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Research Article

Effect of urea and oregano oil supplementation on growth performance and carcass characteristics of lamb fed diets containing different amounts of energy and protein

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Abstract: The experiment was carried out using a 4 × 4 factorial design. There were 16 experimental groups. Each group consisted of 3 lambs. The experiment lasted 56 days. During the experiment, the oregano oil (0 and 5 g/kg DM) and urea (0, 6, 12, and 18 g/head per day) were given to lambs consuming low energy/low protein diets (2350 Kcal/kg DM/ 10.80% CP/DM, respectively) and normal energy/normal protein (2600 Kcal/kg DM, 14.97% CP/DM, respectively) diets. Daily body weight gain of lambs consuming normal energy/normal protein diets and supplemented with 6, 12 and 18 g/head per day urea were significantly (P < 0.01) higher compared to those consumed low energy/low protein diets and supplemented with oregano oil. The voluntary feed intake of lambs consuming the normal energy/normal protein diets supplemented with urea (6, 12 and 18 g/head per day) was lower compared to lambs consuming low energy/low protein diets supplemented with oregano oil and urea. On the other hand, the feed efficiency of lambs consuming the normal energy/normal protein diets supplemented with urea (6, 12 and 18 g/head per day) was significantly (P < 0.01) higher compared to lambs consuming the low energy/low protein diets supplemented with oregano oil and urea. The supplementation of urea to lambs consuming the low energy/low protein diets and the normal energy/normal protein diets increased the weight of cold carcass. The supplementation of urea had no significant (P > 0.01) effect on the other carcass characteristics.

Key words: Lamb nutrition, urea, oregano oil, growth performance, carcass characteristics

Farklı düzeylerde enerji ve protein içeren kuzu besi rasyonlarına kekik yağı ve üre ilavesinin kuzu besi performansı ve karkas özellikleri üzerine etkisi

Özet: Araştırma 4 × 4 faktöriyel deneme desenine göre düzenlemiştir. Her grupta 3 baş kuzu bulunan ve 16 grup ile yürütülen araştırma 56 gün sürmüştür. Araştırma süresince kuzulara düşük enerji/düşük protein (DE (2350 kcal/kg KM)/DP (% 10,80 HP/KM)) ve normal enerji/normal protein (NE (2600 kcal/kg KM)/NP (% 14,97 HP/KM)) içeren rasyonlarla birlikte kekik yağı (KY (0 ve 5 g/kg KM)) ve üre (günde 0, 6, 12 ve 18 g/baş) verilmiştir. Araştırma sonucunda NE/NP ve günde 6, 12, 18 g/baş düzeyinde verilen üre kuzuların toplam ve günlük ortalama canlı ağırlık kazancını DE/DP, KY ve üre verilen tüm kuzulara göre artırmıştır (P < 0,01). Bunun yanı sıra NE/NP ile birlikte günde 6, 12, ve 18 g/baş düzeyinde verilen üre, DE/DP ile birlikte verilen KY ve üreye göre kuzuların günlük ortalama yem tüketimlerini düşürürken (P < 0,01), yemden yararlanma düzeylerini artırmıştır (P < 0,01). Aynı şekilde DE/DP ve NE/NP'li rasyonlarla birlikte günde 6, 12, 18 g/baş düzeyinde verilen üre dozlarının soğuk karkas ağırlığını artırdığı saptanmış (P < 0,01), diğer karkas özelliklerine ise etkisi olmamıştır. Araştırmada rasyonlara katılan KY'nın diğer gruplara göre kuzuların besi performansı ve karkas özellikleri üzerine herhangi bir etkisinin olmadığı saptanmıştır (P > 0,01).

Anahtar sözcükler: Kuzu besisi, üre, kekik yağı, besi performansı, karkas özellikleri

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Introduction

There are several factors affecting the growth performance and carcass characteristics. Energy, protein content of ration, and growth promoters are the main factors affecting growth performance and carcass characteristics of lambs (1). Some experiments showed that daily weight gain and feed efficiency increased with increasing level of energy and protein (2), whereas voluntary feed intake was affected in a different way. Although Stanton and Swanson (1) showed that the increase in energy level of ration did not affect the voluntary feed intake, the increase in energy level of ration decreased the voluntary feed intake. On the other hand, Glimp (3) and Görgülü and Öztürkcan (2) showed that the increase in energy level of ration increased the voluntary feed intake. The increase in the protein level of ration increased the growth performance of lambs (4). The non-protein nitrogen (NPN) can be used to increase the crude protein level of ruminant ration (5). Urea can be used as a nitrogen source in ration to meet 25% of the total protein requirement of lambs (6).

Recently, the use of aromatic plant and essential oil derived from aromatic plant has gained importance since they have antimicrobial characteristic and stimulate digestion. Oregano oil is one of the plant extracts used due to its antimicrobial characteristics and potential to increase enzyme production and activity (7) in monogastric animals and poultry (8). Recently, inclusion of oregano hay (0.4 and 8 kg/t) in lamb's diets had no positive effect on growth performance and carcass characteristics (9).

The aim of this study was to determine the effect of urea and oregano oil supplementation on growth performance and carcass characteristics of lambs consuming diets with different energy and protein levels.

Materials and methods

Approximately 48 Merino lambs (3.5–4-month-old) were obtained from Marmara Livestock Research Institute, Bandırma, Turkey. Lambs fed on diets containing wheat straw, wheat grain, barley grain, wheat bran, sunflower meal, dicalcium phosphate, salt, vitamin and mineral mixtures, oregano oil, and urea (Table 1). The oregano oil obtained by steam distillation was purchased from a company in İzmir, Turkey. The oregano oil consists of 78.9% carvacrol and 6.8% thymol. Commercial urea consists of 46% nitrogen.

Four different diets were prepared to feed the lambs (Table 1). Four different diets, namely low

Table 1. Chemical composition of diets used in the current experiment.

Feedstuffs, %	Diet 1	Diet 2	Diet 3	Diet 4
Wheat grain	20.0	20.0	30.0	30.0
Barley grain	35.0	35.0	32.0	32.0
Wheat bran	5.0	5.0	5.0	5.0
Sunflower meal	8.0	8.0	16.0	16.0
Wheat straw	30.0	30.0	15.0	15.0
Dicalcium phosphate	1.0	1.0	1.0	1.0
NaCl	0.9	0.9	0.9	0.9
Mineral -Vitamin mixture*	0.1	0.1	0.1	0.1
Constituents, %				
Organic matter	93.80	93.80	94.20	94.20
Crude protein	10.80	10.80	14.97	14.97
Crude oil	2.46	2.46	2.50	2.50
Crude fiber	19.10	19.10	14.80	14.80
Ash	6.20	6.20	5.80	5.80
NFE	60.27	60.27	61.88	61.88
ME, kcal/kg KM	2350	2350	2600	2600

*Per 1 kg Mineral -Vitamin mixture: 150 mg $ZnSO_47H_2O$, 80 mg $MnSO_4H_2O$, 200 mg MgO, 5 mg $CoSO_47H_2O$, 1 mg KIO_3 and 5000 IU vitamin A, 1000 IU vitamin D, 20 IU vitamin E

NFE: nitrogen free extract, ME: Metabolizable energy.

energy-low protein with and without oregano oil (diets 1 and 2), normal energy-normal protein (diets 3 and 4) with and without oregano oil, were used (10). The diets 2 and 4 were supplemented with oregano oil. The oregano oil at 5 g/kg DM was included thoroughly into one of the portions. Then 2 diets were obtained after inclusion of oregano oil into diets. The resultant mixtures were then stored in nylon bags with 50 kg capacity. The chemical composition of the diets used in the current experiment is given in Table 1. In addition, dissolved urea in water (300 mL) was given to lambs at 0, 6, 12, and 18 g/head per day twice daily orally at 1000 am and 0200 pm.

Forty eight lambs were randomly divided into 16 groups. Each group contains 3 lambs. The experimental design was a 4 × 4 factorial design. All lambs were fed ad libitum and given free access to fresh water. The lambs were adapted to the diets for 1 week followed by growth trial of 56 days. The feed intake and body weight gain was determined at 2 weeks intervals.

At the end of growth trials, lambs were slaughtered in a private company in Bursa, Turkey. All carcasses were kept at 4 °C for 24 h. The carcasses were disassociated by the method described by Bogner and Matzke (11). Disassociation of lamb carcasses is shown in the Figure. According to this method carcasses were divided into 3 pieces, namely, front part (1), cutlet (2), and leg (3). The primary carcass characteristic of slaughtering lambs such as the cold carcass, front part, cutlet, leg, and dressing percentage were determined.

Chemical analysis

Dry matter (DM), ash, crude protein (CP), ether extract (EE), and crude fiber (CF) contents of the diets used in the current experiment were determined by the method of AOAC (12). Nitrogen free extract (NFE) content was determined by the formula; NFE: (organic matter - (crude protein + ether extract + crude fiber)). Metabolizable energy contents of diet were determined by the formula below (13):

ME (kcal/kg OM) = 3260 + 0.455 × crude protein + 3.517 × ether extract - 4.037 × crude fiber

Statistical analysis

Data obtained in the current experiment were subjected to the analysis of variance (ANOVA) (14). Significance between individual means was identified using the Duncan test (15). Mean differences were considered significant at $P < 0.01$ and $P < 0.001$. Standard errors of means were calculated from the residual mean square in the analysis of variance.

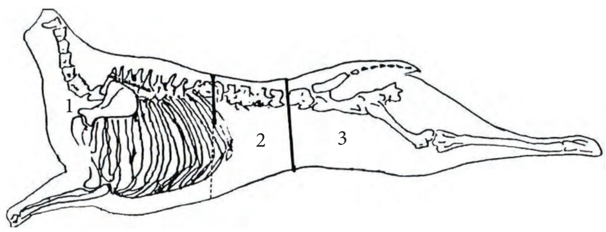

Figure. Disassociation of lamb carcasses.

Results

During the feeding experiment, the body weight gain was determined and is given in Table 2. Although the highest body weight gain was found in lambs fed with diet 4 and 12 g urea, the lowest body weight gain was found in lambs fed with diet 1 and without urea ($P < 0.01$). During feeding experiment the daily feed intake and feed conversion rate of lambs were also determined and given in Table 3. During feeding experiment the lowest daily feed intake was found in lambs fed with diet 4 and 18 g urea/day, the highest daily feed intake was found in lambs fed with diet 2 containing oregano oil without urea ($P < 0.01$). The slaughtering and carcass characteristics of lambs are given in Table 4. The cold carcass weight increased with increasing energy, protein, and urea level of diets ($P < 0.01$), on the other hand the other carcass characteristics were not affected by the level of energy, protein, and urea in diets ($P > 0.01$).

Discussion

In this study the effect of the supplementation of urea and oregano oil on the growth performance and carcass characteristics of lamb diets containing different levels of energy and protein were determined.

Data related to fattening performance are given in Table 2. As can be seen from Table 2, the final body weight ranged from 48.44 to 50.27 kg. The increase in the weight gain among lambs fed with diets 3 and 4

Table 2. The fattening performance of lambs.

		Fattening performance			
		Initial weight, kg	**Final weight, kg**	**Total weight gain, kg**	**Daily weight gain, g/day**
Diet 1		35.42	48.44^{b}	13.02^{b}	232.52^{b}
Diet 2		35.50	48.46^{b}	12.96^{b}	231.43^{b}
Diet 3		35.54	50.04^{a}	14.50^{a}	258.96^{a}
Diet 4		35.50	50.27^{a}	14.77^{a}	263.83^{a}
	SEM	***0.815***	***0.858***	***0.260***	***4.720***
	Sig.	***NS***	***	***	***
Urea	0 g	35.17	48.25^{b}	12.75^{c}	227.72^{b}
	6 g	35.50	49.37^{a}	13.88^{b}	247.88^{a}
	12 g	35.50	49.87^{a}	14.42^{a}	257.45^{a}
	18 g	35.50	49.71^{a}	14.21^{a}	253.74^{a}
	SEM	***0.801***	***0.338***	***0.338***	***4.720***
	Sig.	***NS***	**	**	**
Diet 1	0 g	35.17	47.08^{g}	11.92^{d}	212.89^{e}
	6 g	35.50	47.92^{efg}	12.42^{d}	221.70^{de}
	12 g	35.50	49.50^{bcd}	14.00^{abcd}	250.05^{abcd}
	18 g	35.50	49.25^{bcde}	13.75^{bcd}	245.53^{bcde}
Diet 2	0 g	35.50	47.67^{fg}	12.17^{d}	217.31^{de}
	6 g	35.50	49.08^{bcdef}	13.58^{bcd}	242.62^{bcde}
	12 g	35.50	48.08^{defg}	12.58^{cd}	224.73^{de}
	18 g	35.50	49.00^{cdef}	13.50^{bcd}	241.17^{bcde}
Diet 3	0 g	35.83	49.08^{cdef}	13.25^{bcd}	236.65^{cde}
	6 g	35.50	50.08^{abc}	14.58^{abc}	260.44^{abc}
	12 g	35.33	50.58^{ab}	15.25^{ab}	272.32^{ab}
	18 g	35.50	50.42^{abc}	14.92^{ab}	266.48^{abc}
Diet 4	0 g	35.50	49.17^{bcde}	13.67^{bcd}	244.04^{bcde}
	6 g	35.50	50.42^{abc}	14.92^{ab}	266.46^{abc}
	12 g	35.50	51.33^{a}	15.83^{a}	282.77^{a}
	18 g	35.50	50.17^{abc}	14.67^{abc}	261.90^{abc}
	SEM	***0.602***	***0376***	***0.376***	***8.441***
	Sig.	***NS***	**	**	**

Means within columns with different superscript differ significantly. * *P < 0.01; ** *P < 0.001.
SEM = Standard Error Mean; Sig. = Significant Level; NS: Non-significant

Table 3. The voluntary feed intake and feed efficiency of lambs fed with different diets.

Diets		**Feed intake parameters**	
		Voluntary feed intake, kg	**Feed efficiency, kg**
Diet 1		1.40[a]	6.09[a]
Diet 2		1.42[a]	6.17[a]
Diet 3		1.35[b]	5.23[b]
Diet 4		1.36[b]	5.17[b]
	SEM	***0.029***	***0.156***
	Sig.	***	***
Urea	0 g	1.41	6.26[a]
	6 g	1.39	5.63[b]
	12 g	1.37	5.39[b]
	18 g	1.36	5.38[b]
	SEM	***0.029***	***0.155***
	Sig.	***NS***	**
Diet 1	0 g	1.42[ab]	6.70[ab]
	6 g	1.42[ab]	6.40[abc]
	12 g	1.39[ab]	5.62[abc]
	18 g	1.39[ab]	5.65[abc]
Diet 2	0 g	1.49[a]	6.89[a]
	6 g	1.39[ab]	5.77[abc]
	12 g	1.39[ab]	6.19[abc]
	18 g	1.40[ab]	5.81[abc]
Diet 3	0 g	1.36[b]	5.77[abc]
	6 g	1.35[b]	5.19[abc]
	12 g	1.35[b]	4.95[bc]
	18 g	1.33[b]	5.02[bc]
Diet 4	0 g	1.38[ab]	5.67[abc]
	6 g	1.38[b]	5.16[abc]
	12 g	1.35[b]	4.81[c]
	18 g	1.32[b]	5.05[abc]
	SEM	***0.028***	***0.406***
	Sig.	**	**

Means within columns with different superscript differ significantly. * *P < 0.01; ** *P < 0.001.
SEM = Standard Error Mean; Sig. = Significant Level; NS: Non-significant

Table 4. The slaughter and carcass characteristics of lambs.

Diets		Carcass characteristics				
		Cold carcass weight, kg	**Leg, kg**	**Front part, kg**	**Cutlet weight, kg**	**Dressing percentage, %**
Diet 1		23.58[b]	8.53	12.95	1.57	48.62
Diet 2		23.81[b]	8.70	12.75	1.76	49.04
Diet 3		24.78[a]	8.90	13.33	1.65	49.58
Diet 4		24.83[a]	8.96	13.39	1.68	49.39
	SEM	***0.382***	***0.365***	***0.605***	***0.103***	***0.505***
	Sig.	**	***NS***	***NS***	***NS***	***NS***
Urea	0 g	23.73	8.38	12.97	1.69	49.16
	6 g	24.32	8.88	12.88	1.69	49.24
	12 g	24.94	9.16	13.50	1.61	49.90
	18 g	24.02	8.66	13.08	1.65	48.32
	SEM	***0.981***	***0.368***	***0.603***	***0.102***	***0.502***
	Sig.	***NS***	***NS***	***NS***	***NS***	***NS***
Diet 1	0 g	22.60[f]	8.27	12.20	1.67	48.10
	6 g	23.83[de]	8.97	12.43	1.73	49.55
	12 g	24.03[cde]	8.57	13.43	1.47	48.38
	18 g	23.87[cde]	8.30	13.73	1.39	48.43
Diet 2	0 g	22.97[ef]	7.70	12.77	1.82	48.03
	6 g	23.83[cde]	8.90	12.60	1.73	48.54
	12 g	24.43[bcd]	8.97	13.33	1.57	50.69
	18 g	24.00[cde]	9.23	12.30	1.91	48.91
Diet 3	0 g	24.20[bcde]	8.70	13.13	1.61	49.32
	6 g	24.87[abcd]	8.83	13.10	1.55	49.78
	12 g	25.87[a]	9.30	14.00	1.82	51.17
	18 g	24.20[bcde]	8.77	13.10	1.61	48.04
Diet 4	0 g	25.13[abc]	8.87	13.77	1.67	51.20
	6 g	24.73[abcd]	8.83	13.37	1.79	49.08
	12 g	25.43[ab]	9.80	13.23	1.57	49.37
	18 g	24.00[cde]	8.33	13.20	1.67	47.90
	SEM	***0.290***	***0.736***	***1.206***	***0.205***	***1.012***
	Sig.	**	***NS***	***NS***	***NS***	***NS***

Means within columns with different superscript differ significantly. * *P < 0.01.
SEM = Standard Error Mean; Sig. = Significant Level; NS: Non-significant

was significantly ($P < 0.001$) higher than those obtained in lambs fed diets 1 and 2. The body weight gain ranged from 12.96 to 14.77 kg. The highest body weight gain was obtained for lambs fed with diet 4. The lowest total increase in body weight was obtained from lambs fed with diet 2.

The final body weight of lambs supplemented with urea (0, 6, 12 and 18 g/head per day) ranged from 48.25 and 49.87 kg. The highest final body weight was obtained with lambs supplemented with urea at 12 g/head per day. The lowest final body weight was obtained with lambs which were not supplemented with urea ($P < 0.01$). When the effects of diet and urea supplementation were taken into consideration the final body weight ranged from 47.08 and 51.33 kg. The highest final body weight was obtained for lambs fed diet 4 and supplemented with 12 g urea/day. The total increase in body weight gain ranged from 11.92 to 15.83 kg. The increase in protein and energy had a positive effect on the total increase in body weight gain. The highest total increase in body weight gain was obtained for lambs fed diet 4 and supplemented with urea (12 g/head per day). The lowest total increase in body weight gain was obtained for lambs fed with diet 1 and non-supplemented with urea.

The diet had a significant ($P < 0.01$) effect on the daily body weight gain. Daily body weight gain ranged from 231.43 to 263.83 g. Daily body weight gain of lambs fed diets 3 and 4 was significantly higher than the others. There is a significant ($P < 0.01$) difference between lambs fed diets 2 and 4 supplemented with oregano oil in terms of total and daily body weight gain. The difference between the 2 groups could be the differences in the diets. The increase in energy and protein had a positive effect on the daily body weight gain. This result is in agreement with the findings of Cooper et al. (16) and Çimen and Özsoy (17). When the effect of urea supplementation was taken into consideration, the daily body weight gain for lambs non-supplemented with urea was significantly ($P < 0.01$) lower than the others. The supplementation of urea had a positive effect on the daily body weight gain of lambs. The lowest daily body weight gain was obtained for lambs fed with diet 1 but non-supplemented urea. The highest daily body weight gain was obtained for lambs fed with diet 4 and supplemented with 12 g urea/head per day.

In addition to diets, the increase of urea supplementation level increased the daily body weight gain of all lamb groups. Urea supplementation increased the total crude protein content of diets. Therefore, supplementation of urea may have affected the fattening performance. Another reason for increase in fattening performance is the increase in crude protein digestion since urea provides the micro-organism with quickly available nitrogen source (18). However, it was also reported that the urea supplementation had a negative effect on the fattening performance (19). Wittlinger et al. (20) and Coşkun et al. (21) showed that the supplementation of urea had a positive effect on daily body weight gain. In addition, urea supplementation to diets 3 and 4 may have provided the synchronization of energy and protein, which may have stimulated the microbial growth in the rumen (22,23). The improved microbial growth in the rumen may have resulted in the increase of daily body weight gain (23). On the other hand, Karabulut et al. (24) reported that the urea supplementation more than 1% of DM of diet decreased total body weight gain and daily body weight gain of lambs.

The increase in urea level of diets (18 g/head per day) had a negative effect on live weight gain. This can be explained by rapid degradation of urea in rumen and ineffective utilization of ammonia in the rumen (25,26). On the other hand, oregano oil had no effect on fattening performance of lambs. Inclusion of oregano oil into diet affected the rumen fermentation and decreased microbial fermentation and fattening performance (27). Some researchers also reported that inclusion of oregano oil into ruminant diets decreased the acetic acid production and increased the propionic acid production in the rumen. This inclusion of oregano oil into ruminant diets had a positive effect on the fattening performance (28,29). According to the result of current experiment it can be said that oregano oil up to 5 g/kg DM can be used in lamb's diets without affecting the fattening performance.

Also, the voluntary feed intake and feed efficiency were taken into consideration (Table 3). The voluntary feed intake for lambs fed with diets 1 and 2 were significantly ($P < 0.001$) higher than those fed with diets 3 and 4. The increase in crude protein and energy resulted in a decrease in voluntary feed intake. This result is in agreement with the findings of Çimen and Özsoy (17) and Bahtiyarca et al. (30) who showed that the increase in protein and energy content of diets decreased the voluntary food intake. There is a significant ($P < 0.001$) difference between diets 2 and 4 supplemented with oregano oil. The difference between 2 diets could be due to differences in energy and protein levels. Similar results were obtained by Bampidis et al. (9) who worked with oregano leaves and Bampidis et al. (31) who worked with garlic bulb and peals. In both studies, the voluntary feed intake of lambs was not affected negatively.

The feed intake of lambs supplemented with urea (0, 6, 12 and 18 g/head per day) ranged from 1.36 to 1.41 kg. There were no significant ($P > 0.01$) differences among levels of urea supplementation in feed intake. When the effects of diet and urea supplementation were taken into consideration voluntary feed intake ranged from 1.32 to 1.49 kg. There were significant differences ($P < 0.01$) between experimental groups. The lowest voluntary feed intake was found for the lambs fed diet 4 supplemented with 18 g urea/day. The highest voluntary feed intake was found for the lambs fed with diet 2 non-supplemented with urea. The increase in energy, protein, and urea supplementation decreased the voluntary feed intake.

The feed efficiency of lambs ranged from 5.17 to 6.17 kg. There were significant ($P < 0.001$) differences between diets in terms of feed conversion efficiency. The voluntary feed intake for lambs fed with diets 3 and 4 was lower than the others whereas feed efficiency for lambs fed with diets 3 and 4 were higher than the others. Although there were significant ($P < 0.001$) differences between diets 2 and 4 supplemented with oregano oil in terms of feed efficiency these differences could be due to differences in diets composition.

The feed efficiency of lambs supplemented with urea (0, 6, 12 and 18 g/head per day) ranged from 5.38 to 6.26 kg. There were significant ($P < 0.01$) differences in feed efficiency of lambs supplemented with different urea levels. The urea supplementation decreased the feed consumption that is required to obtain 1 kg daily weight gain. Therefore urea supplementation improved the feed efficiency. The reason why the urea supplementation improved the feed efficiency may be the increase in the amount of nitrogen provided for animal use. In addition, degradation of urea in the rumen increases the production of amino acid due to the increase in the production of ammonia. As a result of this, more nitrogen is retained in the body. Therefore the feed conversion ratio was improved (32). Although 1%-1.5% of urea inclusion into diets had a positive effect on the feed conversion ratio, the urea inclusion level more than 1%-1.5 % had no effect on feed conversion ratio (25,26). On the other hand Ørskov and Grubb (33) and Çelik and Alarslan (34) showed that the urea supplementation increased the feed efficiency of lamb. However, Karabulut et al. (24) showed that the urea supplementation more than 1% of DM of diets decreased voluntary feed intake and feed efficiency.

When the effect of diets and urea supplementation level were taken into consideration, the feed efficiency ranged from 4.81 and 6.89 kg. There were significant ($P < 0.01$) differences among experimental diets in terms of the feed efficiency. The lowest feed intake was found for lambs fed with diet 4 supplemented with oregano oil and 12 g urea. The highest feed intake was found for lambs fed with diet 2 supplemented with oregano oil. The increase in energy, protein, and urea supplementation level decreased the feed intake required for 1 kg daily weight gain but increased the feed efficiency. These results are in agreement with the findings of Bahtiyarca et al. (30) and Coşkun et al. (21). The feed efficiency obtained in this experiment was considerably higher than those obtained by Bampidis et al. (9,31). The reason for differences between these experiments may be due to the higher initial weight of lambs used in the current experiment.

The slaughter and carcass characteristics of lambs are presented in Table 4. The final body weights of slaughtered lambs were accepted as the slaughtering weight (Table 2). The traits of carcasses were determined using the cold carcasses. The cold carcass weight of lambs ranged from 23.58 to 24.83 kg. The cold carcass weight of lambs fed with diets 3 and 4 were significantly ($P < 0.01$) higher than the others. The level of urea had no ($P > 0.01$) effect on the cold carcass weight.

When the effect of diet and urea supplementation level were taken into consideration, the cold carcass weight of lambs ranged from 22.60 to 25.87 kg. There were significant ($P < 0.01$) differences among experimental groups. The lowest cold carcass weight was obtained for lambs fed diet 1 that was not supplemented with oregano oil and urea. The highest cold carcass weight was obtained for lambs fed with diet 3 supplemented with 12 g urea with no oregano oil supplement. The increase in energy, protein and urea level resulted in an increase in cold carcass weight. This result is in agreement with the findings of Görgülü and Öztürkcan (2) and Bahtiyarca et al. (30).

The dressing percentage ranged from 47.90% to 51.20%. The diet and urea supplementation had no significant ($P > 0.01$) effect on dressing percentage. The dressing percentage obtained in the current experiment was similar to those obtained by Yılmaz et al. (35).

The leg, front part, and cutlet of carcasses ranged from 7.70 to 9.80, 12.20 to 14.00, and 1.55 to 1.91 kg, respectively. The diet and urea supplementation level had no significant ($P > 0.01$) effect on the leg, front part, and cutlet of carcasses. The reason why a higher cold carcass weight was obtained with diets containing higher energy and protein is the production of propionic acid rather than acetic acid production in the rumen. Ørskov and Ryle (36) and Bahtiyarca et al. (30) reported that most part of the energy of carbohydrates, which transforms to propionic acid forms in the rumen, is mostly deposited in the body. As a result of this, fattening performance and carcass traits were improved.

In conclusion, low energy/low protein and normal energy/normal protein containing lambs diets did not require oregano oil supplementation whereas the supplementation of urea to low energy/low protein and normal energy/normal protein lambs diets had a positive effect on the fattening performance and feed utilization. The best supplementation level of urea for both diets to obtain a higher fattening performance and better carcass traits was 12 g/head per day. Although oregano oil had no positive effect on fattening performance of lambs, the oregano oil may be used in lamb's diets for healthy and safe lamb meat production. This point should be taken into consideration when further experiments related to the use of oregano oil and other essential oil in ruminant diets are conducted.

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