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The Effect of Restricted Nutrition on Ewe Milking Performance and Lamb Growth Characteristics in Creep Feeding Conditions

Research Article

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ABSTRACT

Nutrient deficiency during lactation period negatively affects dams milk production and lamb growth performance. However, the effect of ewe nutrition level on growth rate of Karacabey Merino lambs raised with access to creep feeding is not clear. Therefore to study these effects, a total of 84 single lambed Karacabey Merino ewes (aged 3, 4, 5 years old, 68.05±0.96 kg of live weight (LW); 2.64±0.07 of body condition scores (BCS)), and their lambs (n=84) were divided into two feeding treatment groups: group with 32-35% (energy and protein) nutrient restriction (restricted feeding; RF) and control (control feeding; CF) group according to 100% of nutrient requirements. Lambs had free access to concentrate feed in creep feeding conditions until 96 days of weaning. Lactation milk yield was higher in CF group than RF group (P=0.01). Except for milk fat content (P=0.495), milking characteristics as daily milk yield, protein, lactose, and non-fat solids (NFS) contents of milk were found higher (P≤0.001) in CF group than RF group. Significant interaction was observed between feeding treatment groups (RF and CF) with lamb gender on the daily weight gain (P=0.01) and weaning weight (P=0.036) of the lambs. Male lambs in CF group were heavier than male lambs in RF group (P=0.01) while female lambs in both groups had similar weaning weight (P>0.05). Growth performance of male lambs was negatively affected by restricted nutrition of their dams, while no significant difference was observed in female lambs. Restricted ewe nutrition negatively affects the potential growth rate of suckling lambs in creep feeding condition.

KEY WORDS creep feeding, milk, restricted nutrition, sheep.

INTRODUCTION

Sheep regularly exposed to inadequate nutrition in traditional grazing systems (Pulina *et al.* 2012). Therefore, seasonal nutrient deficiency during lactation period negatively affects dams' milk productivity and lamb growth characteristics. Feeding practices in group conditions for highly productive breeds (Chillard *et al.* 1998), inadequate nutritive value of ration (Cannas, 2004), and economic concerns (Martin and Kadokawa, 2006) may cause inadequate nutrition in sheep production systems (Akbulut *et al.* 2021).

Karacabey Merino breed obtained by crossing German Mutton Merino rams, and Kıvırcık ewes (Yalçın, 1986; Koyuncu and Uzun, 2009), knowing with high growth performance and early lamb marketing in Turkey (Özcan *et al.* 2004; Koyuncu, 2008; Sezenler *et al.* 2013). Creep feeding is a practice providing suckling lambs with concentrate feed while their dams have no access to feed that offered to lambs. Positive lamb growth responses from creep feeding reported in several studies (Wilson *et al.* 1971; Brand and Brundyn, 2015; Martinez *et al.* 2015). Wilson *et al.* (1971), reported that creep feeding increased DWG 28-36 g/head/d comparing non-creep feeding lambs. The effect of ewe nutrition level on ewe performance and lamb growth in creep feeding conditions for specific breeds are not clearly revealed so far.

Underfed animals mobilize their body reserves, and the loss of body reserves is substantial depending on restriction level and duration (Ribeiro *et al*. 2019). Change of live weight (LW) and body condition score (BCS) throughout the year are common criteria to observe the state of nutritional status of ewes (Calderia *et al*. 2007). Body reserves at birth, and the mobilization of body fat reserves during early lactation are important factors affecting milk production (Cannas, 2004). Late gestation maternal nutrition may also decrease offspring metabolic parameters such as insulin and IGF-1 in suckling lambs (Kiani, 2013). Milk yield and its content mainly depend on feeding conditions (Nickerson, 1995; Caja and Bocquier, 2001). Accordingly, seasonal nutrient deficiency of lactating ewes may limit ewe milk productivity and their lamb growth until weaning. Because lambs' nutrient intake depends on ewes' milk for their early life, after consuming solid foods milk dependency gradually declines (Hernandez and Hohenboken, 1980; Croston and Pollott, 1994; Degen and Benjamin, 2005). Improving lactating ewe nutrition may improve growth rate of their lambs with increasing milk yield (Titi and Obeidat, 2008; Hutton *et al*. 2011), and may increase profitability of lamb meat production (Galvani *et al*. 2014; Brand and Brundyn, 2015).

Therefore, the aim of this study was to investigate the effects of the adequate and restricted feeding level of ewe nutrition on the LW, BCS, milk yield, milk contents and the pre-weaning growth performance of suckling lambs in creep feeding practices.

MATERIALS AND METHODS

Çanakkale Onsekiz Mart University Ethical Council of Animal Research (2010/4-03) approved all the experimental protocols and animal welfare was the first priority when dealing with animals throughout the experiment.

Experimental site

This experiment was carried out at the experimental farm of the Sheep Research Institute located in Northwest Turkey (40˚ 21 N; 27˚ 52 E) at altitude of 65 m. The mean ambient temperature and annual rainfall in this region were 14-31 ˚C and 500-700 mm respectively (TSMS, 2019).

Animals, experimental design and feeding

After parturition, single lambed ewes (n=84) and their lambs (n=84) were used. Ewes were divided into two groups (control feeding (CF), and restricted feeding (RF), based on live weight (LW) 68.05±0.96 kg), body condition scores (BCS; 2.64±0.07), age (3-5 year) and lambs' gender (n=84; 42 males, 42 females). Lambs' LWs were recorded before morning feeding by using an electronic scale in every two weeks while LWs of the ewes were measured monthly. BCSs scaling were determined by an experienced person and LW has been recorded monthly during the experiment period according to 1-5 scale (Russel *et al*. 1969). The feeding plan was estimated 100% of nutrient requirements for control ewes (CF) and around 32-35% of energy and protein restriction for restricted ewes (RF) for lactation according to NRC (2007) (Table 1). The creep feeding system was used for lambs' nutrition. Lambs were kept with their dams all day for the first ten days after birth. After ten days, lambs were separated from their dams and two times daily allowed for suckling morning and afternoon at 08:00 and 16:00, respectively. Suckling time was decreased progressively from 60 minute to 30 minute after two months of lactation. Ewe concentrate feed formulated 60% wheat, 18% wheat bran, 20% sunflower seed meal, 0.1% mineral vitamin premixes, 0.4% salt and 1.5% $CaCO_3$. Lamb concentrate feed formulated 60% wheat, 12% wheat bran, 25% sunflower seed meal, 0.1% min-vit. 1.0% salt and 1.9% $CaCO_3$. The dried samples were ground using a 1 mm sieve, and analyzed for dry matter (DM), crude protein (CP), ash and ether extract (EE) (AOAC, 1985). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) content were analyzed according to method described by Van Soest *et al*. (1991). Metabolic energy (ME) levels of the feeds used in the study was calculated by means of the equation proposed by TSE (1991). ME, kcal/kg OM= 3260 + 0.455 (A) – 4.037 (H) + 3.517 (B), A= crude protein, g/kg OM, H= crude fiber, g/kg OM and B= ether extract, g/kg OM.

Milk yield and contents

Ewes milk yield that determined control milking was assumed consumed by lambs. Lambs were separated from their dams for 10 hours at the milk control day. Morning and afternoon milking was carried out following day (morning milking at 08:00, and afternoon milking next day at 16:00) not to suffering the development of the lambs. Later on, in the morning and afternoon daily milk yield (DMY) and lamb milk consumption were recorded. From test-day milk yields, 96 d milk yields were estimated by the Holland method (Lactation yield=mean of test day yields×lactation duration (days)) (Özcan, 1989). Lactation milk yield were estimated by milk yield and contents (fat, protein, dry matter and lactose, %) were measured 14 day intervals during the 96 day of suckling period at 7 control days. Milking was performed by hand and recorded with 2 g precision weighing scales.

Table 1 Chemical composition of feeds and daily nutrient intake for ewes and lambs

Feed/nutrients	Feeding treatments[1]		Lambs
	Control feeding	Restricted feeding	
Chemical composition, % as DM			
Concentrate			
DM	91.0	91.0	88.5
CP	14.58	14.58	15.19
NDF	24.82	24.82	20.02
ADF	10.63	10.63	12.37
EE	2.40	2.40	2.30
Vetch			
DM	88.50	88.50	-
CP	16.51	16.51	-
NDF	42.07	42.07	-
ADF	30.82	30.82	-
EE	2.10	2.10	-
Alfa alfa forage	-	-	
DM	-	-	90.50
CP	-	-	16.43
NDF	-	-	46.72
ADF	-	-	24.45
EE	-	-	2.90
Nutrient intake (head.d^{-1})			
Concentrate (g/head/d)	1.000	500	Ad-lib
Vetch (g/head/d)	500	500	-
Alfa-alfa (g/head/d)	-	-	100
DM (g/head/d)	1.353	898	-
ME (kcal/head/d)	4.155	2.722	-
CP (g/head/d)	199	135	-

[1] The feeding plan was 100% of nutrient requirements for control feeding (CF) and around 32-35% of energy and protein restriction for restricted feeding (RF) for lactation according to NRC (2007).
DM: dry matter (% of fresh weight); ME: metabolizable energy; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber and EE: ether extract.

Protein, fat, non-fat solid and lactose components were monitored as milk nutrients. Milk samples (50 g) were taken to falcon tubes in the morning and afternoon to determine milk nutrient components. Milk samples kept one day long in the refrigerator 4 ˚C for analysis. Then, taken an average of data from morning and afternoon milks and were used in calculation of average. Milk composition of protein, fat, fat-free dry matter and lactose were analyzed by automated near-infrared spectroscopy.

Data calculation and statistical analyses

Daily concentrate feed intake was calculated as the difference between feed offered and refused by lambs in group based. The calorific value of milk was calculated by adding the energy from protein, fat and lactose using as energy values of 23.4, 39.3, and 17.6 MJ/kg for fat, protein and lactose, respectively (Economides, 1986). All analyses were performed with SAS version 9.3 (SAS, 2014). Data for milk yield, milk contents (fat, protein, milk dry matter, density and lactose) and daily weight gain (DWG) of lamb were analyzed with repeated measured analysis of variance using Proc-Mixed.

The model included the fixed effects of nutrition treatment; CF, and RF, lamb gender (male, female), dam age (3-5 years), experimental periods (12, 26, 40, 54, 68, 82 and 96th days) and the interaction of these factors. Data for lamb birth weight and body weight at weaning were analyzed with ANOVA. Post-hoc comparisons were performed with the Tukey test with a significance level of P < 0.05.

RESULTS AND DISCUSSION

Ewes average LW (68.05±0.96kg), and BCS (BCS; 2.64±0.07) were similar (P>0.05) between CF and RF groups at the beginning of the study (Figure 1 a and b). Ewes in CF group lose 10 kg of BW and 0.2 BCS, while ewes in RF group lose 15 kg BW and 0.75 BCS at the end of the 3 months of early lactation period (P=0.001).

As shown in Table 2, except milk fat content (P=0.495), ewes in CF group had higher (P≤0.001) DMY, milk contents of protein, lactose, and non-fat solids (NFS) than RF group. Accordingly, total milk yield (TMY) was higher (P=0.001) in CF ewes than RF ewes (Table 2). Milk fat content was higher in older ewes than younger (P<0.001).

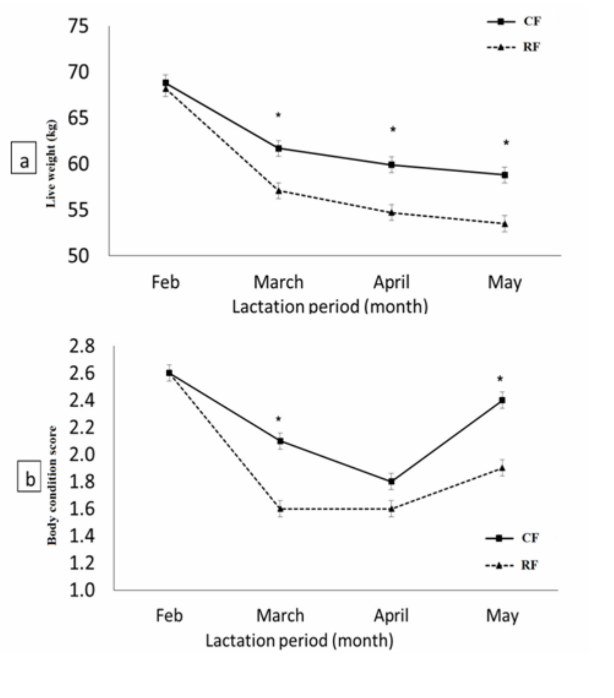

Figure 1 The changes of live weight (a) and body condition score (b) of ewes according to group (CF and RF) in timeline for lactation periods. Error bars represent standard errors of LSMEANS. At each time point, LSMEANS accompanied by an asterisk (*) indicate a significant difference (P<0.05)

In contrast, lactose content was higher in three aged ewes than five aged ewes (P=0.010). Average DMY decreased from 660 g/d at the beginning of lactation to 290 g/d at 96th day of lactation (Figure 2).

Nutrient consumption estimated 135 g/head/d CP and 2.7 kcal/head/d ME in RF ewes while 199 g/head/d CP and 4.2 kcal/head/d ME in CF ewes. Feeding treatment and age interaction was significant on the DMY, milk protein, milk NFS and milk density (P<0.05). Protein, NFS content and density value were similar in all ages in restricted group while found significant between four and five aged ewes in control group (P=0.001).

Feeding treatment (control *vs*. restricted) and period interaction was significant for all milk characteristics (Table 2; P<0.05). Stage of lactation significantly (P<0.01) affected milk quantity and protein, lactose, fat and NFS content. DMY, protein and lactose content were affected from age and treatment interaction (P≤0.05). DMY was found lowest in 3 year ewes in RF group while all ages were similar.

Lamb growth performance

Birth weights was similar (P=0.606) for CF lambs and RF lambs (5.3±0.11 kg) without any significant interaction with feeding treatment. Lamb BW, DWG, and WW were found significant (P<0.05) between dams age. Mean DWG, and WW of lambs from four aged dams were higher than lambs from three and five aged dams (P<0.01). Mean daily concentrate feed consumption of lambs were determined 579.44 g/d, and 595.00 g/d for CF and RF groups respectively (Table 3). Mean concentrate feed intake of lambs increased from 23 $g.d^{-1}$ at 12 days to 1170 $g.d^{-1}$ at 96 days while daily milk offer decreased from 663 $g.d^{-1}$ to 290 $g.d^{-1}$ for the same period (Figure 2). In total, lambs from control and restricted ewes had 48.67 and 49.98 kg concentrate feed consumption and 45.30 kg and 38.80 kg milk offer respectively for 96 days of creep feeding. Average DWG were 313.3 ± 6.01 g/d and 292.7 ± 6.01 g/d for CF and RF lambs, respectively (P=0.016). Lambs WW were 35.3 ± 0.62 kg and 33.5 ± 0.62 kg for CF and RF lambs, respectively (P=0.050).

A significant interaction (P<0.05) between feeding treatment (CF *vs*. RF) and lamb gender was observed at the different control days (Table 4). The interaction effects of lamb gender and ewes feeding treatment was significant on mean DWG (P=0.01) and WW (P=0.036; Figure 2b) of lambs. Mean DWG of male lambs in control group was higher (P=0.010) than male and female lambs in both groups.

In this study, RF had negative significant effect on ewes LW, BCS, milk yield and milk content and lamb performance. In several studies, LW and BCS of Karacabey Merino ewes were reported 62-71 kg, and 2.3-3.5, respectively (Oğan, 1994; Batmaz and Başpınar, 1999; Altınel *et al*. 2000; Köycü *e al*. 2008).

Decreasing LW and BCS in early lactation is inevitable results in lactating animals due to they have possibly highest nutritional requirements in this physiological stage. In this study, nutritional treatments resulted in a difference of 5.45 kg and 0.55 mean LW and BCS of ewes between the CF and RF groups. Milk yields of Karacabey Merino were reported around 97-100 kg for 140-141 days of lactation period (Başpınar *et al*. 1996; Yılmaz and Altınel, 2003). However, milk protein, fat, and lactose contents has not been reported for the Karacabey Merino. Results of this study were in harmony with the several studies for average values protein (5.0-6.3%), fat (4.3-8.7%), and lactose (4.0-5.5%) content (Jandal, 1996; Sevi *et al*. 2000; Ochoa-Cordero *et al*. 2002; Ciuryk *et al*. 2004; Pulina *et al*. 2005; Park *et al*. 2007).

Nutrition markedly affects sheep milk composition. In this study milk fat content was similar between CF and RF groups. Both feeding treatment group (RF and CF) lost body weight.

Milk yield and its composition had also changed according to the stage of lactation, and daily yield declined with the lactation progress. While fat, protein and NFS content increased, lactose content decreased during the later stage of lactation.

Table 2 Least square means of the milk yield and milk contents according to feeding treatment and age during suckling period

Parameter[2]	Feeding treatment[1]			Age				FT × age
	CF	RF	P ≤	3	4	5	P ≤	
TMY (kg)	45±1.73[a]	39±1.73[b]	0.010	43±2.12	41±2.12	42±2.12	0.880	0.176
DMY (g/d)	476±8.59[a]	409±8.59[b]	0.001	447±10.52	433±10.52	447±10.52	0.570	0.001
Protein (%)	6.1±0.01[a]	5.9±0.01[b]	0.001	6.0±0.01	6.0±0.01	6.0±0.01	0.923	0.001
Fat (%)	5.1±0.06	5.0±0.06	0.495	4.8±0.07[b]	5.0±0.07[b]	5.4±0.07[a]	0.001	0.229
Lactose (%)	4.3±0.01[a]	4.1±0.01[b]	0.001	4.3±0.01[a]	4.2±0.01[ab]	4.2±0.01[b]	0.010	0.070
NFS (%)	11.5±0.02[a]	11.0±0.02[b]	0.001	11.3±0.03	11.3±0.03	11.2±0.03	0.566	0.006

CF: control feeding; RF: restricted feeding; TMY: total milk yield; DMY: daily milk yield and NFS: non-fat solids.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

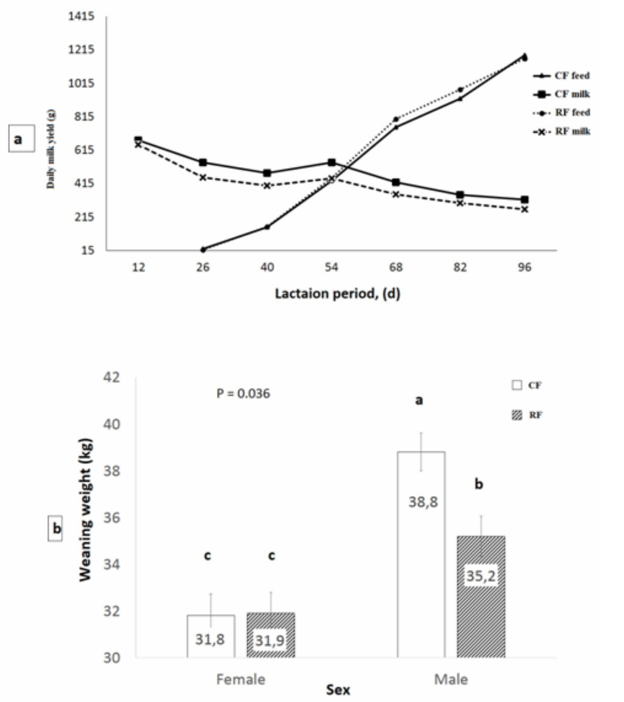

Figure 2 a) daily milk yield (g), and concentrate feed consumption of lambs (g) according to feeding treatment of ewes (CF *vs*. RF)
b) weaning weight of lambs at the 96 day according to feeding treatment of ewes (CF *vs*. RF), and lamb gender
[abc] Different letters and asterisk indicate significant differences among groups (P<0.05)

In agreement with previous studies on milk protein, fat and NFS content of the sheep milk increased with stage of lactation and lactose decreased (Brett *et al*. 1972; Ploumi *et al*. 1998; Ochoa-Cordero *et al*. 2002; Ciuryk *et al*. 2004; Molik *et al*. 2008). Lactose content decreased slightly and the highest value obtained at the first control day in contrast to protein and fat content. Lactation stage, milking interval and weaning time may affect chemical composition of sheep milk (Angeles-Hernandez *et al*. 2020). Milk protein is largely affected by nutritional factors. Dietary-protein solubility and degradability and energy availability at rumen level can largely affect this fraction, especially milk urea (Nudda *et al*. 2020).

Creep time (or suckling time) of lambs would be a dimension for lambs' nutrient intake in addition to dams' feeding conditions. Therefore, creep time may affect both lamb and ewe performance. In this study, during the creep feeding, the lambs had the access to suckling only two times a day with their mother for 1-2 hours in total. Therefore, the conditions that lambs consume all milk produced by their dams are controversial. Lambs dramatically start to consume more solid food at day 40 during creep feeding. Accordingly, creep time had to be restricted to prevent disturbing dams. Improving dams' nutrient may increase growth rate of their offspring (Galvani *et al*. 2014; Brand and Brundyn, 2015).

Alexandre *et al*. (2001), reported a significant difference in DWG of lams from high level fed ewes than adequate and restricted ewes. A significant interaction between lamb gender and feeding treatment was found on the growth performance of lambs.

As a result of interaction between lamb gender and nutritional treatments of dams, male lambs in CF group had higher WW than male lambs in RF group, while female lambs had similar WW in both group. This may be speculate to that male lambs have higher DWG (348 g/d) comparing female (280 g/d). In this case, the nutrient requirements of ewes may evaluate depending on whether they have female or male lambs.

Karacabey Merino breed lambs extensively practices based concentrate diet plus milk from dams in creep feeding condition until weaning around 90-120 days results in 38-40 kg live-weight at slaughter. Several studies evaluated weights of lambs at birth, weaning and fattening performance of Karacabey Merino after weaning (Akgündüz *et al*. 1993; Tekin and Akçapınar, 1994; Altınel *et al*. 2000; Sezenler *et al*. 2013).

Karacabey Merino lambs DWG and WW (around 90 day) were reported as 260-290 g/d, and 26-31 kg respectively (Tekin and Akçapınar, 1994; Özcan *et al*. 2004; Koyuncu and Uzun, 2009). In this study mean DWG and WW of lambs were found higher. Main reason can be explaining here lamb performances evaluated singleton animals and the positive affect of creep feeding.

Table 3 Lambs milk consumption and nutrient intakes according to feeding treatments

Character	Feeding treatments[1] CF	RF	SEM	P
Estimated milk consumption				
Estimated milk intake (g/d)	475.85[a]	409.14[b]	18.29	0.001
Dry matter intake (g/d)	76.87[a]	64.29[b]	1.41	0.001
Estimated milk protein intake (g/d)	28.80[a]	23.91[b]	0.52	0.001
Estimated energy intake (kcal/d)	483.12[a]	403.77[b]	8.86	0.001
Lamb nutrient intake				
Concentrate feed intake (g/d)	579.44	595.00	186.00	-
Feed protein intake (g/d)	77.89	79.99	-	-
Feed energy intake (kcal/d)	1333	1369	-	-

CF: control feeding and RF: restricted feeding.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 Least square means of the lamb daily weight gain (g) and weaning weight (kg) in different rearing periods according to feeding treatments of dams and lamb gender

Days	Feeding treatments[1]				Feeding treatment × lamb gender					
	CF	RF	SEM	P-value	CF Male	CF Female	RF Male	RF Female	SEM	P-value
0-12	289.2	262.6	11.36	0.918	321.4	257.0	251.4	273.9	15.58	NS
12-26	257.0	259.4	11.36	1.000	274.7	239.4	281.9	236.7	15.58	NS
26-40	296.3[a]	238.8[b]	11.36	0.019	324.5[a]	268.1[ab]	235.4[b]	242.2[ab]	15.58	< 0.05
40-54	341.0	316.3	11.36	0.952	388.1[a]	293.9[b]	325.9[ab]	306.8[ab]	15.58	< 0.05
54-68	351.7	347.9	11.36	1.000	379.4	323.9	346.9	348.9	15.58	NS
68-82	353.2	328.9	11.36	0.958	400.2[a]	306.2[bc]	370.8[ab]	287.1[c]	15.58	< 0.05
82-96	304.6	294.7	11.36	1.0000	346.4a	262.8[b]	323.5[ab]	265.9[ab]	15.58	< 0.05
0-96	313.3[a]	292.7[b]	11.43	0.016	347.8[a]	278.7[b]	305.0[b]	280.2[b]	8.34	0.010
Weaning weight	35.3[a]	33.5[b]	0.61	0.050	38.8[a]	31.8[c]	35.2[b]	31.9[c]	0.86	0.036

CF: control feeding and RF: restricted feeding.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.
NS: non significant.

It is assumed that potential high growth rate of male lambs could not achieve as a result of dams' restricted feeding condition (32-35% energy and protein restriction) during suckling period while no difference was observed in female lambs. Therefore, lamb growth performance was negatively affected from low level feeding of their dams and high growth performance of Karacabey Merino lambs declined when ewes fed under the nutrient requirements of lactation.

CONCLUSION

The results of the study provide new evidence for the sheep breed of Karacabey Merino that known for high growth performance and early lamb marketing. Breeder widely practice indoor feeding of ewes combined with creep feeding of lambs in winter. Dams have the highest nutrient requirements during early lacation in the different physiological periods. Even in grazing condition ewes may not compensate their nutrient requirements. Restricted nutrition (32-35% energy and protein restriction) decreased ewe LW, BCS, milk yield, some milk contents (protein, lactose and NFS) during early lactation. Lamb growth performance was also decreased with the interaction of lamb gender in restricted ewes. Considering that possible feed restrictions depending on the production conditions, special care can be taken to feeding of ewes with fattening male lambs. However, the dimensions of feed restriction remain important in rearing conditions for the lambs in creep feeding practices.

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REFERENCES

Akbulut N.K., Harman H., Kal Y. and Kırbaş M. (2021). Examination of blood cortisol and some parameters at parturition and on 30th day postpartum in single and twin-pregnant ewes.

Livest. Stud. **61(2),** 55-59.

Akgündüz V., Ak İ., Deligözoğlu F., Karabulut A. and Filya İ. (1993). Effects of different protein sources on fattening performance and carcass characteristics of Merino male lambs conducted to intensive fattening. *Lalahan Hayvan. Araşt. Derg*. **33(1),** 28-48.

Alexandre G., Archimede H., Chevaux E., Aumont G. and Xande A. (2001). Feeding supply of suckling Martinik ewes reared in intensive conditions effects of supplement levels and litter size. *Ann. Zootech*. **50,** 213-221.

Altınel A., Güneş H., Yılmaz A., Kırmızıbayrak T. and Akgündüz V. (2000). Comparison of the important production traits of Turkish Merino and indigenous Kıvırcık sheep breed. *J. İstanbul Univ. Vet. Fac*. **26(2),** 527-542.

Angeles-Hernandez J.C., Alberto R.V., Kebreab E., Appuhamy J.A.R.N., Dougherty H.C., Castelan-Ortega O. and Gonzalez-Ronquillo M. (2020). Effect of forage to concentrate ratio and fat supplementation on milk composition in dairy sheep: A meta-analysis. *Livest. Sci*. **238,** 104069.

AOAC. (1985). Official Methods of Analysis. Vol. I. 13th Ed. Association of Official Analytical Chemists, Arlington, VA, USA.

Başpınar H., Oğan M., Batmaz E.S., Petek M. and Karamustafaoğlu M. (1996). An investigation on the main production performances of Karacabey Merino sheep under semi-intensive conditions. I. Fertility traits, milk production and body weight at mating. *J. Cent. Anim. Res. Inst*. **6(1),** 40-44.

Batmaz E.S. and Başpınar H. (1999). A study on the decrease lambing interval of Karacabey Merino sheep under semi-intensive conditions. *Turkish J. Vet. Anim. Sci*. **23(4),** 665-672.

Brand T.S. and Brundyn L. (2015). Effect of supplementary feeding to ewes and suckling lambs on ewe and lamb live weights while grazing wheat stubble. *South African J. Anim. Sci*. **45(1),** 89-95.

Brett D.J., Cornett J.L. and Inskip M.W. (1972). Estimation of the energy value of ewe milk. *Proc. Australian Soc. Anim. Prod*. **9,** 286-291.

Caja G. and Bocquier F. (2001). Effects of nutrition on the composition of sheep's milk. Pp. 210 in Sheep and Goat Nutrition: Intake, Digestion, Quality of Products and Rangelands. I. Ledin, Ed. CIHEAM Zaragoza, Zaragoza, Spain.

Calderia R.M., Belo A.T., Santos C.C., Vazques M.I. Portugal A.V. (2007). The effect of long-term feed restriction and over-nutrition on body condition score, blood metabolites and hormonal profiles in ewes. *Small Rumin. Res*. **68,** 242-255.

Cannas A. (2004). Feeding of lactating ewes. Pp. 79-108 Dairy Sheep Nutrition. G. Pulina, Ed. CAB International, Wallingford, Oxon, United Kingdom.

Chillard Y., Bocquier F. and Doreau M. (1998). Digestive and metabolic adaptations of ruminants to under nutrition, and consequences on reproduction. *Reprod. Nutr. Dev*. **38,** 131-152.

Ciuryk S., Molik E., Kaczor U. and Bonczar G. (2004). Chemical composition of colostrum and milk of Polish Merino sheep lambing at different times. *Arch. Tierz*. **47,** 129-134.

Croston D. and Pollott G. (1994). Animal Resources in Planned Sheep Production. Blackwell Science Publication, United Kingdom.

Degen A.A. and Benjamin R.W. (2005). Milk and herbage intakes and growth rate of lambs from 32 to 130 days of age raised on natural pasture in the semi-arid Negev. *Small Rumin. Res*. **58,** 39-45.

Economides S. (1986). Comparative studies of sheep and goats: Milk yield and composition and growth rate of lambs and kids. *J. Agric. Sci*. **106,** 477-484.

Galvani D.B., Pires C.C., Hübner C.H., Carvalho S. and Wommer T.P. (2014). Growth performance and carcass traits of early-weanedlambs as affected by the nutritional regimen of lactating ewes. *Small Rumin. Res*. **120,** 1-5.

Hernandez T.G. and Hohenboken W. (1980). Relationships between ewe milk production and composition and pre-weaning lamb weight gain. *J. Anim. Sci*. **50,** 597-603.

Hutton P.G., Kenyon P.R., Bedi M.K., Kemp P.D., Stafford K.J., West D.M. and Morris S.T. (2011). A herb and legume sward mix increased ewe milk production and ewe and lamb live weight gain to weaning compared to a ryegrass dominant sward. *Anim. Feed Sci. Technol*. **164,** 1-7.

Jandal J.M. (1996). Comperative aspects of goat and sheep milk. *Small Rumin. Res*. **22,** 177-185.

Kiani A. (2013). Plasma levels of anabolic hormones in suckling lambs are affected by late gestational nutrition. *Iranian J. Appl. Anim. Sci*. **3(4),** 755-760.

Köycü E., Sezenler T., Özder M. and Karadağ O. (2008). The relationship between body weight and body condition score in Karacabey Merino ewes. *J. Tekirdağ Agric. Fac*. **5(1),** 61-65.

Koyuncu M. (2008). Growth performance and carcass quality of fattening lambs of Kıvırcık and Karacabey Merino breeds. *Livest. Res. Rural Dev*. **20,** 12-24.

Koyuncu M. and Uzun Ş.K. (2009). Growth performance of Karacabey Merino and Kıvırcık lambs under semi-intensive management in Turkey. *Small Rumin. Res*. **83,** 64-66.

Martin G.B. and Kadokawa H. (2006). Clean, green and ethical' animal production. case study. Reproductive efficiency in small ruminants. *J. Reprod. Dev*. **52,** 145-152.

Martínez M.E., de la Barra R. and de la Fuente F. (2015). Effect of early creep feeding in the performance of Chilota breed lambs. *J. Livest. Sci*. **6(11),** 56-64.

Molik E., Murawski M., Bonczar G. and Wierzchoś E. (2008). Effect of genotype on yield and chemical composition of sheep milk. *Anim. Sci. Pap. Rep*. **26(3),** 211-218.

Nickerson S.C. (1995). Milk production: Factors affecting milk composition. Pp. 3-24 in Milk Quality, F. Harding, Ed. Springer, Boston, Massachusetts.

NRC. (2007). Nutrient Requirements of Sheep. National Academy Press, Washington, DC, USA.

Nudda A., Atzori A.S., Correddu F., Battacone G., Lunesu M.F., Cannas A. and Pulina G. (2020). Effects of nutrition on main components of sheep milk. *Small Rumin. Res*. **184,** 106015-106024.

Ochoa-Cordero M.A., Torres-Hernandez G., Ochoa-Alfaro A.E., Vega-Roque L. and Mandeville P.B. (2002). Milk yield and composition of Rambouillet ewes under intensive management. *Small Rumin. Res*. **43,** 269-274.

Oğan M. (1994). Possibilites of improving important production characteristics of Karacabey Merino through selection. I. performance levels for different characteristics. *Livest. Stud. J.* **34(1),** 47-58.

Özcan L. (1989). Küçükbaş Hayvan Yetiştirme-II. Çukurova Üniversitesi. Ziraat Fakültesi Yayınları, Adana, Turkey.

Özcan M., Ekiz B., Yılmaz A. and Ceyhan A. (2004). The effects of some environmental factors affecting on the growth and greasy fleece yield at first shearing of Turkish merino (Karacabey Merino) lambs. *J. Fac. Vet. Med. Istanbul Univ*. **30(2),** 159-167.

Park Y.W., Ju´arez M., Ramos M. and Haenlein G.F.W. (2007). Physico-chemical characteristics of goat and sheep milk. *Small Rumin. Res*. **68,** 88-113.

Ploumi K., Belibasaki S. and Triantaphyllidis G. (1998). Some factors affecting daily milk yield and composition in a flock of Chios ewes. *Small Rumin. Res*. **28,** 89-92.

Pulina G., Macciotta N. and Nudda A. (2005). Milk composition and feeding in the Italian dairy sheep. *Italian J. Anim. Sci*. **4,** 5-14.

Pulina G., Nudda A., Battacone G., Dimauro C., Mazzette A., Bomboi G. and Floris B. (2012). Effects of short-term feed restriction on milk yield and composition, and hormone and metabolite profiles in mid-lactation Sarda dairy sheep with different body condition score. *Italian J. Anim. Sci*. **11(2),** 150-158.

Ribeiro D.M., Madeira M.S., Kilminster T., Scanlon T., Oldham C., Greeff J., Freire J.P.B., Mourato M.P., Prates J.A.M. and Almeida A.M. (2019). Amino acid profiles of muscle and liver tissues of Australian Merino, Damara and Dorper lambs under restricted feeding. *J. Anim. Physiol. Anim. Nutr*. **103(5),** 1295-1302.

Russel A.J.F., Doney J.M. and Gunn R.G. (1969). Subjective assessment of body fat in live sheep. *J. Agric. Sci*. **72,** 451-454.

SAS Institute. (2014). SAS®/STAT Software, Release 9.1.3. SAS Institute, Inc., Cary, NC. USA.

Sevi A., Taibi L., Albenzio M., Muscio A. and Annicchiarico G. (2000). Effect of parity on milk yield, composition, somatic cell count, renneting parameters and bacteria counts of Comisana ewes. *Small Rumin. Res*. **37,** 99-107.

Sezenler T., Soysal D., Yıldırır M., Yüksel M.A., Ceyhan A., Yaman Y., Erdoğan İ. and Karadağ, O. (2013). Influence of some environmental factors on litter size and lamb growth performance in Karacabey Merino sheep. *J. Tekirdag Agric. Fac*. **10(1),** 40-47.

Tekin M. and Akçapınar H. (1994). The comparison of growth, fattening and carcass characteristics of Turkish Merino and Lincoln x Turkish Merino and Lincoln (F1) lambs. I. Growth and survival rate. *Turkish J. Vet. Anim. Sci*. **18,** 181-187.

Titi H.H. and Obeidat B.S. (2008). Effects of Ca salt supplementation on milk yield and composition and on lamb growth rate of Awassi ewes. *Livest. Sci*. **119,** 154-160.

TSE. (1991). Metabolic Energy Estimation in Animal Feed (Chemical method), TSE 9610, Ankara, Turkey.

TSMS. (2019). Turkish State Meteorological Service. WebMD. https://mgm.gov.tr/ Accessed Dec. 2020.

Van Soest P.V., Robertson J.B. and Lewis B.A. (1991). Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci*. **74,** 3583-3597.

Wilson L.L., Varela-Alvarez H., Hess C.E. and Rugh M.C. (1971). Influence of energy level, creep feeding and lactation stage on ewe milk and lamb growth characters. *J. Anim. Sci*. **33(3),** 686-690.

Yalçın B.C. (1986). Sheep and goats in Turkey. Food and Agriculture Organization of the United Nations, Animal Production and Health Paper, Rome, Italy.

Yılmaz A. and Altınel A. (2003). The effects of some environmental factors affecting on the milk production and growth characteristics of the German Black-Headed Mutton × Fj (Chios×Kıvırcık) crossbreds in comparison with Kıvırcık and Turkish Merinos. *J. Fac. Vet. Med. Istanbul Univ*. **29(2),** 259-266.