Journal homepage: http://www.sasas.co.za/journals

South African Journal of Animal Science 2019, 49 (No. 1)

Short communication

Increasing the productivity of Morkaraman sheep through crossbreeding with prolific Romanov sheep under semi-intensive production systems

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(Received 28 May 2018; Accepted 24 January 2019; First published online 27 March 2019)

Abstract

The aim of this study was to evaluate the effects of cross-breeding Turkish indigenous Morkaraman (M) ewes with prolific Romanov (R) rams on the reproduction and performance traits, growth traits, slaughter and carcass characteristics of the crossbred offspring under semi-intensive production systems. No significant differences were observed between M and RxM for number of ewes lambing. The differences between M and RxM for number of lambs born alive, number of weaned lambs, number of lambs surviving up to 120 days, and up to the end of pasture were significant. Average birth, weaning, and post-grazing weights of lambs were 3.71 kg, 17.81 kg and 23.93 kg and 2.89 kg, 17.14 kg, and 22.32 kg in M and RxM lambs, respectively. The weight difference between M and R x M lambs at birth and at the end of the grazing period was significant. M had higher end-of-pasture and slaughter weight. After the grazing period, the slaughter characteristics of ram lambs were investigated. The differences between M and RxM lambs were significant for weight of slaughter, hot and cold carcass, tail fat, and organs (testis, heart and lung). Additionally, M lambs had a larger *longissimus dorsi* area than RxM lambs. It was evident that the M lambs had higher growth and slaughter values and some carcass characteristics than RxM crossbred lambs. It was concluded that, under the climate and management-nutritional conditions of the region, purebred M is a more suitable breed than RxM crossbreds.

Keywords: Reproduction, growth performance, slaughter traits, carcass characteristics
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Introduction

The livestock sector plays a significant role in Turkey. Red meat consumption is based on cattle, sheep and goats for religious, cultural and economic reasons. Sheep meat forms an important part of red meat consumption, as is evident from the percentage of animals that were slaughtered in 2015 in Turkey, namely 35% cattle, 47% sheep and 19% goats (Anon, 2016). Over recent years the demand for meat has increased with the developing economy (Esenbuga *et al.*, 2009). The meat yield characteristics of many indigenous sheep breeds are usually lower than those of exotic or improved breeds. High reproductive performance, carcass quality, and low input cost are important to ensure profitable production in sheep breeding (Macit *et al.*, 2001). The efficiency of lamb production is affected by reproduction, mothering ability and milk production of the ewes, and growth rate and survival rate of the lambs (Rao & Notter, 2000; Mishra *et al.*, 2007; Gavojdian *et al.*, 2013).

The Morkaraman (M) is a fat-tailed breed that is reared extensively in the eastern and north-eastern parts of Turkey. It is assumed that the current M breed is the result of natural selection under difficult environmental conditions. Production levels reported for this breed are typical of an unimproved mountain breed. For centuries, Eastern Anatolian farmers have used the M breed to produce meat, milk and wool (Macit, 2002; Esenbuga *et al.*, 2009). The Romanov (R) is a prolific sheep breed that is adapted to cold climatic conditions with superior reproductive characteristics. This breed has been used in cross-breeding

URL: http://www.sasas.co.za
ISSN 0375-1589 (print), ISSN 2221-4062 (online)
Publisher: South African Society for Animal Science
http://dx.doi.org/10.4314/sajas.v49i1.21

activities in recent years, because it is a polyoestrous breed that often produces multiple lambs (Cemal & Karaca, 1999; Aslan, 2008).

The aim of this study was to evaluate the effect of cross-breeding Turkish indigenous M ewes with prolific R sires on the productivity, performance traits, slaughter and carcass characteristics of their crossbred offspring under semi-intensive production systems.

Material and Methods

The experiment was carried out at the Research and Application Farm of the Agriculture Faculty, Atatürk University, Erzurum, Turkey. Eighty-two purebred M ewes and 51 RxM crossbred (50% M x 50% R) ewes were used. The ewes were kept under intensive conditions. The ages of the ewes ranged from two to seven years. The purebred M ewes were mated to M rams and the RxM crossbred ewes were mated to RxM rams for 4 5 - 60 days between October and December. The lambs (78 M and 72 RxM) were born from April to May. They were identified and weighed at birth and kept with their dams in an open barn. All lambs were weighed within 24 hours of birth and their birth weight, birth type, breed, sex, dam age, and birth date were recorded.

The ewes were fed 2 kg/day (± 0.2 kg) of roughage and 300 g/day (± 50 g) of a concentrate mixture (13% crude protein, 8.7% crude cellulose, 2% crude fat, 9% crude ash, and 2400 Kcal ME per kg) during the gestation period and at lambing. All lambs were allowed to suckle freely for a two-month period. Thereafter, the lambs were weaned and left to graze on dryland pasture. In the pasture, the primary forage plants were *Festuca ovina*, *Bromus tomentalus*, *Medicago* sp., *Koleleria cristata* and *Onobrychis* sp. After weaning, in addition to grazing on pastures, the amount of concentrate feed available to lambs was calculated each fortnight, based on 1.5% - 2.0% of total bodyweight (Alkass *et al.*, 1985). The lambs had access to the concentrate feed, which consisted of barley (43%), corn (25%), soybean meal (11%), wheat bran (5%), molasses (8%) and sunflower meal (8%), premix (0.05%), salt (0.95%) and di-calcium phosphate (3%). The concentrate mixture contained 88% dry matter, 12.6% crude protein, 7.8% crude fat and 2800 Kcal ME/kg. Feeding and management practices were applied equally to all lambs.

Number of ewes mated, number of ewes that lambed, number of lambs born, and born alive, and number of lambs weaned, lamb survival up to the 120th day and the end of grazing were recorded, and reproduction parameters were calculated. The effects of breed and age of the ewe (174 days old) on these parameters were estimated. Birth weights, weaning weights and end-of-pasture weights of all lambs were recorded and daily weight gain during certain periods was calculated. The effects of breed, age of dam, sex and birth type on the growth traits was also estimated (SPSS, 2010).

Following the grazing period, 4 M and 5 RxM lambs (between 181 and 220 days old), which were selected randomly, were fasted for a 24-hour period and their slaughter weight was recorded (SPSS 2010). At the time of slaughter, head, skin, feet and offal were removed from the carcass, and hot carcass weights were recorded. The carcasses were numbered and kept in the cold storage room at +4 °C for 24 hours. Following the resting process, cold carcass weights were determined and the kidney, kidney fat and pelvis fat were extracted from the cold carcass and weighed separately. Cold carcasses were evaluated for marbling, and yield grade and proportion yield of boneless retail cuts were calculated as described by Boggs & Merkel (1984). Weighed carcasses were divided into two halves along the medial line and divided into cuts in compliance with the standards (Anon, 1973) and each cut was weighed. Before dividing, the tail was removed from the carcass between the tail vertebra and end-rump vertebra, and then weighed. Kidney-pelvis fats were obtained together, but weighed separately. Carcasses were divided into 10 cuts, namely shoulder, neck, rib, loin, sirloin, leg, hind shank, fore shank and breast and flank, apart from the tail. The marbling score on the *longissimus dorsi* (LD) muscle, which was observed between the 12th and 13th vertebrae, was evaluated by two experienced assessors. Yield grade was calculated through the formula (Burson & Doane, 1983):

Yield grade = 0.4 + [10 x external fat thickness (inch)]

Marbling scores were calculated: slight+ (12), slight (11), slight- (10).

The GLM procedure of SPSS (SPSS, 2010) was used to analyse the data. The *t*-test procedure was applied during the assessment of slaughter and carcass characteristics. During this evaluation, slaughter weight was included in the model as a covariate. Differences between groups were determined with Duncan's multiple comparison test.

Results and Discussion

The reproductive performances of Morkaraman and RxM ewes are given in Table 1, and the effects of breed and age of dam on reproductive performance and survival ability of the lambs are given in Table 2.

Table 1 Reproductive performance of Morkaraman and Romanov x Morkaraman (RxM) crossbreds ewes

Traits	Morkaraman	RxM
Number of ewes mated	82	51
Number of ewes lambing	72	46
Ewes with single lambs	66	21
Ewes with multiple lambs	6	25
Number of lambs born	78	73
Number of lambs born alive	78	72
Number of lambs weaned	75	62
Number of ewes lambing / number of ewes mated (%)	0.88	0.90
Single birth rates per ewes lambing (%)	0.92	0.46
Multiple birth rates per ewes lambing (%)	0.08	0.54

Table 2 Effect of breed and age of dam on reproductive performance of and survival ability of the lambs (± SE)

	N	Number of ewes lambing / number of ewes mated	Number of lambs born alive / number of ewes lambing	Number of weaned lambs / number of ewes lambing	Number of surviving lambs up to 120 days / number of ewes lambing	Number of surviving lambs up to the end of pasture / number of ewes lambing
Breed		ns	*	*	*	*
Morkaraman	82	0.88 ± 0.04	1.08 ± 0.08	1.04 ± 0.06	1.02 ± 0.06	1.01 ± 0.07
RxM	51	0.90 ± 0.07	1.56 ± 0.15	1.35 ± 0.12	1.26 ± 0.11	1.15 ± 0.13
Age of ewe		*	*	*	*	*
2	54	$0.87^{b} \pm 0.04$	$1.17^{b} \pm 0.06$	$1.02^{b} \pm 0.06$	$1.00^{b} \pm 0.06$	$0.85^{b} \pm 0.07$
3	39	$0.87^{b} \pm 0.05$	$1.28^{b} \pm 0.07$	$1.20^{b} \pm 0.07$	$1.15^{b} \pm 0.07$	$1.01^{b} \pm 0.09$
4	2	$1.00^{a} \pm 0.21$	$1.48^{a} \pm 0.28$	$1.40^{a} \pm 0.31$	$1.40^{a} \pm 0.29$	$1.35^{a} \pm 0.35$
5	11	$1.00^{a} \pm 0.09$	$1.49^{a} \pm 0.12$	$1.36^{a} \pm 0.14$	$1.19^{b} \pm 0.13$	$1.19^{b} \pm 0.15$
6	5	$1.00^{a} \pm 0.17$	$1.38^{ab} \pm 0.22$	$1.28^{ab} \pm 0.24$	$1.13^{b} \pm 0.24$	$1.13^{b} \pm 0.28$
7 ≥	22	$0.50^{c} \pm 0.09$	$1.11^{b} \pm 0.09$	$1.10^{b} \pm 0.10$	$1.10^{a} \pm 0.09$	$1.05^{b} \pm 0.11$

[a, b] Mean values with different superscript differ significantly (P <0.05)
* P <0.05, ns: non-significant,
RxM: Romanov x Morkaraman crossbreds

The breed of the ewe had a significant effect on the number of lambs weaned and the survival rate of lambs at all stages, but no effect on the number of ewes that lambed. Crossbred ewes produced significantly more lambs compared with M ewes. This can be explained through the higher prolificacy of the pure Romanov breed (Turkyilmaz, 2013). The current findings are similar to those of Gootwine & Goot (1996) for Awassi, East Friesian and their crossbred ewes, of Esenbuga & Dayioglu (2002a) for Awassi and Morkaraman, and of Kremer *et al.* (2010) for Corriedale and Friesian x Corriedale crossbred ewes.

The effects of lamb genotype, sex, birth type and age of dam on the growth traits of the lambs from birth until the end of the grazing period are given in Table 3. The differences in birth weights and end-of-

pasture weights were significant between M and RxM lambs (P <0.05). Age of dam influenced the birth weight of lambs significantly. Accordingly, the highest birth weight was obtained from the lambs born to four-year-old dams. The lowest birth weight was for lambs born to two-year-old dams, for which these were their first lambs. Birth weights of male lambs were significantly heavier than the female lambs and their end-of-pasture weights and daily live-weight gain were also significantly higher.

Table 3 Effect of lamb genotype, sex, birth type and age of dam on growth traits of lambs from birth until the end of the grazing period (± SE)

Sources	N	Birth weight (kg)	Weaning weight (kg)	DWG during pre-grazing period (kg)	End-of-pasture weight (kg)	DWG during grazing period (kg)
Genotype		*	ns	ns	*	*
Morkaraman	78	3.71 ± 0.09	17.811 ± 0.64	0.165 ± 0.048	23.93 ± 0.74	0.093 ± 0.008
RxM	72	2.89 ± 0.09	17.143 ± 0.63	0.168 ± 0.043	22.32 ± 0.56	0.081 ± 0.006
Age of dam		*	ns	ns	ns	ns
2	56	2.89^{c} ± 0.08	16.03 ± 0.54	0.169 ± 0.044	22.80 ± 0.65	0.087 ± 0.007
3	43	3.21^{bc} ± 0.09	16.43 ± 0.54	0.166 ± 0.045	22.70 ± 0.66	0.083 ± 0.007
4	4	3.97^{a} ± 0.29	18.18 ± 1.81	0.161 ± 0.055	23.66 ± 1.45	0.082 ± 0.015
5	20	2.98^{c} ± 0.13	17.74 ± 0.95	0.174 ± 0.047	23.21 ± 0.72	0.084 ± 0.007
6	6	3.38^{b} ± 0.23	19.10 ± 1.44	0.176 ± 0.052	22.45 ± 1.18	0.077 ± 0.012
7≤	21	3.35^{b} ± 0.13	17.38 ± 0.82	0.152 ± 0.046	23.94 ± 0.79	0.111 ± 0.008
Sex		*	ns	ns	*	*
Female	86	3.20 ± 0.08	17.46 ± 0.51	0.160 ± 0.045	20.33 ± 0.58	0.062 ± 0.007
Male	64	3.40 ± 0.09	17.50 ± 0.57	0.173 ± 0.046	25.92 ± 0.62	0.112 ± 0.008
Type of birth		*	*	ns	ns	ns
Single	86	3.54 ± 0.09	18.43 ± 0.62	0.165 ± 0.045	23.25 ± 0.48	0.080 ± 0.006
Multiple	64	3.06 ± 0.09	16.53 ± 0.59	0.168 ± 0.046	22.99 ± 0.47	0.094 ± 0.006

$^{a, b, c}$ Mean values with different superscripts are significantly different at P <0.05
* P <0.05, ns: non-significant
DWG: daily weight gain
RxM: Romanov x Morkaraman crossbreds

Single-born lambs were heavier (P <0.05) than multiple-born lambs in terms of birth weight, weaning weight and end-of-pasture weights. Unlike the results of this study, where growth performance in purebred lambs was higher than in crossbred lambs, in a study on the growth characteristics of purebred Awassi, Charollais x Awassi and Romanov x Awassi crossbred lambs by Abdullah *et al.* (2010), it was found that Charollais x Awassi lambs had the highest (P <0.05) daily live weight gain and Awassi lambs the lowest. Contrary to this study, Kremer *et al.* (2010) stated that breed and type of birth did not significantly affect birth weight. In agreement with this study, dam age had a significant effect on birth weight. In another study comparing growth performance between purebred and crossbred ewes (Assaf ewes and American Suffolk x Assaf), Rosov & Gootwine (2013) reported no significant difference owing to breed for birth weight and growth after weaning in contrast to this study. However, crossbred lambs were significantly superior in terms of daily weight gain before weaning. The differences could be attributed to breed and environmental factors.

Birth weight obtained in this study was higher than the values reported by Macit *et al.* (2001) and lower than those reported by Esenbuga & Dayioglu (2002b) and Ozturk *et al.* (2012) for Morkaraman lambs and lower than Macit *et al.* (2001) for RxM lambs. The birth weights in a study of Paim *et al.* (2013) were similar for M lambs, and heavier for RxM lambs, and daily live weight gain up to weaning and in the grazing period were heavier for both M and RxM lambs. The weaning weight in this study was similar to those of Esenbuga & Dayioglu (2002b) for Awassi and M, and lower than the values reported by Macit *et al.* (2001) for Awassi, M, and Tuj lambs and their crossbred lambs. The end-of-pasture weights and daily live weight increases at

pasture were lighter than the end-of pasture weights and reduced daily live weight increases at pasture by Macit *et al.* (2001) and Esenbuga & Dayioglu (2002b) for Awassi and M.

Slaughter and carcass characteristics of M and RxM lambs are summarized in Table 4. Slaughter weights were heavier (P <0.05) for M ram lambs than RxM ram lambs. Significant differences were observed between M and RxM lambs for hot carcass weight and cold carcass weight. The marbling, fat thickness, yield grade and retail cuts in the M and RxM ram lambs were similar except for the LD area. LD area was greater for M lambs than RM lambs.

Table 4 Slaughter and carcass characteristics of Morkaraman and Romanov x Morkaraman (RxM) crossbreds lambs (± SE)

	Morkaraman (n = 4)	**R x M (n = 5)**
Slaughter weight (kg)	$36.66^{a} \pm 1.30$	$29.89^{b} \pm 1.17$
Hot carcass weight (kg)	$16.67^{a} \pm 0.65$	$13.34^{b} \pm 0.58$
Hot dressing percentage (%)	45.46 ± 1.48	44.61 ± 1.13
Cold carcass weight (kg)	$16.23^{a} \pm 0.64$	$12.96^{b} \pm 0.57$
Cold dressing percentage (%)	43.26 ± 1.12	43.75 ± 1.30
Marbling	10.25 ± 0.85	10.00 ± 0.84
LD area (cm^2)	$13.94^{a} \pm 0.62$	$10.87^{b} \pm 1.06$
Fat thickness over LD (mm)	1.83 ± 0.30	1.36 ± 0.10
Yield grade	1.12 ± 0.04	0.94 ± 0.11
Retail cuts	48.83 ± 0.08	49.14 ± 0.18
Offal parts (kg)		
4 Feet	0.70 ± 0.02	0.66 ± 0.01
Head	2.03 ± 0.11	1.77 ± 0.09
Tail fat	$1.78^{a} \pm 0.21$	$0.27^{b} \pm 0.18$
Testicles	$0.26^{b} \pm 0.03$	$0.45^{a} \pm 0.02$
Skin	4.64 ± 0.42	3.14 ± 0.36
Spleen	0.06 ± 0.01	0.05 ± 0.01
Heart	$0.16^{b} \pm 0.01$	$0.22^{a} \pm 0.01$
Lung	$0.42^{b} \pm 0.03$	$0.59^{a} \pm 0.03$
Liver	0.45 ± 0.02	0.52 ± 0.02
Carcass cuts (kg)		
Neck	0.663 ± 0.095	0.812 ± 0.081
Shoulder	3.365 ± 0.271	2.426 ± 0.229
Fore shank and breast	2.305 ± 0.318	2.847 ± 0.268
Loin	3.063 ± 0.122	2.780 ± 0.103
Sirloin	2.316 ± 0.195	2.434 ± 0.164
Rib	1.420 ± 0.099	1.328 ± 0.084
Flank	0.337 ± 0.043	0.308 ± 0.037
Hind shank	1.042 ± 0.237	1.181 ± 0.200
Kidney	0.083 ± 0.005	0.080 ± 0.004
Kidney fat	0.113 ± 0.026	0.131 ± 0.022
Pelvis fat	0.025 ± 0.016	0.071 ± 0.014

[a, b] Mean values with different superscripts are significantly different at P <0.05
LD: *longissimus dorsi* muscle

The slaughter characteristics for purebred lambs in this study were lower than those reported by Abdullah *et al.* (2010), Yaprak (1997), Esenbuga *et al.* (2009), Ozturk *et al.* (2012), and were higher than those reported by Macit *et al.* (2002) and Ulusan *et al.* (1996) in terms of slaughter weight. The hot carcass weight for purebred lambs was lower than that reported by Abdullah *et al.* (2010), Esenbuga *et al.* (2009), Ozturk *et al.* (2012), Macit (2002), and Teke (2005), and was higher than that reported by Paim *et al.* (2013) and Erkus (2008). The cold carcass weight for purebred lambs was lower than that reported by Abdullah *et al.* (2010), Yaprak (1997), Esenbuga *et al.* (2009), Ozturk *et al.* (2012), and Macit (2002) and was higher than reported by Paim *et al.* (2013) and Erkus (2008). All the slaughter characteristics for crossbred lambs in this study were lower than those reported by Abdullah *et al.* (2010), Rodriguez *et al.* (2011), Souza *et al.* (2013) and were higher than reported by Paim *et al.* (2013).

Conclusion

Improving reproductive traits can have a bigger economic impact than merely improving growth rate. Because the Romanov is a highly prolific and precocious breed, crossbreeding with the Morkaraman breed will improve reproduction traits in terms of the number of lambs born and weaned. RxM crossbreeding improved fertility. However, survivability at different ages of RxM lambs decreased as the month proceeded, perhaps with having lower birth weights and failing to adapt to environmental conditions. However, the number of animals slaughtered per breed was not enough to obtain reliable estimates pertaining to carcass characteristics of lambs. Further investigations are needed to clarify the policy of crossbreeding programmes using Romanov sheep for meat production in Turkey.

Acknowledgements

This research is a project supported by the BAP unit of Atatürk University (2012/240).

Authors Contributions

NE designed the study and edited the manuscript, and DT collected the data and conducted statistical analyses of the data.

Conflict of Interest Declaration

The authors declare that they have no conflicts of interest.

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