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Comparison of reproductive performance, live weight, survivability, and fleece characteristics of indoor-raised Central Anatolian Merino and Malya sheep

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ABSTRACT - This study was conducted to compare Central Anatolian Merino (CAM) and Malya sheep under intensive conditions in terms of reproductive traits, birth and weaning weights, fattening performance, and some fleece characteristics. In this study, 840 CAM and 194 Malya ewes were used for the comparison of reproductive performance, whereas 740 and 211 lambs were used to compare growth traits between the two breeds. Additionally, the fattening performance of 61 CAM and 68 Malya lambs were compared. Finally, for the comparison of wool quality traits, 94 CAM and 90 Malya lambs were used. The lambs were kept together with the sheep that gave birth to them for 10 days. After this period, lambs were given lamb starter feed, alfalfa hay, and vetch hay in addition to milk. When lambs reached 40 days old, they were taken to the pasture with the sheep. In this period, pasture grass, growing lamb concentrate feed, alfalfa hay, and vetch hay were given in addition to milk. Lambs were weaned when they reached an average age of 90 days, and their live weights were determined. A determined number of lambs was selected from weaned male lambs. For these animals, in the fattening period, barley, alfalfa hay, vetch hay, meadow hay, and lentil straw were provided *ad libitum* in addition to 400 g/day/head of fattening feed. This study indicated that birth rate was better for CAM sheep than for Malya sheep. However, Malya lambs may have more advantages than CAM lambs in terms of survival and fattening performance. Although birth weight was higher for Malya sheep than for CAM sheep, the opposite result was observed for the weaning weight. The beginning weights of fattened male lambs were higher for CAM lambs than for Malya lambs, but the ending weights of both fattened groups were similar.

Keywords: fattening performance, fleece characteristics, reproductive traits, sheep, weaning weights

1. Introduction

Merino and Merino-derived sheep breeds have been widely distributed across the world, both as purebred and crossbreed. They represent an economically important genetic resource which over time has been used as the basis for the development of new breeds (Ciani et al., 2015).

The sheep population of Turkey comprises 21 native multipurpose breeds; an estimated 40% of the population belongs to the White Karaman breed, which is an indigenous, fat-tailed, seasonal sheep breed (Ertuğrul et al., 2009; Arsoy and Sağmanlıgil, 2018).

The crossing studies in Turkey were carried out for many years and had various aims, including to improve meat and milk production, wool characteristics, and reproductive potential (Akçapınar, 1994). One of the resultant crossbreeds is the Central Anatolian Merino (CAM) sheep, developed for meat and wool breeding. It was developed by crossing the White Karaman and the German Mutton Merino breeds. These crossbred animals have a genetic background that is approximately 75-80% Merino sheep (Kaymakçı and Taşkın, 2008). Malya sheep, which is a thin-fleeced and semi-fat-tailed breed, is also formed by crossing the German Mutton Merino breed with the White Karaman breed; the Malya breed has a genetic background that is approximately 35-40% Merino sheep (Çolakoğlu and Özbeyaz, 1999; Sönmez et al., 2009).

Reproductive performance in animal husbandry is a very important trait that affects profitability. Ewe live weights, nutrition, weather, and season have all reportedly influenced reproductive performance (Gaskins et al., 2005; Akhtar et al., 2012; Aktaş et al., 2015). Ewe live weight is an important trait that affects the survival rate of lambs. On the other hand, birth type, sex, management practices, and feeding conditions are quite effective factors on birth weight and weaning weight of lambs (Notter et al., 2005; Aliyari et al., 2012; Aktaş and Doğan, 2014).

The aim of fattening of lambs is to achieve slaughter weight as soon as possible by feeding with various feedstuffs such as milk, roughage, and concentrated feed. In the intensive fattening active, lambs are fed high-quality concentrate and roughage until weaning age (Önk et al., 2017). This system aims to slaughter lambs at weaning (an approximate age of 3-4 months), after they reach live weight of 30-35 kg.

Turkey has about 42,126,781 heads of sheep that are consisted of 38,579,748 heads of indigenous breeds and 3,547,033 heads of Merino sheep (TUIK, 2020), and is the eighth largest sheep breeder country in the world (FAO, 2019). The total production of fleece mainly depends on the number of sheep raised in sheep industry. Nearly 79,754 tons of greasy fleece were obtained from 42,126,781 heads of sheep in 2020 in Turkey. Although the share of Merino sheep for this production in 1991 was 4%, this rate has reached up to 14% in 2020. The average greasy fleece production per shearing for Turkish domestic sheep is 1.8 kg, whereas it is approximately 3.1 kg for Merino sheep (TUIK, 2020).

In spite of the importance of sheep in Turkey, there have been relatively few publications on the Merino-derived sheep breeds recently in the international literature (Yılmaz et al., 2013). This study was conducted to contribute to the existing knowledge by comparing CAM and Malya sheep under intensive conditions in terms of reproductive traits, birth and weaning live weights, fattening performance, and some fleece characteristics.

2. Material and Methods

The animal materials for this study were CAM and Malya sheep on a private farm in the Bala District of Ankara, Turkey. Bala district is located between 39°33'49" N and 33°7'47" E coordinates. The final report of this study was approved by International Center for Livestock Research and Training Animal Research Ethics Committee, decision number 2021/185.

In this study, 840 CAM and 194 Malya ewes were used to compare reproductive performance, whereas 740 and 211 lambs were used to compare growth traits (birth weight, weaning weight, and live weight at 150th days) between two breeds. Additionally, the fattening performance of 61 CAM and 68 Malya lambs were compared. Finally, for the comparison of wool quality traits (fiber diameter and length), 94 CAM lambs and 90 Malya lambs were used.

Gestation rate, infertility rate, single or twin birth rate, lamb number per ewe mated, litter size, and survival rate were the reproductive features measured via the methods proposed by Kaymakçı and Sonmez (1996). The determined parameters were calculated as follows:

Gestation rate = (number of ewes at mating − infertile sheep / number of ewes at mating) × 100

Single birth rate = (number of sheep with single lamb / number of sheep giving birth) × 100

Twin birth rate = (number of sheep with twin lambs / number of sheep giving birth) × 100

Lamb number per ewe mated = number of lambs at birth / number of ewes at mating

Litter size = number of lambs at birth / number of sheep giving birth

Survival rates at weaning = (number of living lambs at weaning / number of living lambs at birth) × 100

The live weights of CAM and Malya lambs born in February or March on one farm were determined within 24 h by electronic weighing. Current practice of ration formulation for this study, followed feeding standards developed in National Research Council (NRC) standard of the USA (NRC, 2007). Lambs were kept together with the sheep that gave birth to them for 10 days, and they were fed only milk. After this period, lambs were given *ad libitum* access to lamb starter feed, alfalfa hay, and vetch hay in addition to milk. When lambs reached 40 days old, they were taken to the pasture with the sheep. In this period, growing lamb concentrate feed, alfalfa hay, and vetch hay were given *ad libitum* in addition to milk and pasture. Lambs were weaned when they reached an average age of 90 days, and their live weights were determined. A determined number of lambs was selected from weaned male lambs with close dates of birth. For these animals, in the fattening period, barley, alfalfa hay, vetch hay, meadow hay, and lentil straw were provided *ad libitum* in addition to 400 g/day/head of fattening feed. Roughage and concentrate feed rate was 50:50%, and the amount of the feed was increased according to weight gain of lambs (NRC, 2007). The nutritional contents of the feed consumed by animals are listed in Table 1.

Table 1 - Nutrient content of feeds in research

Feed	DM (%)	CA (%)	CP (%)	NDF (%)	ADF (%)	ME (Mcal/kg)
Lamb starter feed	92.01	6.72	18.24	26.12	9.86	2.70
Growing lamb concentrate	92.55	9.38	17.67	29.38	10.60	2.60
Fattening feed	92.36	5.06	13.14	18.66	7.59	2.80
Barley	90.78	2.51	13.05	22.09	6.67	2.70
Alfalfa hay	93.48	10.47	15.40	50.81	37.65	2.07
Vetch hay	93.29	8.38	7.74	71.23	47.83	2.32
Meadow grass	93.57	7.71	8.29	63.82	34.12	1.92
Lentil straw	92.46	9.26	6.44	63.27	40.98	1.81

DM - dry matter; CA - crude ash; CP - crude protein; NDF - neutral detergent fiber; ADF - acid detergent fiber; ME - metabolizable energy.

Fleece samples (50-100 g) were taken from the left lateral rib area of the animals at different age periods (weaning, 150th day, and one year old). Fiber diameter (measured in micrometers) was determined using an optical fiber diameter analyzer (OFDA 2000). Fleece length was measured in centimeters using the International Wool Textile Organization (IWTO-TM-17-859) analytic method with an USTER AL+FL 100 device (Tuncer et al., 2017).

Generalized linear models were used for statistical inferences, for which phenotypic observations of each trait were used as dependent variables, and all the other factors were included in the model as fixed factors. After the linear model fitting, Tukey's test was applied to determine the statistical significance of the difference between the variables. SPSS v.15 package program (2005) was used for statistical analysis. For live weights (birth, 90th and 150th days), the following statistical model was adopted:

$$Y_i = \mu + a_j + b_k + c_l + e_{ijk},$$

in which Y_i = record of each observation for live weight, μ = general average, a_j = breed (CAM/Malya), b_k = birth type (singles/twins), c_l = sex, and e_{ijk} = error effect.

P≤0.05 was set as the threshold for statistical significance. For the statistical analysis of fleece characteristics, breed (two levels: CAM and Malya sheep), age group (three levels: lamb, yearling, adult), and the combined breed-age interactions were included in the model. The statistical model of the design was as follows:

$$Y_i = \mu + a_j + b_k + c_l + e_{ijk},$$

in which Y_i = the fleece quality, μ = general average, a_j = breed, b_k = age, and e_{ijk} = error effect.

3. Results

The CAM sheep had a higher birth rate, whereas the Malya sheep had a higher twin birth rate and a higher rate of survival to weaning (Table 2). A comparison of birth weights of the CAM and Malya lambs, in terms of their sex and birth types, showed similar results (Table 3). Birth weight, weaning weight, and daily live weight gain (DLWG) of CAM lambs were 3.82, 31.83, and 0.31 kg, respectively; the respective weights of Malya lambs were 4.02, 28.68, and 0.28 kg. Although birth weight of Malya lambs was higher than that of CAM lambs (P<0.01), the weaning weight of CAM lambs was higher than that of Malya lambs (P<0.01).

Although the difference between breeds for birth weights of male lambs was not significant, the weaning weight of Malya lambs before fattening was significantly lower than that of CAM lambs (P<0.01; Table 4).

No statistical difference was found in terms of fiber diameter according to the ages of both breeds (Table 5). Although the fiber length at weaning of Malya lambs was significantly longer than that of CAM lambs (P<0.01), fiber length at the end of fattening of CAM lambs was longer than that of Malya lambs (P<0.01). However, no significant difference between breeds was found with regard to fiber length in adult sheep (Table 6).

Table 2 - Descriptive values for the reproductive traits of Central Anatolian Merino (CAM) and Malya sheep

	CAM		Malya	
	n	%	n	%
Number of ewes at mating	840	-	194	-
Infertility rate	54	6.43	28	14.43
Gestation rate	786	93.57	166	85.57
Single birth	570	86.26	112	83.73
Twin birth	216	13.74	54	16.27
Lamb number per ewe mated	-	1.19	-	1.13
Litter size	1.27	-	1.33	-
Survival rates at weaning	-	90.01	-	95.90

Table 3 - Birth and weaning weights (kg) of Central Anatolian Merino (CAM) and Malya lambs

Breed	Birth type	Sex	n	Birth weight (kg)	P	Weaning weight (kg)	P	DLWG (kg)	P
CAM	Single	Male	312	4.00±0.04	0.93	31.84±0.22	0.39	0.31±0.02	0.24
		Female	77	3.67±0.07		31.34±0.44		0.30±0.07	
	Twin	Male	251	3.98±0.04	0.84	31.83±0.25	0.35	0.31±0.03	0.32
		Female	100	3.64±0.06		32.31±0.39		0.32±0.06	
Malya	Single	Male	81	4.02±0.07	0.88	29.78±0.43	0.29	0.28±0.01	0.18
		Female	35	4.01±0.11		27.70±0.66		0.26±0.01	
	Twin	Male	69	4.05±0.08	0.91	29.74±0.47	0.30	0.28±0.01	0.22
		Female	26	4.01±0.13		27.50±0.76		0.26±0.01	
Total CAM			740	3.82±0.03	0.01	31.83±0.17	0.01	0.31±0.05	0.01
Total Malya			211	4.02±0.05		28.68±0.30		0.28±0.04	

DLWG - daily live weight gain.

Table 4 - Birth and fattening performance traits of male lambs

	Birth type	n	Birth weight (kg)	P	Fattening weight (kg)				
					Initial	P	Final	P	DLWG
CAM	Single	27	4.18±0.12	0.65	34.49±0.76	0.36	47.99±1.13	0.37	0.29±0.04
	Twin	34	4.09±0.11		32.89±0.68		44.83±1.01		0.27±0.05
Malya	Single	37	3.95±0.11	0.62	31.01±0.65	0.25	45.61±0.97	0.26	0.28±0.03
	Twin	31	3.96±0.12		30.69±0.71		44.30±1.06		0.27±0.03
Total CAM		61	4.14±0.08	0.10	33.69±0.51	0.01	46.41±0.76	0.16	0.28±0.05
Total Malya		68	3.95±0.08		30.85±0.48		44.95±0.72		0.27±0.03

CAM - Central Anatolian Merino; DLWG - daily live weight gain.

Table 5 - Fleece characteristics of Central Anatolian Merino (CAM) and Malya sheep

	Age	Fiber diameter (µ)					Fiber length (mm)				
		n	mean±SEM	Min	Max	CV (%)	n	mean±SEM	Min	Max	CV (%)
CAM	Weaning	22	24.1±0.36b	20.5	26.7	7.16	22	28.1±1.21c	15.0	35.0	20.15
	150th day	30	24.9±0.31b	20.3	27.8	6.89	30	83.6±2.06a	70.0	105.0	13.49
	1 year	42	25.9±0.30a	21.1	31.9	7.70	42	64.6±1.05b	50.0	80.0	10.58
	Total	94	25.1±0.20	20.3	31.9	7.82	94	62.1±2.28	15.0	105.0	35.69
Malya	Weaning	30	24.5±0.35b	21.0	29.8	7.85	30	34.3±1.06d	25.0	45.0	16.98
	150th day	30	24.9±0.39b	21.7	29.7	8.55	30	71.5±2.92e	45.0	115.0	22.42
	1 year	30	26.3±0.37a	22.8	29.7	7.78	30	63.6±1.85b	50.0	85.0	15.96
	Total	90	25.3±0.23	21.0	29.8	8.49	90	56.5±2.07	25.0	115.0	34.83

SEM - standard error of the mean; CV - coefficient of variation.
a,b - Different letters in the same column represent statistically significant differences (P<0.01).

Table 6 - Comparison of fleece characteristics of the two breeds by age periods

	Age	CAM	Malya	P
Fiber diameter (µ)	Weaning	24.1±0.36	24.5±0.35	0.41
	150th day	24.9±0.31	24.9±0.39	0.90
	1 year	25.9±0.30	26.3±0.37	0.43
Fiber length (mm)	Weaning	28.1±1.21	34.3±1.06	0.01
	150th day	83.6±2.06	71.5±2.92	0.01
	1 year	64.6±1.05	63.6±1.85	0.63

CAM - Central Anatolian Merino.

4. Discussion

This study examined the characteristics of several productive traits related to growth and fleece production in CAM and Malya sheep. Furthermore, we evaluated various pieces of information about some reproductive indices. The results revealed that the birth rates of the CAM breed in this study were similar to the rates of the same breed reported by Thieme et al. (1999a; 92.2%) and Karakuş and Aşkın (2007; 93.44%) but higher than those reported by Ünal and Akçapınar (2001; 80.8%). Birth rates of Malya breed in this study were lower than the rates of the same breed reported by Çolakoğlu and Özbeyaz (1999; 87.72%) and Karakuş and Aşkın (2007; 93.94%). The twinning rates for CAM and Malya sheep in this study were lower than those determined by Thieme et al. (1999a; 27.1%) and Ünal and Akçapınar (2001; 39.6%) for CAM breed and those determined by Çolakoğlu and Özbeyaz (1999; 29.4-44.6%) for Malya breed. Finally, the survival rates at weaning of the Malya breed were similar to those reported by Çolakoğlu and Özbeyaz (1999; 91.40-96.24%) and by Aktaş et al. (2016; 91.40-96.24%) for CAM sheep. It is possible that different reproductive features may be related to different environmental conditions, such as maintenance, climate, and feeding conditions.

In general, the direct heritability estimates of traits of CAM sheep were moderate for birth weight, weaning weight, and average daily weight gain, as found to be 0.22, 0.32, and 0.33, respectively (Behrem, 2021). One of the most important factors affecting the survival of lambs is birth weight (Dalton et al., 1980; Hinch et al., 1985). In this study, although the birth weight of Malya sheep was higher than that of CAM sheep, the opposite result was observed for weaning weight (at 90 days; P<0.01; Table 3). The DLWG of CAM sheep was greater than that of Malya sheep at weaning (Table 3). The reason for the lower birth weight of CAM breed may be due to the lower average birth weight of female CAM (Table 4). In the literature (Chaudhry et al., 1982; Singh et al., 1984; Hinch et al., 1985; Cloete et al., 2001; Ünal and Akçapınar, 2001; Mortimer et al., 2018), birth weight (3.30-4.60 kg) and weaning weight (16.7-32.9 kg) of Merino sheep raised in different countries were similar to those of CAM sheep in this study. The average birth weights of CAM and Malya sheep in this study were lower than those determined by Çolakoğlu and Özbeyaz (1999; 4.59 kg) in Malya sheep and by Ünal and Akçapınar (2001; 4.41-4.71 kg) and Aktaş et al. (2016; 4.14 kg) in CAM sheep. The weaning weights (at 90 days) determined in this study were higher than those reported by Thieme et al. (1999b; 17.10 kg) and Ünal and Akçapınar (2001; 19.74-21.06 kg) in CAM lambs (at 75 days) but weaning weight of Malya was lower than those reported by Çolakoğlu and Özbeyaz (1999; 31.80 kg) in Malya lambs (at 105 days).

The source of variation in weaning weights among these studies may be the different weaning ages used by the different studies. The DLWG of CAM sheep was higher than that of Malya sheep at weaning (Table 3). A comparison was made between the DLWG of CAM and Malya lambs in this study and the DLWG of other local sheep breeds in Turkey. The DLWG in this study were higher than those reported by Akçapınar (1981) in Dağlıç, White Karaman, and Kıvırcık sheep; by Tekin et al. (1993) in White Karaman and İvesi sheep; and by Esen and Yıldız (2000) in White Karaman sheep.

The mean weaning weights obtained before fattening of male lambs (90th day) were approximately 33.69 and 30.85 kg for CAM and Malya lambs, respectively; the live weights after the final fattening of male lambs (150th day) were 46.41 and 44.95 kg, respectively, and the DLWG in fattening were 0.28 and 0.27 kg, respectively (Table 4). Although the average live weights of CAM lambs at the beginning of fattening were higher (P<0.01), there was no difference in live weights at the end of fattening, indicating that Malya lambs had better fattening performance. In this study, the average live weights of CAM lambs at the end of fattening were higher than those determined by Koçak et al. (2016; 44.00 kg) in the same breed. The average live weights of Malya lambs after fattening were higher than the values reported by Çolakoğlu and Özbeyaz (1999; 41.48 kg) and Karabacak and Boztepe (2007; 40.80 kg) for the same sheep breed. The differences in live weights at the end of fattening may be a result of feeding differences.

A comparison was made between the average live weight after the final fattening of male CAM and Malya lambs in this study and the same weight measure of other local sheep breeds in Turkey. Results showed that the weights in this study were higher than those reported by Sarıçiçek et al. (1996) in Karayaka sheep, by Işık and Kaya (2011) in Tuj sheep, by Sen et al. (2013) in Karayaka sheep, and by Sarı et al. (2014) in Hemşin sheep. It can be concluded that Merino genotype has a positive effect on these differences.

Average daily weight gain determined for CAM and Malya sheep at the end of fattening (0.28 and 0.27 kg, respectively; Table 4) was higher than those in other intensive feeding studies reported by Eliçin et al. (1982) in White Karaman lambs (0.17 kg), by Macit et al. (1997) in Tuj lambs (0.23 kg), by Esen and Yıldız (2000) in White Karaman lambs (0.24 kg), by Altın et al. (2005) in Kıvırcık lambs (0.25 kg), by Sen et al. (2013) in Karayaka lambs (0.20 kg), by Yıldırım et al. (2013) in Karayaka male lambs (0.21 kg), and by Önk et al. (2017) in Tuj male lambs (0.22 kg). However, the results of this study were similar to those in an intensive feeding study reported by Sen et al. (2011) in Karayaka male lambs (0.27 kg) and by Gökdal et al. (2012) in Kıvırcık twin male lambs (0.265 kg). The reason for this may be that Merino genotype increases fattening performance in local sheep breeds.

Fiber diameters of both sheep breeds in the first year of age were thicker (P<0.01) than the fibers from other age periods (Table 5). This result agrees with reports in the scientific literature (Mullaney et al., 1969; Swan and Purvis, 2000; Hatcher et al., 2005). Fiber diameters of CAM and Malya sheep were similar to those reported by Çolakoğlu and Özbeyaz (1999; 24.61 µm) in Malya sheep and by Tuncer and Cengiz (2018; 25.16 µm) in CAM sheep, but were higher than those reported earlier by Ünal and Akçapınar (2001; 22.19 µm) and Arık et al. (2003; 23.46 µm) in CAM sheep.

In this study, the longest average fleece lengths from the CAM and Malya sheep were measured on the 150th day (P<0.01). The average fleece length was higher in CAM sheep than in Malya sheep. This may be caused by the different Merino genotype ratio. The fleece fiber lengths of both sheep were lower than the lengths reported by Çolakoğlu and Özbeyaz (1999; 10.27 cm) in Malya sheep and by Ünal and Akçapınar (2001; 7.45 cm) and Tuncer and Cengiz (2008; 13.12 cm) in CAM sheep, but the lengths in this study were higher than those reported by Arık et al. (2003; 4.78 cm) in CAM sheep.

In the literature reported earlier in this discussion, the differences observed in fleece diameters and lengths from the same breeds are likely due to the differences of shearing seasons and factors such as age, management strategies, and genetic backgrounds of the animals.

5. Conclusions

The results of this study indicate that the weight at the beginning of fattening and the birth rate of Central Anatolian Merino sheep were better than those of Malya sheep, but the birth weight and survival rate of Malya lambs at weaning are higher. Although Central Anatolian Merino lambs had higher weights at the beginning of fattening, there was no statistically significant difference in live weights at the end of fattening. Moreover, with regard to the fattening performance, Malya lambs slightly outperformed Central Anatolian Merino lambs. Furthermore, no significant difference in fleece quality was observed between the adult members of the two breeds. We hope that the results of this research will contribute to breeding studies as well as increasing the income of breeders.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: S. Behrem and S.S. Tuncer. Data curation: S. Behrem and H.H. Şenyüz. Formal analysis: S. Behrem and H.H. Şenyüz. Investigation: S. Behrem and S.S. Tuncer. Methodology: S.S. Tuncer and H.H. Şenyüz. Resources: S. Behrem and S.S. Tuncer. Software: S.S. Tuncer. Supervision: S.S. Tuncer. Validation: S. Behrem and H.H. Şenyüz. Visualization: S. Behrem and H.H. Şenyüz. Writing-original draft: S. Behrem and S.S. Tuncer. Writing-review & editing: S.S. Tuncer.

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