bending Rigidity of the Fabrics

According to the circular bending rigidity results (Figure 9) it can be seen that usage of wool fiber in blend decreases bending rigidity statistically. However, the fabrics containing 70% acrylic/10% wool/20% angora and 70% acrylic/30% angora have the lowest circular bending rigidity value, which is related with the lower fiber stiffness of angora fibers.

4. CONCLUSION

Due to the advantageous properties, acrylic yarns have been widely used for clothing industry. They are also used in blends with other textile fibers. In this research acrylic fibers were blended with animal fibers such as wool and angora fibers and 5 different yarns were produced by using ring spinning process. The blended yarns were knitted in single jersey structure and after the production, yarn and fabric properties were investigated. According to the results, following statements can be concluded;

- Blending acrylic fiber with wool and angora fiber, increases the CV_m, number of thin/thick places and neps of the yarn, and also increases the mass per unit area and thickness of the fabric, while decreasing air permeability.
- 70% acrylic/30% angora and 70% acrylic/30% wool yarns have the lowest tensile strength value, while 100% acrylic and 70% acrylic/10% wool/20% angora yarns have the highest, which is related with the CV_m values of the yarns. Yarn strengths were also found parallel with the results of bursting strength values of the fabrics.
- Since 70% acrylic /20% wool /10% angora containing yarn has high CV_m, number of thin/thick places and neps, it has the highest pin friction and yarn to yarn friction coefficient values. In contrary, 70% acrylic/30% angora and 100% acrylic yarns, which have lower CV_m values, have lower pin and yarn to yarn friction coefficients.
- According to the correlation analysis, it was pointed out that there is a strong correlation between the CV_m, number of thin-thick places, neps and the results of pin and yarn to yarn friction coefficients.
- Fabric bursting strength changes parallel with the yarn breaking strength, which is depending on the yarn CV_m and fiber tensile properties.
- Fabrics consist of three fiber types have higher kinetic friction coefficient, due to their high yarn friction coefficients.
- Usage of wool and Angora rabbit fiber in blend decreases fabric circular bending rigidity and supplies a softer handle.

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