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DETERMINATION OF FLEECE QUALITIES OF MALYA SHEEP (11/16 AKKARAMAN X 5/16 DEUTSCHES MERINOFLEISCHSCHAF) AND EFFECT OF AGE AND SEX ON THESE QUALITIES

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This study was carried out to investigate fleece qualities of Malya ewes and rams and effect of age (14 months age, 26 months age, 38 months age, 50 months age and 62 months age and older) and sex (ewe and ram) on fleece traits. The data were collected from 100 head ewes and 50 head rams raised at Malya State farm and were analyzed by using least squares method. The least squares means was calculated for greasy fleece weight (2.90±0.08 kg), clean wool percentage (50.05±0.69%), tenacity (18.72±0.52 Cn/Tex), fiber elasticity (31.17±0.43%), fiber diameter (26.66 ±0.19 μm), staple length (H) (31.88±0.46 mm), and staple length (B) (47.67±0.72 mm), medullated fiber rate (23.52±0.73%), comfort factor (78.04±1.14%), and opacity (75.67±0.11%). Effect of age on all fleece traits was significant (P<0.001-P<0.05) except for fiber elasticity. Effect of sex on all fleece traits was significant (P<0.001-P<0.05) except for fiber diameter, tenacity and comfort factor. It can be generally concluded that younger and rams have higher fleece yield and fleece quality than older and ewes and fleece quality of Malya sheep was between textile and carpet industry and is closely similar to textile type wool.

Keywords: Crossbreed Merino, fiber quality, fiber characteristics, wool, opacity

INTRODUCTION

When it was considered fine, uniform and high-quality wool being suitable for textile industry, Merino sheep come to remember. To produce very thin and uniform fleece, Merino with combing wool was imported from Spain to Turkey in 1841. Especially, after the declaration of the Republic of Turkey, Hungarian Merino in 1928 and Deutsches Merinofleischschaf in 1934 were imported. Backcrossing studies of domestic sheep breeds with Deutsches Merinofleischschaf rams were started in order to improve the meat yield and fleece quality. Thus, new breeds were obtained as Karacabey Merino (West Anatolia Merino), Central Anatolia Merino (Konya Merino) with backcrossing system, and Malya sheep (11/16 Akkaraman x 5/16 Deutsches Merinofleischschaf) with the combination crossbreeding system. Wool production in the world was 2043000 tons (Anonymous, 2012) and Turkey produces 1.4% of wool production in the world. While there is a reduction in number of domestic sheep from 39590493 heads in 1991 to 25892582 heads in 2012 in Turkey, Number of Merino sheep increased from 841847 heads in 1991 to 1532651 heads in 2012. Wool production of domestic sheep was 57902 tons in 1991, in 46392 tons in 2012 and wool production of Merino sheep increased from 2590 tons in 1991 to 4788 tons in 2012 (Tuik, 2013). Ratio of very thin and uniform fleece to wool production in Turkey was 4% in 1991 and 9% in 2012. Wool prices have been falling by using of synthetic fibers in the industry in recent years and wool price can only reimburse costs of shearing. However, importance in human life of wool and woolen fabrics will not be lost, even wool will be more important than synthetic fabrics again in the future due to be organic production.

For Malya ewes, greasy fleece weight 2.45 kg, clean wool percentage 50%, staple length 7.8 cm, kemp amount 0.9%, and fiber diameter 28 μm were reported by Düzgüneş and Pekel (1966). Çolakoglu and Ozbeyaz (1999) reported greasy fleece weight, staple length, fiber diameter, crimps in 2.54 cm, and clean wool percentage in Malya ewes were 2.36 kg, 10.27 cm, 24.61 μm, 8.75 and 48.34%, respectively. There is not yet a detailed study about wool traits of Malya sheep, a synthetic breed obtained with the combination crossbreeding method. Some factors affect fleece quality as increasing of age, sex of sheep, corral type, feeding and management. This experimental study was done to investigate the effects of age and sex on fleece qualities and to determinate fleece qualities of Malya ewes and rams.

MATERIALS AND METHODS

Animal material used in experimental study was Malya ewes and rams reared in Malya State Farm in the middle Anatolia region of Turkey. Wool samples were collected from 100 ewes and 50 rams. 10 samples from rams and 20 samples for ewes in each age group (14 months, 26 months, 38 months,

50 months and 62 months and older) were taken. Sheep were sheared with machine in April in Malya State Farm. At shearing, 2 years old and older ewes were at 2nd month of lactation. However, 1 year old ewes have not gestation and lactation at shearing. Ewes have made their first birth at 2 years old and in February. Greasy fleece was measured with scale in precision of 100 grams after shearing. Wool samples were taken on the right side of the sheep from the close midpoint region of last rib in the chest area of each animal, approximately 50 gram wool samples were taken. Samples collected were packed in labelled plastic bags. Wool samples were sent for analyses to Wool and Mohair Analysis Laboratory of Lalahan Livestock Research Institute.

As wool characteristics, greasy fleece weight, clean wool percentage, tenacity, fiber elasticity, fiber diameter, staple length (H and B), medullated fiber rate, comfort factor, and opacity were investigated. Uster AL100-FL100 device was used for analysis of staple length. Uster FL100 makes scanning and Uster AL100 makes optical reading. This device gives two measures called the length Hauter (H) and Barbie (B) value. Hauter is average staple length value based on number of fibers. Barbie is average staple length value based on weight, H and B length values are used in the textile industry (Anonymous, 1995; Garip *et al*., 2010). Both Barbie values and Hauter values were used in this study. After fiber samples were placed into staple length measurement unit of device, Uster AL100-FL100 device measures length measurements from a lot region of fibers (1200 points) by helping of capacitors. Measuring ranges were from 0.125 to 0.250 mm as be digital (Garip *et al.,* 2010).

Uster OFDA 100 device (Instrument for measuring wool diameter) was used for the analysis of fiber diameter. Single Fiber Tensile Tester Fafegraph device was used for the analysis of tenacity, and fiber elasticity. After washing wool samples with warm and soapy water to determine clean wool percentage, samples were left to dry at 105°C in oven. Clean wool percentage was found with ratio of clean wool amounts to greasy wool amounts after drying operation is finished (Koyuncu *et al.,* 1999; Garip *et al.,* 2010). Minitab package program was used for statistical analysis (Minitab, 1998). The method of least squares was used for determination of effective factors on all wool traits. Effects of sex and age on all wool traits were investigated. Duncan's multiple range tests were used for multiple comparisons in important subgroups (Duncan, 1955).

The model used to analyze the wool characteristics was:

$Y_{ij} = ì + A_i + B_j + e_{ij}$ where;

For wool characteristics, Y = traits, ì = overall mean, Ai = age of sheep; where i= 1 year, 2 years, 3 years, 4 years, 5 years and older, Bj = sex where; j = female and male, eij= was the random residual effect.

Pearson's phenotypic correlations between wool traits were estimated (Tekin, 2010).

RESULTS AND DISCUSSION

The least squares means for wool traits of Malya ewes and rams were shown in Table 1. Except for elasticity and number of fibers, effect of age on all wool characteristics was statistically significant (P<0.001-P<0.05). Except for fiber diameter, tenacity and comfort factors, effects of sex on other characteristics were statistically significant (P<0.001-P <0.05). Average greasy fleece weight was 2.90±0.08 kg. Greasy fleece weight was lower in females with 2.32 kg than 3.48 kg in males.

As first shearing of hogget at 1 age group was done 14 months age, 1 age group has higher greasy fleece weight. As shearing was done in April month of every year, 2-5 years old sheep was sheared with 12-month intervals. Also, greasy fleece weight decreased after 1 year old with increasing age. Greasy weight decreases with each successive age. This implies decreasing in greasy weight occurs only after 1 year old.The mean clean wool percentage was 50.05±0.69% and 53.55±0.80% in ewes, 46.56±1.13 in rams. Effects of age and sex on clean wool percentage were statistically significant (P<0.001 - P<0.05). Clean wool percentage showed an increasing from 1 year age to 3 years old.

***Greasy fleece weight*:** The effect of sex and age on greasy fleece weight was statistically significant (P<0.001). The highest greasy fleece weight was with 3.77 kg in 1 year old hoggets, the lowest greasy fleece weight was 2.44 kg in 5 years old sheep. Higher greasy fleece weight in 1 year old yearlings may be caused by the absence of pregnancy and lactation and being approximately 14 months of age of them when shearing. Greasy fleece weight was higher with 3.48 kg in males than females with 2.32 kg. This may be caused by having rams more body weight and body surface than ewes, besides, the buildup of more gravel because of cleaning not with urine of faeces in the rump of rams.

Although some authors reported greasy fleece weight increased until 3-4 years old (mature age) with increasing age, then decreased with increasing age (Demir, 1989; Çolakoğlu and Özbeyaz, 1999), some authors reported that greasy fleece weight did not change with increasing of age (Aksoy *et al*., 2001; Garip *et al.,* 2010). Except for declaration of the literature, decreasing of greasy fleece weight with increasing of age was observed in this study. There is a decline in greasy fleece weight with increasing of age after 1 year old. It can be said that greasy fleece weight significantly changed for sheep between 1 and 5 years old.

Greasy fleece weights are different in different studies, different breed and different regions. Average greasy fleece weight for Akkaraman was reported between 1.69 kg and 2.45 kg (Tekeş, 1973; Çolakoğlu and Özbeyaz, 1999; Garip

Table 1: The least squares means for wool traits of Malya ewes and rams

Traits	n	Greasy fleece weight (kg)	Clean wool percentage (%)	Tenacity (Cn/Tex)	Fiber elasticity (%)	Fiber diameter (µm)	Staple length (B) (mm)	Staple length (H) (mm)	Medullated fiber rate (%)	Comfort factor (%)	Opacity (%)	Fiber number (number)
Age		***	*	**	ns	***	***	***	*	***	**	ns
1 (14 months)	30	3.77±0.16 a	46.10± 1.48 b	15.88±1.11c	30.16± 0.92	24.74± 0.40 c	47.39± 1.55 a	29.99± 0.98 bc	26.58± 1.56 a	87.91±2.42 a	76.31±0.24 a	4740.24±211.89
2 (26 months)	30	2.92±0.16 b	49.95±1.48ba	19.83±1.11ab	31.55± 0.92	26.67± 0.40 b	51.82± 1.55 a	34.92± 0.98 a	22.31± 1.56 ab	78.04±2.42 b	75.58±0.24 ab	5238.07±211.89
3 (38 months)	30	2.76±0.16bc	52.18± 1.48 a	21.66±1.11a	32.16± 0.92	27.98± 0.40 a	49.66± 1.55 a	32.86± 0.98ab	22.25± 1.56 ab	69.84±2.42 c	75.31±0.24 b	5109.14±211.89
4 (50 months)	30	2.60±0.16bc	50.14±1.48ab	18.27±1.11bc	32.21± 0.92	26.82± 0.40ab	47.83± 1.55 a	32.82± 0.98 ab	20.25±1.56 b	78.11±2.42b	75.04±0.24 b	4797.87±211.89
5 and older (62 months and older)	30	2.44±0.16 c	51.89± 1.48 a	17.98±1.11bc	29.78± 0.92	27.09± 0.40ab	41.64± 1.55 b	28.83± 0.98 c	26.18± 1.56 a	76.31±2.42 bc	76.11±0.24 a	5072.24±211.89
Sex		***	***	ns	*	ns	*	***	**	ns	***	**
female	100	2.32±0.09 b	53.55± 0.80 a	19.57±0.60	32.25±0.50a	26.72± 0.22	49.81± 0.84 a	33.68± 0.53 a	25.87± 0.84 a	76.52±1.31	76.14± 0.13 a	5339.00±114.6 a
Male	50	3.48±0.12 a	46.56± 1.13 b	17.88±0.85	30.09±0.71b	26.60± 0.31	45.53± 1.18 b	30.09± 0.75 b	21.16± 1.19 b	79.56±1.85	75.20± 0.19 b	4644.02±162.1 b
Means	150	2.90 ±0.08	50.05± 0.69	18.72±0.52	31.17± 0.43	26.66 ±0.19	47.67 ±0.72	31.88± 0.46	23.52 ± 0.73	78.04± 1.14	75.67± 0.11	4991.51±99.27

Data show mean ns: non-significant, *: P<0.05, ** : P<0.01, ***: P<0.001,

a,b,c: The differences between the means of groups carrying various letters in the same column are significant

Table 2. Phenotypic correlations among wool traits

	Greasy fleece weight	Staple length (H)	Staple length (B)	Fiber diameter	Fiber elasticity	Tenacity	Clean wool percentage	Comfort factor	Opacity	Medullated fiber rates
Staple length (H)	-0.204 *									
Staple length (B)	0.08 ns	0.78 ***								
Fiber diameter	-0.06 ns	0.32 ***	0.33 ***							
Fiber elasticity	0.03 ns	0.15 ns	0.31 ***	0.13 ns						
Tenacity	0.05 ns	0.36 ***	0.42 ***	0.72 ***	0.41 ***					
Clean wool percentage	-0.30 ***	0.32 ***	0.34 ***	0.27 ***	0.32 ***	0.36 ***				
Comfort factor	0.05 ns	-0.35 ***	-0.35 ***	-0.96 ***	-0.14 ns	-0.75 ***	-0.28 ***			
opacity	-0.10 ns	-0.02 ns	0.05 ns	-0.01 ns	0.07 ns	0.04 ns	0.17 *	-0.01 ns		
Medullated fiber rates	-0.09 ns	-0.02 ns	0.04 ns	0.04 ns	0.01 ns	0.07 ns	0.16 *	-0.07 ns	0.95 ***	
Number of fiber	-0.09 ns	0.02 ns	0.01 ns	-0.02 ns	0.17 *	0.03 ns	0.08 ns	0.04 ns	0.16 *	0.10 ns

Data show mean NS: non-significant, *: P<0.05, ** : P<0.01, ***: P<0.001,

et al., 2010). Average greasy fleece weight for Merino was reported between 2.1 kg and 4.6 kg (Tekin *et al*., 1999; Dellal *et al*., 2000; Halıcı and Tekin 2007). In this study, average greasy fleece weight for Malya sheep was 2.9 kg and higher than values of Akkaraman and at the lower limit of Merino. It was shown that greasy fleece weight reported as 2.35 kg for Malya by Çolakoglu and Özbeyaz (1999) increased in recent years. This increasing may be caused by the selection made in direction of fleece weight of rams and improvement of care and feeding conditions.

Greasy fleece weights for other domestic sheep (Tuj, Red Karaman, Cine Capari, and Menemen sheep) in previous studies were reported between 1 kg and 2.4 kg (Ulusan, 1995; Altın *et al.,* 1999; Aksoy *et al.,* 2001), and less than the value obtained from Malya. Greasy fleece weight of Malya breed is similar to Norduz and Acipayam sheep (Yılmaz and Denk, 2004, Yüceer *et al.,* 2010) and lower than 3.3 kg in Turkish Merino (Tekin *et al.,* 1999). It can be said that Malya sheep having Merino genotype is one of breeds having the most greasy fleece weight after Merino and Merino crossbred sheep in Turkey.

***Clean wool percentage*:** The clean wool percentage has economic importance due to being main factor taken into account while determined wool prices by wool traders. The selling price of wool with low clean wool percentage will be lower than wool with high clean wool percentage. In this study, the average clean wool percentage of Malya breed was found at 50.05% and low level.

The effect of sex and age on clean wool percentage was statistically significant (P<0.05). The clean wool percentage was 46.56% for rams and 53.55% for ewes. Low clean wool percentage in rams can be caused by pollution in parts of the chest and abdomen of wool, as a result of homosexuality among rams. Also, large amounts grease in rams can be caused by the breeding of rams and ewes in different shelters. The highest clean wool percentage was 52.18% in 3 years old, the lowest clean wool percentage was with 46.10% in 1 year old, it can be caused by having more grease, lanolin and sweat in very young sheep. It can be said that clean wool percentage increased up to adult age with increasing of age, then decreased slightly.

Clean wool percentage for Merino, which have fabric type fleece, was reported in between 38.5% and 56.6% in previous studies (Şahan *et al.,* 1995; Dellal *et al.,* 2000, Halıcı and Tekin, 2007). The clean wool percentage of domestic sheep with coarse mixed wool (carpet type fleece) was between 51.41% and 75.19% (Altın *et al.,* 1999; Çolakoğlu and Özbeyaz 1999; Küçük *et al.,* 2000). It can be said that clean wool percentage in fabric type fleece is lower than carpet type fleece as reported by Tellioğlu (1975). This can be caused by being more yolk in fabric type wool and specifications for holding more dirt due to formation from large number of fine-lifer in fabric wool type. Clean wool percentage for Malya breed was in agreement with values between 48.34% and 67% reported for this breed (Düzgüneş and Pekel 1966; Çolakoğlu and Özbeyaz, 1999).

***Tenacity*:** The mean of tenacity was 18.72±0.52 Cn/Tex. Although effect of age on tenacity was statistically significant (P<0.01), effect of sex on tenacity was non-significant (P>0.05). Tenacity was the highest with 21.66 Cn/Tex in 3 years old and the lowest in 1 year old with 15.88 Cn/Tex. While tenacity at 3 years old is high, tenacity has been a slight decrease with aging and increasing of age after three years. Although the effect of sex on tenacity was statistically non-significant (P>0.05), tenacity was 17.88 Cn/Tex for rams and 19.57 Cn/Tex for ewes. Lower tenacity

in male can be caused by the selection made in the direction of fine-wool of rams for many years in this farm.

Tenacity was reported between 5.2 gr and 14 gr for Merino (Şahan *et al.,* 1995; Dellal *et al.,* 2000; Halıcı and Tekin, 2007), between 7.3 gr and 10.5 gr for Merino crossbreed with Turkish domestic sheep and English meat sheep (Şahan *et al.,* 1995) and between 11.4 gr and 20.7 gr for domestic sheep in Turkey (Tekeş, 1973; Garip *et al.,* 2010; Peşmen and Yardımcı 2012). Tenacity for Malya sheep in this study was similar to values of domestic breeds and higher than values for Merino and Merino crossbred.

***Fiber elasticity*:** Means of fiber elasticity for Malya sheep was 31.17±0.43%. This value was between the limits of literature, for example, between 27.2% and 39% for Akkaraman (Tekeş, 1973; Garip *et al.,* 2010) between 23.3% and 35.1% for Turkish Merino (Şahan *et al.,* 1995; Dellal *et al.,* 2000, Halıcı and Tekin, 2007), between 29% and 34.8% for Merino crossbreed with Turkish domestic sheep and English meat sheep (Şahan *et al.,* 1995). It can be said that fiber elasticity for Malya sheep was slightly lower than Akkaraman and was upper limit of Merino and Merino crossbreed.

The effect of sex on fiber elasticity was statistically significant (P<0.05), fiber elasticity was 32.25% for ewes, 30.09% for males. Fiber elasticity of Malya sheep was similar to between 30% and 32.7% at other domestic breed like Norduz, Menemen, Morkaraman, Hamdani and Karagül (Küçük *et al*., 2000; Yılmaz and Denk, 2004; Peşmen and Yardımcı, 2012).

***Fiber diameter*:** Means of fiber diameter for Malya sheep was 26.66±0.19 µm. While the effect of age on fiber diameter was statistically significant (P<0.001), effect of sex on fiber diameter was non-significant (P>0.05). Fiber diameter was the highest with 27.98±0.40 µm in 3 years old and the lowest with 24.74±0.40 µm in 1 year old. Fiber diameter was for ewes and rams 26.6 µm and similar to each other. The effect of sex on fiber diameter was statistically non-significant, similarly previous studies (Tekin *et al.,* 1999; Yılmaz and Denk, 2004; Taherpour and Mirzaei, 2012). It can be said that fiber diameter increased to 3 years old and decreased after 3 years old.

Fiber diameter was between 21.3 µm and 27.5 µm for Merino (Tekin *et al.,* 1999; Dellal *et al.,* 2000; Halıcı and Tekin 2007) and between 27 µm and 28.8 µm for Akkaraman (Tekeş, 1973; Garip *et al.,* 2010). It can be said that fiber diameter of Malya breed was at the upper limit of Merino and smaller than Akkaraman and other native breeds. In previous research (Çolakoğlu and Özbeyaz 1999), fiber diameter for Malya sheep was reported 24.6 µm and thinner 2 µm than the value of this study. This can be caused by small sample number in previous research and genetic distractions due to being a crossbreed of Malya sheep. Fiber diameter for Malya sheep was smaller than other domestic sheep breed in Turkey, between 32.9 and 42 µm for Morkaraman (Ulusan, 1995; Kuçuk *et al*., 2000; Topal and Emsen, 2011), between 30 and 31.3 µm for İvesi (Tekeş, 1973, Topal and Emsen, 2011), 34.4 µm for Acıpayam (Yüceer *et al*., 2010), between 28.4 µm and 36.6 µm for Tuj (Ulusan, 1995; Aksoy *et al*., 2001), 34.2 µm for Hamdani (Küçük *et al.,* 2000), 39.1 µm for Karagül (Küçük *et al.,* 2000), 30.9 µm for Menemen (Peşmen and Yardimci, 2012) and 37.5 µm for Norduz (Yilmaz and Denk, 2004).

Although the effect of age on fiber diameter was non-significant in some researches (Tekin *et al.,* 1999; Aksoy *et al.,* 2001; Taherpour and Mirzaei, 2012), fiber diameter is the thickest in 1 year old and thinned with increasing age in some researches (Yılmaz and Denk, 2004; Peşmen and Yardımcı, 2012). Taherpour *et al* (2012) reported increased with increasing age of fiber diameter, although statistically non-significant. In this study, the effect of age on fiber diameter was statistically significant (P<0.001). The thinnest fiber diameter was at 1 year old in this research. Increasing of fiber diameter up to 3 years can be explained by increasing of fiber diameter with advance of aging.

***Staple length (H and B)*:** Staple length was determined as H (Hauter) and B (Barbe) using Uster AL100-FL100 device. Staple length values were determined according to the number of fibers (H value), and volume and weight of fibers (B value) and these values are important to the textile industry. Hauter and Barbe length values are smaller than values measured manually in previous studies. Studies reporting B and H values were used only in comparison to eliminate the method differences to compare with staple length in this study.

Average length as B value was 47.67±0.72 mm. Effect of age and sex on B length value was statistically significant (P<0.001-P<0.05). B length was the highest with 51.82±1.55 mm in 2 years old and the lowest with 41.64±1.55 mm in 5 and older. Barbe length for males (45.53 mm) was shorter than females (49.81 mm). Similarly, H length value was the highest with 34.92 mm in 2 years old, the lowest length value with 28.83 mm in 5 and older, 33.68 mm for female and 30.09 mm for male.

B length value was at the upper limit with values between 37.8 mm and 45.4 mm for Akkaraman (Garip *et al.,* 2010), was higher than with 36.1 mm and 40.9 mm for Merino (Halıcı and Tekin 2007) and lower than 58.6 mm for Acıpayam (Yüceer *et al.,* 2010). It can be said that B length value for Malya was higher than Merino and lower than values of other native breeds.

H length value was at the upper limit of values between 27.7 mm and 30.3 mm for Akkaraman (Garip *et al*., 2010), was higher than with 25.7 mm and 29.8 mm for Merino (Halıcı and Tekin, 2007) and lower than 37.6 mm for Acıpayam (Yüceer *et al*., 2010). It can be said that H length value for Malya was higher than Merino and lower than values of other native breeds. Düzgüneş and Pekel (1966) reported longer staple length manually as 7.81 cm in Malya sheep.

To be shorter staple length in rams than ewes can be caused by more preferring rams called broken hairy (short and very often hairy) while sheep breeders at Middle Anatolia are selecting rams for breeding. Malya rams with long hairy were not preferred by breeders. For this reason, breeding rams subject to selection in the short hairy direction.

***Medullated fiber rate*:** There are four types of fiber like real, medullated, kemp, and heterotip in greasy fleece. Medullated fiber rate determines wool quality and evaluation location of wool in industry (Dellal *et al.,* 2000). Wool can be used in carpet or textile industry, according to medullated fiber rate. The average medullated fiber rate was 23.52±0.73%. The effect of sex and age on medullated fiber rate was statistically significant (P<0.01-0.05). While medullated fiber rate was the highest with 26.58% at 1 year old and 26.18% in 5 years old, and very low with values 20.25% and 22.31% between 2 and 4 years old. Increasing of medullated fibers rate in 5 years old can be connected with aging. Decreasing in medullated fiber rate from 1 year old up to 4 years of age, can be connected to an increase in numbers of secondary follicles with increasing of age in agreement with Şenel (1995)

Primary follicle occurs firstly and before birth or while in uterus of mother, the hairs form on primary follicle, and hairs on secondary follicle will begin to grow after birth of lambs. Kemp hairs were generally thick and consist of primary follicle. While lamb continues to grow, most of the thick hairs fall. Activities of primary follicles generally stop after 3-4 years. Secondary follicles form mostly fine hairs and especially hairs formed by secondary follicles are suitable to use in the textile industry (Şenel, 1995).

A medullated fiber rate was 21.16% for males and 25.87% for females. Less medullated fiber in males than females can be caused with selection as breeding of rams that have short and thin wool. Also, rams have been selected according to having structure of heart-shaped tail, large body and having not black stain in feet, mouth, ears, eyes and body. Selection in females is almost negligible and all of females are reared as breeding in this farm.

Average medullated fiber rate with 23.52±0.73% was higher than values between 1% and 2% for Merino (Özcan, 1975; Dellal *et al.,* 2000), 4.82% for Malya sheep (Özcan, 1975), 10.7% for Karayaka (Koyuncu *et al.,* 1999), between 5.46% and 12.79% for Çine çaparı (Altın *et al.,* 1999), 7.5% for Norduz (Yılmaz and Denk, 2004), 7.25% for Tuj (Aksoy *et al.,* 2001), 6.4% Hamdani (Küçük *et al.,* 2000) and lower than 24.47% for Morkaraman and 42.57% for Karagül (Küçük *et al.,* 2000), and between 32.8% and 33.5% for Akkaraman (Garip *et al.,* 2010). In this study, Average medullated fiber rate was very higher than medullated fiber ratio 4.82% reported earlier for Malya breed (Özcan, 1975), it may be caused by differences in method. It can be said that medullated fiber rate of Malya sheep was lower than some native sheep breed like Akkaraman, Morkaraman and Karagül.

***Comfort degree*:** Comfort factor is the percentage of fibers being less or equal to 30 µm. Threshold value determined by device for comfort degree is 30 µm, comfort degree for samples which thickness is too much will be decrease. So fiber fineness is thinner than 30 µm that comfort degree will be greater. Similar to fiber diameter, the effect of age on comfort degree was significant (P<0.001). Comfort degree is negatively related to fiber diameter; change of comfort degree is corresponding to changes in fiber diameter as shown in Table 1. Means of comfort degree for Malya sheep was 78.04±1.14%. Comfort degree was the highest with 87.91±2.42% at 1 year old hogget which have the finest fiber diameter. Comfort degree was the lowest with 69.84±2.42% at 3 years old which have thickest fiber diameter.

***Opacity*:** Opacity is the relative capacity of fibers to obstruct the light transmission when scanned under both dark and bright field image (Rafat *et al.,* 2007). Means of opacity for Malya sheep was 75.67±0.11%. While opacity was the highest 76.31±0.24% in 1 year old and 76.11±0.24% in 5 years old and very low with values between 75.04% and 75.58% between 2 and 4 years old. If medullated fiber rate increase, opacity will increase. Similarly, as medullated fiber rate, effect of age and sex on opacity degree were significant (P<0.001-P<0.01). Opacity is higher in groups having more medullated fiber rate. Value of lower opacity at textile type fleece is desired.

***Fiber number examined in analysis of fiber diameter*:** Average fiber number examined by device when fiber diameter measurements were taken from the wool samples. Mean number of fibers investigated to determine fiber diameter by device was 4991.51±99.27. It is seen to be different number of fibers analyzed for determination to fiber diameter in each age and sex groups in Table 1. Similarly, Rafat *et al.* (2007) reported that approximately 4000 fiber numbers were taken for fiber diameter measurements from the samples in Angora rabbit.

***Phenotypic correlations*:** Phenotypic correlations can be used to improve fleece characteristics. Phenotypic correlations are important to plan in breeding strategies aimed at improving the textile properties of wool. Phenotypic correlations among some wool traits were presented in Table 2. Phenotypic correlations were generally similar to findings of Halıcı and Tekin (2007). Comfort factor has a negative correlation to staple length, fiber diameter, clean wool percentage and tenacity. Thus, producing sheep with shorter, finer, weaker fibers will improve the comfort factor of the fleece.

Phenotypic correlations between fiber diameter and some traits of wool (tenacity and clean wool percentage) were positive, especially correlation between fiber diameter and tenacity was 0.72 and high level. This positive correlation

shows that selection according to lower tenacity can be caused thinning in fiber diameter and increasing of quality wool.

Although phenotypic correlation between greasy fleece weight and staple length (H) was statistically significant and negative, phenotypic correlations between greasy fleece weight and staple length (B) was non-significant (P>0.05). Phenotypic correlation between greasy fleece weight and clean wool percentage was negative and statistically significant (P<0.001).

Phenotypic correlations between fiber diameter and staple lengths (H and B) were positive and moderate level. If fiber diameter decreases, staple length will decrease. Phenotypic correlations between clean wool percentage and all traits were middle level and positive except for greasy fleece weight and comfort factor. Phenotypic correlations between comfort factor and some traits (Staple length (H, B), clean wool percentage, fiber diameter and tenacity) were at negative and high level. Selection can be done according to high comfort degree to improve wool quality. Phenotypic correlation between opacity and Medullated fiber rate was 0.95 and very high. If medullated fiber rate increased, opacity will increase.

***Conclusions*:** Fleece quality of Malya sheep is at better level than the native breeds in Turkey because of having thinner fiber diameter. Fleece which is similar to textile type has been obtained by adding Merino genotype at 35% ratio to domestic sheep in Turkey. More suitable fleece type for textile industry can be obtained by selecting in direction of thinner fiber diameter and fleece quality in Malya sheep herd. Rams showed higher fleece yield than ewes and generally higher quality fleece traits. Rams may be have lower medullated fiber rate and thinner fiber diameter than ewes as a result of intensive selection for rams in this farm, Increasing of sheep age has a negative effect on fleece yield and some fleece traits such as fiber diameter, tenacity and staple length determining quality of fleece. It can be said that fleece quality will decrease with increasing of sheep age and rams have better quality fleece than ewes.

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REFERENCES

Aksoy, A.R., T. Kırmızıbayrak, M. Saatçi and M.T. Dalci. 2001. Production traits of Tushin sheep, II. Milk and wool yield. Vet. Bil. Derg. 17: 123-126.

Altın, T., O. Karaca, İ. Cemal and O. Atay. 1999. The wool yield and wool characteristics of Çine Çaparı and Çine Type (regional synthetic) sheep. Uluslararasi Hayvancılık'99 Kongresi, 760-765, 21-24 Eylül 1999, Ege Üniversitesi Ziraat Fakültesi, İzmir.

Anonymous. 1995. IWTO International wool textile organization specification, the international wool secretariat raw wool department, UK.

Anonymous. 2013. FAO statistical yearbook 2012. Europe and Central Asia food and agriculture, 2012; Available online at http://www.fao.org/docrep/017/i3138e/i3138e.pdf

Çolakoğlu, N. and C. Özbeyaz. 1999. Comparison of some production traits in Malya and Akkaraman sheep. Turk. J. Vet. Anim. Sci. 23: 351-360.

Dellal, G., F. Söylemezoğlu, S. Etikan and Z. Erdoğan. 2000. A research on some wool characteristics of Anatolian Merino Ewes. Tarim Bilimleri Dergisi 6: 48-53.

Demir, H. 1989. Comparison of Dağlıç and Ramlıç sheep for the important production characteristics. II. Fertility, milk production and wool characteristics. J. Fac. Vet. Univ. İstanbul. 15: 39-52.

Duncan, D.B. 1955. Multiple Range and Multiple F-Tests. Biometrics 11:1-42.

Düzgüneş, O. and E. Pekel. 1966. Comparative researches on the properties related yields of various Merino x Akkaraman crossbreeds in the Central Anatolian conditions. T.B.T.A. Kurumu Projesi VHAG-6; pp.13-24.

Garip, M., B. Coşkun, E.S. Polat, A. Yilmaz, M. E. Tekin, T. Çağlayan and N. Kılıç. 2010. Wool properties in Kangal Akkaraman sheep, Eurasian J. Vet. Sci. 26: 93-99.

Halıcı, İ., and M.E. Tekin. 2007. The yield and quality of first sheared wool of Anatolian Merino reared at public flocks in Eskişehir district. Hayvancilik Araş. Derg. 17:9-16.

Koyuncu, M., S. Duru and E. Tuncel. 1999. The wool production and characteristics of Karayaka male hoggets. Hayvansal Üretim 39-40: 24-29.

Küçük, M., O. Yılmaz and C. Y. Ateş. 2000. The evaluation of Morkaraman, Hamdani and Karakul wool for carpet wool type. YYU Vet. Fak. Derg. 11: 54-59.

Minitab. 1998. Minitab Release 12.1 version for Windows, Minitab Inc.

Özcan, L. 1975. Comparasion in terms of their wool and follicle features of Malya, Akkaraman and Anatolian Merino sheep at Malya state farm and research on early selection of these facilities. Çukurova üniversitesi Ziraat Fakültesi yayinlari 83: 22-89.

Peşmen, G. and M. Yardimci. 2012. Fleece qualities of Menemen sheep: I. Morphologic and physical qualities. Eurasian J. Vet. Sci. 28: 99-105.

Rafat, S.A., H. Rochambeau, M. Brims, R.G. Thebault, S. Deretz, M. Bonnet and D. Allain. 2007. Characteristics of Angora rabbit fiber using optical fiber diameter analyser. J. Anim. Sci. 85:3116–3122.

Şahan, U., M. Koyuncu, V. Akgündüz and F. Delgözoğlu. 1995. The wool production and characteristics of mutton breeds x Merino crossbreds F1. Lalahan Hay. Araşt. Enst. Derg. 35: 92-109.

Şenel, M. 1995. Zootekni. Anadolu University, Open Education Faculty Textbook; pp.156-181.

Taherpour, N. and F. Mirzaei. 2012. Wool characteristics of crossbred Baghdadi wild ram and Iran native sheep. Agric. Sci. 3: 184-186.

Tekin, M.E. 2010. Statistics on the computer with examples. Textbook. Selçuk üniversitesi veteriner fakültesi yayin ünitesi, Konya; pp.121-128.

Tekeş, M.A. 1973. Wool characteristics of Awassi x Akkaraman crossbred. Zootekni Araştırma Enstitüsü Dergisi. 13: 34-50.

Tekin, M.E., R. Kadak, A. Akmaz and A. Ergin, 1999. The wool characteristics of Turkish Merino, German Blackheaded Mutton Sheep, Hampshire Down, Lincoln Longwool, Corriedale and Their F1 and B1 Crossbreed Sheep. Turk. J. Vet. Anim. Sci. 23:391-396.

Tellioğlu, S. 1975. Comparisons in terms of wool characteristics among Merino, Morkaraman, and their F1 and G1 crossbreeds. Atatürk Üniv. Yayinlari, 419.

Tuik. 2012. Hayvancilik İstatistikleri. Available online at http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=682.

Topal, E. and H. Emsen. 2011. Some morphologic characteristics of Redkaraman and Awassi sheep wool. Alinteri. 20:9-17.

Ulusan, H.O.K. 1995. The performances of yield of Tushin and Morkaraman ewes at the farm of Veterinary Faculty University of Kafkas, Kars. I. The traits of wool. Kafkas Üniv. Vet. Fak. Derg. 1:86-88.

Yilmaz, O. and H. Denk. 2004. Fleece yield and characteristics of Norduz sheep. Vet. Bil. Derg. 20: 8l-85.

Yüceer, B., H. Akçapınar and F.T. Özbaşer. 2010. The body weight and fleece traits of Acipayam sheep. Lalahan Hay. Araşt. Enst. Derg. 50:73-80.