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Comparison of The Some Properties of Handknitted Fabrics From Wool and Angora Handspun Yarns

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Abstract – In this study, natural colored (dark gray) wool and white angora fibers were firstly hand-spun and then hand knitted fabrics were produced from these yarns. Then, mass per unit area, air permeability and the hand of the fabrics were compared statistically. In addition to this, the knitted fabric made of white angora fiber was dyed in gray and the washing and rubbing fastness values of the gray dyed angora fabric were compared with the ones of the fabric made of natural colored (pigmented) gray wool. Because the color in the pigmented wool fiber is due to the melanin pigment in the cortical cells forming the cortex layer of the fiber, not the dye which is added to the structure, washing and rubbing fastness of the pigmented wool fabric was superior as expected. On the other hand, since no additional dye was used, a waste load was not created and a more ecological production in terms of environment was obtained.

Keywords *–Pigmented wool, angora, handle, air permeability, dyeing*

I. Introduction

As generally known, wool fibers have more or less yellow color due to the yellow colored products which are generated by the degradation of some amino acids forming macromolecules. However, some of the wool fibers are gray, brown or black. These colors, which are not desirable, grow out of the pigments in the cortex layer [1]. In protein fibers melanin pigment exists. Melanin is a natural protein pigment, produced by specialized cells called melanocytes [2]. The well-known end-use of natural colored wool is handcrafts. Spinners, weavers, felters and other wool crafters use the wool from colored sheep for its natural look and its absence of dye chemicals [3].

Consumers in the major wool consuming economies are placing increasing importance on the comfort and softness properties of textiles. There is, a variety of fibers harvested from mammals including: Caprinae, cashmere, mohair, cashgora, quivet; other Bovidae, yak wool, bison wool, cow down; Camelidae, alpaca, guanaco, llama, vicuña, Bactrian camel wool; and Leporidae, Angora rabbit [4]. The Angora rabbit (*Oryctolagus cuniculus*) is raised solely for its fine and soft hair, unlike other breeds which are produced for their meat and fur [5]. These fibers provide high status to people having them in their clothes. Since synthetic fibers do not have the same potential, angora fibers are called “Luxury Fibers” [6]. Angora fiber production is the third largest animal fiber industry in the world after wool and mohair. China dominates the world Angora fiber trade by producing approximately 90% of the world Angora fiber [7]. Because of its fineness, softness, lightness and good insulating properties, Angora rabbit hair is used in the production of high quality yarns for hosiery and knitted garments [8].

In this study, natural colored (dark gray) wool and white angora fibers were firstly hand-spun and then hand knitted fabrics were produced from these yarns. Then, mass per unit area, air permeability and the hand of the fabrics were measured, and the results were compared statistically. In addition to this, the knitted fabric made of white angora fiber was dyed in gray and the washing and rubbing fastness values of the gray dyed angora fabric were compared with the ones of the fabric made of natural colored gray wool.

II. Materials and Method

In this study, natural colored (dark gray) wool and white angora fibers were firstly hand-spun and then hand knitted fabrics were produced from these yarns. After fabric samples were conditioned under standard laboratory conditions (20±2 °C, 65±2% Relative Humidity), mass per unit area, air permeability and handle properties were tested.

For determination of mass per unit area of the fabrics, the width and length values of the fabrics were measured and the area of the fabrics were calculated. Then the weight of the fabrics was measured and the mass per unit areas was calculated based on the measured weight corresponding to this area. Experiments were performed in 3 replicates.

The air permeability of conditioned fabrics was measured on Prowhite Airtest 2 according to TS 391 standard. Circular specimen holder of 5 cm² test area was placed uniformly on the test specimen with sufficient tensile force in order not to wrinkle. After the air suction assembly was started, the airflow passing through the specific area of the test sample was gradually increased until a pressure difference of 100 Pa was reached between the two sides of the fabric and the amount of air passing through the fabric was recorded as 1/m²/s. The experiment was repeated 3 times under the same conditions.

Hand of fabrics were evaluated by subjective method. For this purpose, a group of 10 people, aged between 22 and 42 years, consisting of 5 males and 5 females with high school, associate degree and bachelor's degree, were asked to give a value between 1 and 10 (1 very hard, 10 very soft) to the hand of the fabrics. The tests were carried out in laboratory environment via using the mechanism shown in Figure 1 to prevent the testers from seeing the fabric they touched.



Figure 1: The mechanism used in the evaluation of the behavior of fabrics

Angora fabric was dyed according to the graph given in Figure 2 in Thermal HT laboratory dyeing machine at 30:1 liquor ratio in order to compare the fastness values of dyed angora fabrics and naturally colored wool fabrics. 1.2% Lanaset Gelb 2R, 0.7% Lanaset Rot G and 1.9% Lanaset Blue 2RA was used in the receipt. The pH of dyeing liquor was adjusted to 4.5 with acetic acid/natrium acetate buffer; no auxiliaries were used in the dyeing process. The color yield (K/S) and CIEL*a* b* values of the both fabric samples were measured by spectrophotometer. Washing and rubbing fastness tests were also performed on the samples.

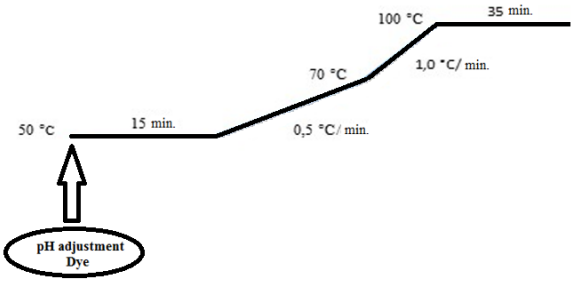


Figure 2: Dyeing graph used to dye angora fabrics

Measurements of the remission (R%) values of the samples were measured on a X-Rite Color i7 model spectrophotometer under D65 daylight with 10° observation. (K/S) values were calculated by using the Kubelka-Munk equation with the remission (R %) values measured in the spectral region of 400-700 nm and the maximum absorption (minimum remission) wavelength.

$$K/S = (1-R)^2/2 \times R \quad (1)$$

R = Reflectance at maximum absorption wavelength (λ_{max})
K = Absorption coefficient,
S = Scattering coefficient.

The CIEL*a*b* values of the samples were also measured by spectrophotometer.
L*: Lightness-darkness value (+ lighter, - darker)
a*: Red-green value (+ red, - green)
b*: Yellow-blue value (+ yellow, - blue)

Colorfastness to washing of samples was determined according to TS-7584 (ISO-105 C06). For washing fastness of the sample, which was stitched with multifiber fabric on one side, was treated with a detergent solution of 4 g/L for 30 minutes at 40°C and was evaluated by grey scale. Colorfastness to rubbing of samples was determined according to TS-717 (ISO 105-X12) by using crock meter in both dry and wet state and then was evaluated by grey scale.
The results were statistically evaluated. As there were two samples in statistical evaluation, t-Test for Independent Samples was used.

III. Results and Discussion

Air permeability tests of knitted fabrics made of wool and angora according to TS 391 EN ISO 9237 standard were performed. The air permeability values of the knitted fabrics made of wool and angora were obtained by measuring the three different parts of the fabric samples with Prowhite Airtest II device. The results were shown in Figure 3 and the results of statistical analysis were given in Table 1.

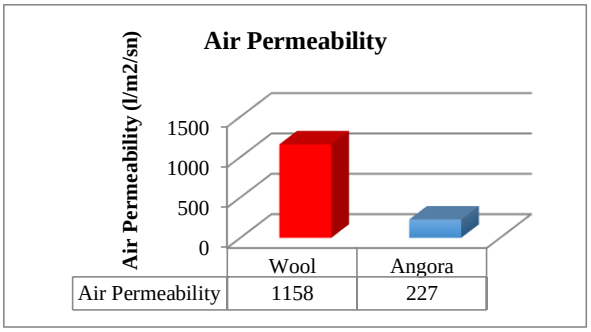


Figure 3: Air permeability results of 100% wool and 100% angora hand-knitted fabrics

Table 1: Descriptive statistics of air permeability results of knitted fabrics and t-test result

Descriptive Statistics				
	n	$\bar{x}$	s	s^2
Wool	3	1158	129.57	16789
Angora	3	227	38.69	1497
2-tailed distribution				
p-level	0.0069			

When the results are evaluated, the air permeability values of the hand-knitted fabrics produced using 100% wool fibers were higher than the air permeability values of the fabrics produced with using 100% angora fibers and the difference was found to be statistically significant (p = 0.0069). First of all, when the mass per unit area values of fabrics were measured, it was seen that the mass per unit area of the wool fabric was 606.3 g/m^2 and that of the angora fabric was 833.6 g/m^2. Therefore, it was normal that the air permeability of angora fabric, which had higher results of mass per unit area, was lower. In addition, since the fineness of angora fibers was generally lower than the wool fibers (in this study it was approx. 33 µm for wool and 15 µm for angora), it is natural that the air permeability of the fabric obtained by using the yarn produced from these fibers was lower.

Fabric hand results were given in Figure 4 and the related statistical evaluation was given in Table 2. According to the

results, the fabrics produced from 100% wool fibers were harder than the 100% angora fabrics and the difference between the averages was found to be statistically significant (p = 0.0000). When the previous studies on the microscopic features of angora and wool fibers were examined, the reason for this situation could be understood. In angora and wool fibers, although the number of scales in 100 microns was close to each other, angora fibers were significantly lower compared to the thickness of the scales and thus the angle of the scales with the axis [9]. This leads to a lower friction coefficient of fibers, which is the reason why the fabrics produced from angora fibers were both softer and non-felt.

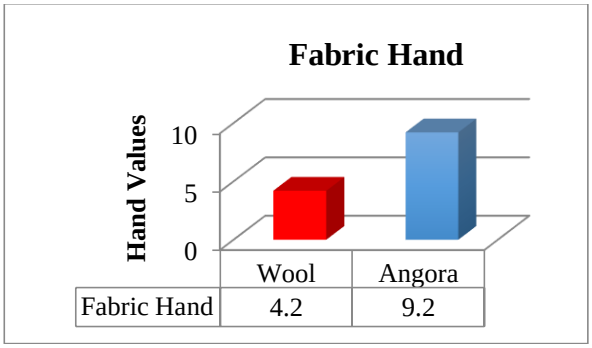


Figure 4: Fabric hand results of 100% wool and 100% angora hand-knitted fabrics

Table 2: Descriptive statistics of fabric hand results of knitted fabrics and t-test result

Descriptive Statistics				
	n	$\bar{x}$	s	s^2
Wool	10	4.2	1.98	3.95
Angora	10	9.2	0.91	0.84
2-tailed distribution				
p-level	0.00000			

After comparing the air permeability and hand properties of the fabrics, the knitted fabric made of white angora fibers was also dyed into gray color and CIEL*a*b* and color yield (K/S) values of the fabric made of natural gray colored wool and the fabric dyed into gray color made of angora fibers were compared. The results were given in Table 3.

Table 3: Color measurement results of naturally colored (pigmented) wool and dyed angora fabrics

Fabric	L*	a*	b*	K/S	nm
Pigmented wool	37,83	1,61	5,49	7,29	400
Dyed angora	20,93	0,66	1,16	17,17	450

As can be seen from Table 3, the color of the dyed angora fabric is darker and its nuance is less yellowish (more blue) compared to naturally colored wool fabric. Washing and rubbing fastness results of the fabric made of a naturally colored gray wool and dyed angora fabric were given in Table 4. As can be seen from Table 4, the washing and rubbing fastness values of the pigmented wool is higher compared to dyed angora fabric. Because the color in the pigmented wool fiber does not come from the dye added to the structure, but because of the melanin pigment in the cortical cells forming the cortex layer of the fiber [10].

Table 4: Washing and rubbing fastness results of the naturally colored (pigmented) wool and dyed angora fabrics

Fastness		Pigmented Wool	Dyed Angora
Washing fastness	**WO**	5	4
	PAC	5	5
	PES	5	4-5
	PA	5	3
	CO	4-5	4-5
	CA	5	4
Rubbing fastness	**Dry**	5	4-5
	Wet	4-5	4

IV. CONCLUSION

The air permeability of fabrics woven from Angora yarns was significantly lower than that of natural colored wool knitted fabrics. This suggests that angora fabrics may be more advantageous in terms of thermal insulation. In the subjective hand evaluation tests, angora fabrics were significantly softer than natural colored wool fabrics. It is thought that the cause of this condition is due to weaker scales than wool fibers. This is an important advantage especially in terms of clothing comfort. In addition, the weaker of the scales in angora fibers makes the use of angora clothes possible for people even who are allergic to wool especially due to their prickling properties.

Because the color in the pigmented wool fiber is due to the melanin pigment in the cortical cells forming the cortex layer of the fiber, not the dye which is added to the structure, washing and rubbing fastness of the pigmented wool fabric was superior as expected. On the other hand, since no additional dye was used, a waste load was not created and a more ecological production in terms of environment was obtained.

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