The Effect of Propylene Glycol on Fattening Performance, Slaughter and Carcass Characteristics of Akkaraman Lambs Depending on Dose and Fattening Duration

AKıN YAKAN[1*], HÜSEYIN ÖZKAN[1], BARAN ÇAMDEVIREN[2], HASAN HÜSEYIN KEÇELI[1], UFUK KAYA[3], İREM KARAASLAN[4], GÜVEN GÜNGÖR[5], NECMETTIN ÜNAL[6], BILAL AKYÜZ[7], KORHAN ARSLAN[7], SAVAŞ SARıÖZKAN[8], AYTAÇ AKÇAY[9], CEYHAN ÖZBEYAZ[6]

[1] Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Genetics, 31060, Hatay, Turkey
[2] Hatay Mustafa Kemal University, Institute of Health Sciences, Department of Molecular Biochemistry and Genetics, 31060, Hatay, Turkey
[3] Hatay Mustafa Kemal University, Faculty of Veterinary Medicine, Department of Biostatistics, 31060, Hatay, Turkey
[4] Hatay Mustafa Kemal University, Technology and Research & Development Center, 31060, Hatay, Turkey
[5] Bingöl University, Faculty of Veterinary Medicine, Department of Biostatistics, 12000, Hatay, Turkey
[6] Ankara University, Faculty of Veterinary Medicine, Department of Animal Science, 06070, Ankara, Turkey
[7] Erciyes University, Faculty of Veterinary Medicine, Department of Genetics, 38039, Kayseri, Turkey
[8] Erciyes University, Faculty of Veterinary Medicine, Department of Animal Health Economics and Management, 38039, Kayseri, Turkey
[9] Ankara University, Faculty of Veterinary Medicine, Department of Biostatistics, 06070, Ankara, Turkey

SUMMARY

This study was conducted to determine the effect of Propylene Glycol (PG) on fattening performance, slaughter and carcass characteristics of Akkaraman lambs at different fattening periods. The animal material of the study consisted of 72 Akkaraman male lambs weighing approximately 20 kg at the age of 2,5-3 months. The lambs were divided into 3 groups (Control, PG1,5 and PG3) according to PG intake and slaughter days (60th, 90th and 120th days of fattening). The slaughter weights of the Control, PG1,5 and PG3 groups were 36.60, 37.89 and 38.81 kg on the 60th day of fattening, 47.13, 48.63 and 49.38 kg on the 90th day of fattening and 54.01, 57.66 and 60.05 kg on the 120th day of fattening ($P<0.05$), respectively. While the daily feed intake on the slaughter days from the beginning of fattening to the end of fattening were similar in all groups, the concentrate feed consumed for 1 kg of live weight gain values turned into an advantage for PG groups after the 70th day of fattening. This showed that PG intake had a positive effect on fattening performance after the 70th day of fattening. In order to increase fattening performance in Akkaraman lambs, it was determined that PG should be used at a dose of 3% of metabolic body weight (PG3) and for at least 3 months. In the early stages of fattening (60th day), testicular weight and ratio were higher in the PG3 group compared to the other groups ($P<0.001$). This indicates that the anabolic effect of PG is also short-period of fattening. Apart from this, it was determined that PG had no significant effect on slaughter and carcass characteristics. It was concluded that PG significantly affected carcass traits during the first 60 days of feeding, but this effect may have diminished in later periods due to metabolic homeostasis. Furthermore, the effect of PG on carcass traits varied for different carcass weights, probably due to the duration of metabolic exposure.

KEY WORDS

Propylene Glycol, Akkaraman lamb, Fattening, Slaughter, Carcass.

INTRODUCTION

In recent years, the rising population has led to a heightened demand for red meat production. Enhancing fattening performance in red meat production has thus become a critical objective. Although many feed additives are used and different fattening systems are created for this purpose, an effective method that replaces conventional fattening systems is not yet known.

Propylene glycol (PG), which is a glycogenic substance and has been used as an indirect energy source for many years, has been used to protect lactating cows from negative energy balance and to treat ketosis (1). Although PG has been used in cattle fattening for the last few years due to its glycogenic effect, there is very limited information on this subject. In addition, there is no scientific study on its effects in lamb fattening (fattening performance, slaughter-carcass characteristics, meat quality). PG, which is used as an indirect energy source, reaches the liver through the ruminal-hepatic cycle and is converted into glu-

Corresponding Author:
Akın Yakan (yakan@mku.edu.tr)

Table 1 - Concentrate feed composition, nutritient content, energy levels and fatty acid ratios.

Ingredients	Ratio (%)	Protein (%)	Enery (kcal/ kg)
Wheat	19,2	11,0	2770
Barley	20,5	12,0	2630
Sunflower seed meal	8,0	29,0	2550
Cottonseed oil meal	13,0	32,0	2200
Corn	20,3	8,9	2855
Maize bran	13,0	21,0	2650
Molasses	5,0	8,5	2890
Marble powdered (%38 Ca^{++})	0,2	-	-
Premix*	0,1	-	-
NaCl	0,7	-	-
Total	100,0	16,01	2629,6
Dry matter	89,67		
Crude ash	5,48		
Crude oil	2,43		
Crude protein	15,91		

Fatty acids (%)					
C10:0	0,002	C18:1	17,715	C22:2n6	0,014
C11:0	0,006	C18:2n6	50,677	C22:6n3	0,011
C12:0	0,033	C18:3n3	1,954	C24:0	0,089
C13:0	0,010	C20:0	0,179	C24:1	0,009
C14:0	0,593	C20:1	0,008	∑SFA	28,909
C14:1	0,027	C20:2n6	0,006	∑MUFA	18,249
C15:0	0,032	C20:3n3	0,024	∑PUFA	52,841
		C20:4n6	0,013	∑n6	50,734
C15:1	0,029				
C16:0	23,455	C20:5n3	0,119	∑n3	2,107
C16:1	0,454	C22:0	0,055		
C18:0	4,454	C22:1	0,008		

*: Per 1,5 kg premix contains 15 000 000 IU Vit A, 3 000 000 IU Vit D_3, 50 g mangane, 50 g iron, 50 g zinc, 10 g copper, 0,8 g iodine, 0,2 g cobalt, 0,3 g selenium.

Table 2 - Live weights of lambs in fattening period (kg) (Means±SEM).

Items	Groups						P
	n	Con	n	PG1,5	n	PG3	
Beginning	24	19,872±0,73	24	20,290±0,71	24	20,499±0,53	0,797
7th day	24	21,571±0,80	24	22,632±0,67	24	23,059±0,48	0,272
14th day	24	24,038±0,86	24	25,237±0,70	24	25,760±0,46	0,212
21th day	24	26,508±0,87	24	27,570±0,63	24	27,542±0,52	0,464
28th day	24	27,938±0,93	24	28,793±0,63	24	29,112±0,71	0,541
35th day	24	30,025±1,02	24	30,604±0,69	24	30,850±0,70	0,768
42th day	24	32,658±1,26	24	33,600±0,75	24	34,083±0,77	0,567
49th day	24	34,947±1,22	24	36,433±0,98	24	36,720±0,84	0,433
56th day	24	37,169±1,26	24	39,033±0,93	24	39,513±0,80	0,238
63th day	16	40,000±1,54	16	41,918±0,89	16	42,987±0,88	0,188
70th day	16	42,243±1,44	16	44,131±0,92	16	45,100±0,79	0,181
77th day	16	44,462±1,46[a]	16	46,468±0,94[ab]	16	48,512±0,78[b]	**0,043**
84th day	16	47,400±1,41[a]	16	48,831±1,04[ab]	16	50,793±0,68[b]	**0,019**
91th day	8	48,275±1,81[a]	8	50,837±1,15[ab]	8	52,475±0,87[b]	**0,044**
98th day	8	49,925±2,10[a]	8	52,637±1,30[ab]	8	54,700±1,33[b]	**0,020**
105th day	8	51,612±2,08[a]	8	54,475±1,33[ab]	8	56,612±1,24[b]	**0,041**
112th day	8	53,225±2,06[a]	8	56,650±1,43[ab]	8	58,737±1,20[b]	**0,032**
120th day	8	54,010±1,98[a]	8	57,662±1,46[ab]	8	60,050±1,18[b]	**0,026**

[a,b]: Groups with different letters in the same line are different.

cose. The primary objective of fattening is to attain a significant increase in live weight over a specified period. In conventional fattening applications, high-energy rations rich in easily digestible carbohydrates are used to achieve this goal. Easily digestible carbohydrates are converted into glucose, maltose, trehalose and limit dextrin by salivary amylase in the mouth and pancreatic amylase in the small intestine. Maltose is then converted to glucose by maltase, trehalose by trehalose and limit dextrin by glycosidases, which enter enterocytes in the small intestine and are then transported to the liver via the portal vein. Upon reaching the liver, glucose is either converted to glycogen for storage or undergoes glycolysis to form ATP via the Kreps cycle. During glycolysis, NAD+H, Glycerol and Citrate are released, and amino acids are formed as intermediate residual products. Citrate is converted into fatty acids via Acetyl CoA and these fatty acids are converted into Triacylglycerols by combining with glycerol, which is also a product of glycolysis. Triacylglycerols are packaged into VLDL (Very Low-Density

Table 3 - Means (±SEM) of daily weight gain (DWG) (g).

Items	Groups						P
	n	Con	n	PG1,5	n	PG3	
Beginning- 7th day	24	222±12[a]	24	334±4[b]	24	365±5[b]	**<0,001**
8-14th day	24	360±14	24	372±5	24	385±3	0,161
15-21th day	24	353±4[b]	24	333±16[b]	24	258±21[a]	**<0,001**
22-28th day	24	211±17[b]	24	174±12[a]	24	220±14[b]	**0,048**
29-35th day	24	304±19[b]	24	246±15[a]	24	248±15[a]	**0,030**
36-42th day	24	355±21	24	383±15	24	404±18	0,177
43-49th day	24	330±17[a]	24	404±15[b]	24	365±16[a]	**0,009**
50-56th day	24	317±18	24	371±24	24	332±16	0,163
57-63th day	24/16#	394±32[a]	24/16#	386±21[a]	24/16#	495±19[b]	**0,005**
64-70th day	16	310±19	16	316±18	16	301±25	0,891
71-77th day	16	311±28[a]	16	334±18[a]	16	487±12[b]	**<0,001**
78-84th day	16	416±16[b]	16	337±19[a]	16	334±13[a]	**0,002**
85-91th day	16/8##	232±33	16/8##	296±18	16/8##	225±23	0,109
92-98th day	8	235±23[a]	8	257±30[a]	8	317±25[b]	**0,010**
99-105th day	8	241±11	8	262±26	8	273±23	0,419
106-112th day	8	230±45[a]	8	310±31[b]	8	303±30[b]	**0,020**
113-120th day	8	193±32[a]	8	253±22[b]	8	329±41[c]	**0,021**

[a,b,c]: Groups with different letters in the same line are different.
#: At the beginning of fattening, there were 24 lambs in each group, but after the slaughtering on the 60th day of fattening, 16 lambs remained in each group.
##: On the 61st day of fattening, there were 16 lambs in each group, while there were 8 lambs in each group after slaughtering on the 90th day of fattening.

Lipoprotein) and sent to tissues through the blood and stored as fat. Considering this mechanism, glucose arriving in the liver is either converted into glycogen and stored in the liver and muscles or it enters the Kreps cycle and is converted into ATP and fat. When PG, the focus of this project, is orally ingested in ruminants, it is converted into propionic acid, a three-carbon volatile fatty acid, by rumen fermenters (protozoa and bacteria). This propionic acid then transported to the liver through the ruminal-hepatic cycle. In the liver, propionic acid enters the Kreps cycle in mitochondria and is converted to succinyl CoA, fumarate, malate and oxalacetate, respectively. Oxalacetate enters gluconeogenesis to form glucose (2, 3). In other words, the mechanism by which oral feeds enter the small intestine and are converted into glucose and transported to the liver occurs directly through the ruminal-hepatic cycle as a result of oral administration of PG (4).

It is hypothesized that PG is primarily converted to propionate in the *rumen*, thus acting as a precursor for glucose synthesis. If PG increased propionate concentration, an increased gain to feed would be expected. Since PG is stored as glycogen in the liver and muscles after rumen fermentation, it can be used to provide the energy required for growth processes. Thus, it is thought that it may have a positive effect on the growth and fattening performance of lambs. Oral administration of PG to lambs may trigger the above anabolic mechanisms and may cause an increase in fattening performance (5, 6). The Akkaraman sheep breed constitutes almost half of Turkey's sheep population and is an important domestic breed used for meat pro-

Table 4 - Means (±SEM) of daily concentrate feed intake (DCFI) (g).

Items	Groups						P
	n	Con	n	PG1,5	n	PG3	
Beginning- 7th day	24	712±27	24	735±28	24	701±22	0,401
8-14th day	24	744±25	24	747±23	24	719±8	0,358
15-21th day	24	851±24	24	853±21	24	817±7	0,225
22-28th day	24	948±30	24	950±27	24	926±15	0,534
29-35th day	24	1125±55	24	1087±42	24	1062±40	0,373
36-42th day	24	1470±166	24	1565±135	24	1476±109	0,646
43-49th day	24	1531±153	24	1627±108	24	1503±126	0,529
50-56th day	24	1597±142	24	1698±107	24	1525±124	0,367
57-63th day	24/16#	1668±135	24/16#	1811±100	24/16#	1685±122	0,433
Beginning- 60th day	24	1172±180	24	1220±152	24	1147±139	0,375
64-70th day	16	1760±123	16	1885±84	16	1790±124	0,463
71-77th day	16	1997±79	16	2057±62	16	2038±109	0,653
78-84th day	16	2080±58	16	2116±70	16	2133±98	0,664
85-91th day	16/8##	2078±71	16/8##	2061±41	16/8##	2142±94	0,452
Beginning- 90th day	16	1421±183	16	1469±148	16	1417±173	0,884
92-98th day	8	2104±91	8	2040±36	8	1950±49	0,310
99-105th day	8	2220±75	8	2185±51	8	2149±58	0,170
106-112th day	8	2445±71	8	2450±69	8	2475±88	0,814
113-120th day	8	2465±76	8	2421±85	8	2476±85	0,606
Beginning- 120th day	8	1847±308	8	1778±230	8	1730±224	0,412

#: At the beginning of fattening, there were 24 lambs in each group, but after the slaughtering on the 60th day of fattening, 16 lambs remained in each group.
##: On the 61st day of fattening, there were 16 lambs in each group, while there were 8 lambs in each group after slaughtering on the 90th day of fattening.

Table 5 - Means (±SEM) of concentrate feed consumed for 1 kg of live weight gain (1 kg CFCLWG) (kg).

Items	Groups						P
	n	Con	n	PG1,5	n	PG3	
Beginning- 7th day	24	3,362±0,30[b]	24	2,186±0,07[a]	24	1,935±0,08[a]	**<0,001**
8-14th day	24	2,128±0,17	24	2,001±0,07	24	1,866±0,03	0,226
15-21th day	24	2,415±0,05[a]	24	2,617±0,18[a]	24	3,333±0,30[b]	**0,027**
22-28th day	24	4,111±0,24	24	4,873±0,22	24	3,884±0,21	**0,016**
29-35th day	24	3,817±0,23	24	4,506±0,31	24	4,369±0,35	0,300
36-42th day	24	4,181±0,34	24	4,019±0,23	24	3,607±0,11	0,242
43-49th day	24	4,736±0,61	24	3,999±0,24	24	4,170±0,24	0,388
50-56th day	24	5,118±0,35	24	4,746±0,55	24	4,614±0,25	0,690
57-63th day	24/16#	4,473±0,43[b]	24/16#	4,694±0,36[b]	24/16#	3,429±0,22[a]	**0,037**
Beginning- 60th day	24	3,816±0,30	24	3,738±0,48	24	3,468±0,21	0,522
64-70th day	16	5,852±0,62	16	5,828±0,15	16	5,950±0,57	0,981
71-77th day	16	6,478±0,47[b]	16	6,246±0,26[b]	16	4,206±0,27[a]	**<0,001**
78-84th day	16	5,073±0,12[a]	16	6,311±0,39[b]	16	6,285±0,36[b]	**0,037**
85-91th day	16/8##	10,063±0,43[b]	16/8##	6,778±0,30[a]	16/8##	8,999±0,34[b]	**<0,001**
Beginning- 90th day	16	4,755±0,41	16	4,524±0,43	16	4,358±0,37	0,657
92-98th day	8	9,143±0,61[b]	8	7,901±0,40[b]	8	6,223±0,28[a]	**<0,001**
99-105th day	8	9,370±0,57	8	8,656±0,77	8	8,118±0,61	0,419
106-112th day	8	11,716±1,32[b]	8	8,218±0,75[a]	8	8,256±0,48[a]	**0,020**
113-120th day	8	12,965±1,75[b]	8	9,854±0,66[a]	8	7,885±0,77[a]	**0,021**
Beginning- 120th day	8	7,464±1,42[b]	8	5,974±0,75[a]	8	5,496±0,61[a]	**0,028**

[a,b]: Groups with different letters in the same line are different.
#: At the beginning of fattening, there were 24 lambs in each group, but after the slaughtering on the 60th day of fattening, 16 lambs remained in each group.
##: On the 61st day of fattening, there were 16 lambs in each group, while there were 8 lambs in each group after slaughtering on the 90th day of fattening.

Table 6 - Means (±SEM) of slaughter characteristics on the 60th day of feeding.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Slaughter weight (kg)	36,60 ± 2,92	37,89 ± 2,88	38,81 ± 2,60	0,863
Hot carcass weight (kg)	19,50 ± 1,89	20,25 ± 1,82	21,21 ± 1,68	0,807
Hot carcass ratio (%)	51,02 ± 1,16	50,73 ± 1,48	50,37 ± 2,38	0,543
Skin weight (kg)	3,72 ± 0,30	4,12 ± 0,28	3,79 ± 0,27	0,587
Skin ratio (%)	10,17 ± 0,32[ab]	10,98 ± 0,40[a]	9,76 ± 0,10[b]	**0,034**
Head weight (kg)	1,72 ± 0,09	1,49 ± 0,13	1,77 ± 0,05	0,111
Head ratio (%)	4,76 ± 0,16	4,12 ± 0,47	4,64 ± 0,22	0,361
Feet weight (kg)	1,04 ± 0,05	1,07 ± 0,05	1,03 ± 0,04	0,797
Feet ratio (%)	2,88 ± 0,09	2,91 ± 0,17	2,71 ± 0,13	0,556
Heart weight (g)	152,29 ± 9,08	153,50 ± 7,71	167,00 ± 9,04	0,430
Herat ratio (%)	0,42 ± 0,02	0,41 ± 0,02	0,43 ± 0,01	0,713
Lung weight (g)	718,00 ± 4,92	799,75 ± 45,21	884,28 ± 73,33	0,135
Lung ratio (%)	1,99 ± 0,09	2,21 ± 0,25	2,32 ± 0,20	0,541
Liver weight (g)	690,86 ± 53,95	769,00 ± 59,93	770,57 ± 41,86	0,504
Liver ratio (%)	1,90 ± 0,11	2,03 ± 0,06	2,02 ± 0,14	0,619
Kidney weight (g)	118,00 ± 7,01	116,25 ± 7,65	127,29 ± 7,02	0,531
Kidney ratio (%)	0,33 ± 0,01	0,31 ± 0,01	0,33 ± 0,02	0,316
Spleen weight (g)	75,57 ± 23,95	83,75 ± 14,15	69,86 ± 2,93	0,824
Spleen ratio (%)	0,19 ± 0,04	0,22 ± 0,02	0,18 ± 0,01	0,681
Testicles weight (g)	19,50 ± 1,89[b]	39,13 ± 9,93[b]	101,43 ± 14,40[a]	**<0,001**
Testicles ratio (%)	0,05 ± 0,001[b]	0,11 ± 0,03[b]	0,26 ± 0,03[a]	**<0,001**

[a,b]: Groups with different letters in the same line are different.

duction. This study investigated, for the first time, the effects of long-term (60, 90, and 120 days) use of Propylene Glycol at different doses on fattening performance, as well as its impact on slaughter-carcass and meat quality parameters in fattening Akkaraman lambs.

MATERIAL AND METHODS

Animal material and fattening procedure

Animal experiment of the study was carried out at the Sheep and Goat Experimental Unit of Erciyes University's Centre for Agricultural Research and Application. The Akkaraman male lambs used in the study were weaned (2-3 months old) and had a live weight (LW) of 15-20 kg. The study employed a 3x3 experimental design with two dependent variables. One of the dependent variables is the dose of PG and the other is the feeding duration. The PG 1.5 mL/kg $LW^{0.75}$ (PG1.5) and 3 mL / kg $LW^{0.75}$ (PG3) dosing groups (7) and control (Con) were formed. A total of 72 sheep were used, consisting of three groups of 60, 90 and 120 days of fattening. The lambs were subjected to group feeding and placed in a total of 18 paddocks (4x18=72), each group with two replicates. The divisions are 6.6 m2, of which 3 m^2 are indoor and 3.6 m^2 open. Thus, they can be found freely in open or closed spaces.

In the study, lambs were fed commercial sheep feed (2600 kcal/kg ME and 16% HP) (Table 1) and clean water ad libitum, 100 g/head/day of alfalfa hay. Before the study begins, the lambs are adapted to feeding for a week. Feed consumptions were carried out daily, and lambs were also weighed weekly. PG is given orally every day at 8:00 a.m. PG dosage was recounted in pro-

Table 7 - Means (±SEM) of individual cuts of carcass on the 60th day of feeding#.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Cold carcass weight (kg)	18,830±1,89	19,540±1,79	20,500±1,61	0,802
Cold carcass ratio (%)	51,02 ± 1,16	50,73 ± 1,48	50,37 ± 2,38	0,788
Leg weight (kg)	2,990 ± 0,28	3,010 ± 0,28	3,000 ± 0,22	0,998
Leg ratio in carcass	51,05 ± 1,10	51,08 ± 1,09	52,61 ± 0,96	0,498
Lean weight (g)	1270,00 ± 88,84	1352,00 ± 102,90	1490,57 ± 108,62	0,341
Lean ratio (%)	42,90 ± 1,67[b]	45,15 ± 0,95[b]	49,69 ± 1,36[a]	**0,021**
Fat weight (g)	1135,00 ± 108,96	1023,50 ± 98,24	921,43 ± 60,40	0,264
Fat ratio (%)	38,05 ± 1,84[a]	33,89 ± 0,89[b]	30,90 ± 1,35[b]	**0,034**
Bone weight (g)	564,43 ± 38,79	621,50 ± 45,10	578,29 ± 29,08	0,638
Bone ratio (%)	19,05 ± 0,44	20,95 ± 0,74	19,40 ± 0,30	0,139
Foreleg weight (kg)	1,530 ± 0,08	1,600 ± 0,11	1,580 ± 0,09	0,884
Foreleg ratio in carcass	31,84 ± 0,49	30,86 ± 0,85	29,48 ± 0,84	0,096
Lean weight (g)	764,00 ± 55,26	817,25 ± 44,38	865,71 ± 55,35	0,470
Lean ratio (%)	49,72 ± 1,84[b]	51,22 ± 0,75[ab]	54,77 ± 1,34[a]	**0,042**
Fat weight (g)	470,00 ± 34,47	481,75 ± 42,76	401,14 ± 27,61	0,214
Fat ratio (%)	30,87 ± 1,86	29,91 ± 1,38	25,50 ± 1,49	0,077
Bone weight (g)	295,14 ± 13,39	297,00 ± 16,91	309,71 ± 13,64	0,738
Bone ratio (%)	19,41 ± 0,68	18,87 ± 1,11	19,73 ± 0,63	0,802
Back weight (kg)	1,230 ± 0,11	1,200 ± 0,11	1,210 ± 0,09	0,988
Back ratio in carcass	16,73 ± 0,90	16,71 ± 0,58	15,58 ± 0,44	0,282
Lean weight (g)	439,43 ± 14,9[b]	461,75 ± 19,55[b]	538,29 ± 14,59[a]	**0,001**
Lean ratio (%)	36,89 ± 2,07[b]	38,57 ± 1,55[b]	44,87 ± 1,35[a]	**0,010**
Fat weight (g)	422,57 ± 79,15	394,25 ± 38,40	320,43 ± 24,85	0,230
Fat ratio (%)	33,12 ± 3,41	32,27 ± 1,76	26,32 ± 1,04	0,028
Bone weight (g)	359,14 ± 21,90	351,25 ± 17,51	348,57 ± 19,07	0,936
Bone ratio (%)	29,99 ± 1,86	29,16 ± 0,62	28,82 ± 0,66	0,826
Loin weight (kg)	0,613 ± 0,04	0,645 ± 0,06	0,664 ± 0,04	0,747
Loin ratio in carcass	13,15 ± 0,39[a]	12,39 ± 0,27[ab]	11,87 ± 0,27[b]	**0,046**
Lean weight (g)	265,43 ± 14,96	280,00 ± 23,17	308,86 ± 18,47	0,243
Lean ratio (%)	44,27 ± 3,03	44,45 ± 2,62	46,80 ± 2,02	0,712
Fat weight (g)	242,29 ± 44,79	262,88 ± 43,11	240,29 ± 27,23	0,909
Fat ratio (%)	38,36 ± 5,04	38,95 ± 3,32	35,91 ± 2,73	0,775
Bone weight (g)	103,14 ± 10,50	100,25 ± 8,72	113,43 ± 7,02	0,495
Bone ratio (%)	17,37 ± 2,08	16,61 ± 2,27	17,30 ± 1,12	0,962
Neck weight (kg)	0,658 ± 0,07	0,645 ± 0,05	0,636 ± 0,03	0,961
Neck ratio in carcass	14,60 ± 1,25	15,71 ± 1,12	19,58 ± 0,91	0,137
Lean weight (g)	244,57 ± 21,65	285,00 ± 11,87	300,57 ± 20,15	0,204
Lean ratio (%)	37,53 ± 1,94[b]	44,77 ± 1,36[a]	47,25 ± 1,69[a]	**0,009**
Fat weight (g)	216,86 ± 24,10	171,13 ± 26,11	149,71 ± 14,61	0,108
Fat ratio (%)	33,35 ± 2,74[a]	25,56 ± 2,42[b]	23,32 ± 1,41[b]	**0,027**
Bone weight (g)	187,71 ± 12,20	188,00 ± 9,08	185,71 ± 10,02	0,985
Bone ratio (%)	29,12 ± 1,29	29,67 ± 1,63	29,43 ± 1,54	0,966
Breast+ flank weight (kg)	0,960 ± 0,13	1,070 ± 0,10	1,040 ± 0,07	0,824
Breast+ flank in carcass	6,67 ± 0,48	6,63 ± 0,27	6,61 ± 0,41	0,996
Lean weight (g)	249,14 ± 24,06[b]	397,13 ± 27,29[a]	424,57 ± 16,43[a]	**<0,001**
Lean ratio (%)	26,28 ± 2,24[b]	37,34 ± 1,92[a]	41,11 ± 1,37[a]	**<0,001**
Fat weight (g)	575,14 ± 56,20	512,75 ± 54,76	449,43 ± 33,39	0,197
Fat ratio (%)	59,87 ± 2,21[a]	47,03 ± 2,46[a]	43,09 ± 1,85[a]	**<0,001**
Bone weight (g)	131,43 ± 10,67[b]	165,75 ± 9,22[a]	163,14 ± 7,37[a]	**0,043**
Bone ratio (%)	13,86 ± 0,86	15,63 ± 0,75	15,80 ± 0,69	0,228
Tail weight (kg)	1,44 ± 0,13[b]	1,59 ± 0,11[b]	2,08 ± 0,19[a]	**0,044**
Tail ratio in carcass (%)	15,37 ± 0,39b	16,67 ± 0,88b	20,42 ± 1,27a	0,011
Eye muscle area (cm^2)	21,21±0,88	22,47±0,82	21,78±0,49	0,801
Eye muscle area (cm^2)	21,21±0,88	22,47±0,82	21,78±0,49	0,801
Back fat deep (mm)	3,81±0,31[c]	7,45±0,45[b]	5,43±0,52[a]	**<0,001**

a,b,c: Groups with different letters in the same line are different.
#: Since the dissection was performed on the half carcass, the carcass parts were shown on the half carcass.

Table 8 - Means (±SEM) of slaughter characteristics on the 90th day of feeding.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Slaughter weight (kg)	47,13 ± 3,87	48,63 ± 1,73	49,38 ± 1,23	0,841
Hot carcass weight (kg)	26,58 ± 2,52	26,60 ± 1,11	27,47 ± 0,94	0,829
Hot carcass ratio (%)	55,84 ± 1,37	54,66 ± 0,76	55,58 ± 0,98	0,671
Skin weight (kg)	5,14 ± 0,49	5,27 ± 0,29	5,11 ± 0,20	0,897
Skin ratio (%)	10,83 ± 0,43	10,83 ± 0,42	10,33 ± 0,28	0523
Head weight (kg)	1,99 ± 0,09	2,08 ± 0,06	2,07 ± 0,05	0,718
Head ratio (%)	4,35 ± 0,26	4,31 ± 0,11	4,20 ± 0,10	0,756
Feet weight (kg)	1,13 ± 0,06	1,16 ± 0,04	1,16 ± 0,03	0,936
Feet ratio (%)	2,47 ± 0,13	2,39 ± 0,04	2,35 ± 0,04	0,675
Heart weight (g)	182,86 ± 14,62	189,50 ± 10,10	210,75 ± 8,18	0,180
Herat ratio (%)	0,39 ± 0,02	0,39 ± 0,02	0,43 ± 0,01	0,209
Lung weight (g)	950 ± 70	1005 ± 81	972 ± 63	0,899
Lung ratio (%)	2,47 ± 0,13	2,39 ± 0,04	2,35 ± 0,04	0,858
Liver weight (g)	832,86 ± 88,63	823,50 ± 31,99	915,00 ± 34,69	0,202
Liver ratio (%)	1,77 ± 0,11	1,70 ± 0,06	1,85 ± 0,05	0,182
Kidney weight (g)	131,14 ± 8,90	135,25 ± 5,42	143,00 ± 4,24	0,391
Kidney ratio (%)	0,28 ± 0,02	0,28 ± 0,01	0,29 ± 0,01	0,707
Spleen weight (g)	90,00 ± 6,93	83,75 ± 3,06	77,50 ± 4,70	0,348
Spleen ratio (%)	0,19 ± 0,01	0,17 ± 0,01	0,16 ± 0,01	0,058
Testicles weight (g)	217,14 ± 38,56	279,50 ± 49,15	188,50 ± 19,52	0,272
Testicles ratio (%)	0,44 ± 0,06	0,59 ± 0,12	0,38 ± 0,04	0,264

portion to living weight. The dosage was based on the metabolic living weights ($LW^{0.75}$) as weekly.

Slaughter and Carcass Characteristics

On the 60th day of feeding, eight lambs in groups Con, PG1.5 and PG3 (a total of 24 heads) were slaughtered. The lambs were not fed in the evening before the slaughters, but they had unlimited access to water. On the morning of the slaughtering, the live weights have been determined and the slaughters were made at the pilot unit. With these procedures, the post-slaughtering procedures shown below, were applied in the same way on the 90th and 120th days of fattening.

The weight of the skin, head and legs, and their ratio to living weight, the weight of heart, lungs, liver, kidneys, spleen and testicles, and the ratio of living weight have been identified as slaughtering properties.

Carcass characteristics include hot and cold carcass weights and the ratio of living weight. For this purpose, the hot carcass weights were immediately determined after slaughtering. It was then held at +4 °C for 24 hours, and the cold-carcass weights were detected. Hot and cold carcass weights are calculated in relation to the live weight in slaughtering. The cold carcasses were cut into leg, foreleg, neck, back, loin, tail and breast+flank. After weighing of each part physically dissected to meat, fat and bone, then weights and ratio to whole cuts were recorded. Back fat depth was measured with the calipers while MLD area was measured with a planimeter after drawing on parchment paper. It was measured between the 12th and 13th rib regions. Physical dissections of the carcasses were performed in the right half of the carcasses. Carcass cutting is based on the standard method by Colomer-Rocher et al. (8).

Statistical Analysis

The sample size of the study was determined based on statistical power analysis. The minimum number of samples required, taking the effect size of 0.40 (using the Cohen criteria) = 0.05 and = 0.20 (Power= 0.80), is at least 66. As a result, the sample size of each group (Con, PG1.5 and PG3) was 24 and a total of 72 animals (Power=0.83). The 24 lams in each group were divided into three subgroups (n=8) with breeding periods of 60, 90 and 120 days. Variance analysis was used in the statistical analysis of the effect of PG (Con, PG1.5 and PG3) on living weight gain, feed conversion ratio, slaughtering and carcass traits. The significance of differences in the effect of PG between groups was tested with the Duncan test. NCSS 9 and Minitab 17 packages were used in all statistical analyses.

RESULTS

Fattening performance

For feed groups initiated at approximately 20 kg (Con, PG1.5 and PG3) similar weights continued until day 70th, and higher weights began to be detected in PG groups ($P<0,05$) from day 77th. The data obtained for average living weights during the study are shown in Table 2.

Similar to live weight gain in feeding, daily live weight gains (DWG) in PG groups were better, with different levels of feeding period ($P<0,05$; $P<0,01$ and $P<0,001$) (Table 3).

Table 4 shows the quantities of daily concentrate feed intake in fattening period. There was no difference between the groups in the amount of feed consumed during the experiment.

The concentrate feed consumed for 1 kg of live weight gain (1 kg CFCLWG) are shown in Table 5. The 1 kg CFCLWG of group Con was higher in the first week than in the PG group ($P<0,001$). Subsequently, this effect generally disappeared by the 70th day of the feeding and began to reappear after the 77th day ($P<0,05$; $P<0,01$ and $P<0,001$). The evaluation from starting of feeding to 120th days showed better values for 1 kg CFCLWG in PG groups than for Con ($P<0,05$).

Slaughter and Carcass Characteristics

Means of the slaughtering characteristics of slaughtered lambs on the 60th day of feeding are given in Table 6. In the Cand PG

Table 9 - Means (±SEM) of individual cuts of carcass on the 90th day of feeding#.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Cold carcass weight (kg)	25,75 ± 2,44	25,73 ± 1,12	26,70 ± 0,89	0,789
Cold carcass ratio (%)	54,11 ± 1,32	52,85 ± 0,68	54,03 ± 0,94	0,534
Leg weight (kg)	3,57 ± 0,30	3,71 ± 0,16	3,81 ± 0,15	0,767
Leg ratio in carcass	28,12 ± 0,78	28,85 ± 0,45	28,55 ± 0,61	0,728
Lean weight (kg)	1,87 ± 0,14	2,04 ± 0,12	2,07 ± 0,09	0,506
Lean ratio (%)	53,51 ± 1,40	55,40 ± 1,49	54,81 ± 1,25	0,655
Fat weight (g)	987,14 ± 120,09	960,25 ± 69,41	991,75 ± 70,29	0,950
Fat ratio (%)	27,55 ± 1,68	26,19 ± 1,62	26,07 ± 1,28	0,776
Bone weight (g)	654,57 ± 42,01	676,50 ± 28,78	720,50 ± 25,81	0,365
Bone ratio (%)	18,94 ± 0,74	18,42 ± 0,45	19,12 ± 0,53	0,604
Foreleg weight (kg)	2,02 ± 0,15	2,12 ± 0,07	2,14 ± 0,05	0,762
Foreleg ratio in carcass	16,02 ± 0,70	16,52 ± 0,25	16,06 ± 0,21	0,405
Lean weight (kg)	1,14 ± 0,08	1,19 ± 0,05	1,20 ± 0,02	0,756
Lean ratio (%)	56,72 ± 1,01	56,36 ± 1,14	56,40 ± 1,09	0,966
Fat weight (g)	520,29 ± 59,40	560,00 ± 27,91	553,00 ± 36,88	0,843
Fat ratio (%)	25,21 ± 1,39	26,56 ± 1,12	25,70 ± 1,25	0,752
Bone weight (g)	359,71 ± 20,14	361,50 ± 15,16	382,00 ± 11,72	0,493
Bone ratio (%)	18,07 ± 0,70	17,08 ± 0,35	17,90 ± 0,48	0,308
Back weight (kg)	1,57 ± 0,15	1,60 ± 0,09	1,55 ± 0,08	0,904
Back ratio in carcass	12,25 ± 0,29	12,44 ± 0,33	11,61 ± 0,46	0,365
Lean weight (g)	667,57 ± 61,37	675,50 ± 36,44	682,38 ± 37,54	0,979
Lean ratio (%)	43,56 ± 0,71	42,63 ± 1,45	44,31 ± 0,99	0,646
Fat weight (g)	429,00 ± 55,95	469,25 ± 43,17	393,75 ± 39,68	0,476
Fat ratio (%)	27,22 ± 1,81	29,27 ± 1,80	25,26 ± 1,53	0,288
Bone weight (g)	436,43 ± 28,32	446,25 ± 28,52	464,13 ± 15,99	0,677
Bone ratio (%)	29,21 ± 1,54	28,10 ± 1,03	30,42 ± 1,15	0,369
Loin weight (kg)	0,710 ± 0,08	0,751 ± 0,03	0,830 ± 0,03	0,233
Loin ratio in carcass	5,57 ± 0,43	5,85 ± 0,17	6,26 ± 0,32	0,419
Lean weight (g)	336,57 ± 33,43	336,25 ± 16,27	391,50 ± 16,26	0,086
Lean ratio (%)	48,27 ± 1,22	44,92 ± 1,30	47,40 ± 1,28	0,207
Fat weight (g)	266,86 ± 41,18	291,50 ± 19,81	313,50 ± 19,51	0,555
Fat ratio (%)	36,58 ± 1,82	38,66 ± 1,38	37,76 ± 1,35	0,682
Bone weight (g)	104,71 ± 10,70	122,50 ± 8,91	122,75 ± 10,93	0,416
Bone ratio (%)	15,14 ± 0,94	16,42 ± 1,07	14,83 ± 1,21	0,580
Neck weight (kg)	0,799 ± 0,05	0,864 ± 0,04	0,866 ± 0,03	0,508
Neck ratio in carcass	6,48 ± 0,50	6,72 ± 0,23	6,49 ± 0,18	0,744
Lean weight (g)	386,57 ± 25,17	393,50 ± 23,71	422,25 ± 13,16	0,381
Lean ratio (%)	48,38 ± 1,27	46,18 ± 1,32	49,59 ± 1,04	0,178
Fat weight (g)	195,14 ± 10,56	228,00 ± 23,51	207,50 ± 18,25	0,462
Fat ratio (%)	24,52 ± 0,56	26,33 ± 1,52	24,02 ± 1,26	0,505
Bone weight (g)	216,29 ± 14,50	234,00 ± 12,49	225,63 ± 13,67	0,673
Bone ratio (%)	27,10 ± 0,98	27,49 ± 0,58	26,39 ± 1,27	0,741
Breast+ flank weight (kg)	1,56 ± 0,16	1,66 ± 0,09	1,61 ± 0,09	0,870
Breast+ flank in carcass	12,17 ± 0,52	12,88 ± 0,36	12,03 ± 0,40	0,300
Lean weight (g)	581,71 ± 56,40	618,25 ± 39,50	619,25 ± 44,14	0,853
Lean ratio (%)	38,43 ± 1,38	38,22 ± 3,57	39,15 ± 1,66	0,941
Fat weight (g)	738,86 ± 81,85	804,75 ± 95,39	738,75 ± 54,19	0,833
Fat ratio (%)	47,92 ± 1,73	47,57 ± 3,55	46,49 ± 1,61	0,838
Bone weight (g)	202,00 ± 15,39	234,75 ± 13,49	226,13 ± 11,18	0,311
Bone ratio (%)	13,65 ± 0,90	14,21 ± 0,46	14,36 ± 0,47	0,797
Pelvic fat weight (g)	113,07 ± 20,78	105,25 ± 11,35	106,19 ± 8,63	0,991
Pelvic fat ratio in carcass (%)	1,71 ± 0,28	1,62 ± 0,16	1,55 ± 0,20	0,903
Tail weight (kg)	2,40 ± 0,22	1,90 ± 0,16	2,29 ± 0,11	0,128
Tail ratio in carcass (%)	18,82 ± 0,64[a]	14,76 ± 1,04[b]	17,27 ± 0,85[ab]	**0,020**
Eye muscle area (cm^2)	26,78±1,19	24,21±1,41	25,69±1,29	0,652
Back fat deep (mm)	9,02±0,64	10,05±0,89	11,15±0,80	0,254

a,b: Groups with different letters in the same line are different.
#: Since the dissection was performed on the half carcass, the carcass parts were shown on the half carcass.

groups, almost all characteristics were similar (except the testicles and skin ratio).

The weight and ratios for the result of the slaughtered lambs on the 60th day of the feed are shown in Table 7. The loin, breast+flank and tail weight were the highest in the group PG3 (P<0,05; P<0,01 and P<0,001). The back fat depth was highest in the PG1.5 group while the lowest was in the Con group (P<0,001). The ratio of carcass cuts and dissections calculated from carcass weights showed that the PG3 group had a higher leg meat ratio compared to other groups, while the fat ratio was low (P<0,01). Similarly, the meat ratio for the PG3 group was found to be significantly higher in all parts of the carcass than in other groups (P<0,01 and P<0,001).

Slaughters on the 90th day of feeding resulted in similar results in terms of slaughtering characteristics in all groups (Table 8). Table 9 shows the weight (g and kg) and ratios (%) for the characteristics of the carcasses. All values except the tail ratio were similar among groups.

In the obtained values on the 120th day of the last slaughtering, the PG3 group had the heaviest slaughter weight and hot carcass weight (P<0,05) (Table 10). The testis had the highest value in weight and ratio of PG1.5 (P<0.05).

In the 120th day of feeding, the highest cold carcass weight was in the PG3 group and the lowest in the Con group (P<0,01). Similar conditions have been observed for the weight of the leg, foreleg and neck (P<0,05 and P<0,01). The carcass cuts ratios were similar among the groups in all parameters (except meat and fat ratios in breast+flank cut) (Table 11).

DISCUSSION

Fattening Performance

Fattening performance is determined by LW, DWG and FCR. The initial weight of fattening was estimated at approximately 20 kg, with no differentiation among the groups, and at the 120th day of fattening LWs were 54,010; 57,662 and 60,050 kg in Con, PG1,5 and PG3 groups, respectively (P<0,05). While the groups showed similar values in terms of LWs until the 70th day, they were ranked from 77th day, as Con<PG1,5<PG3 (P<0.05). This continued between the 77th and 120th days of feeding (P<0,05). In their study on cattle, Chanjula et al. (9) noted that 14 days of glycerin, which is an indirect source of energy and can be converted into PG at first degradation in rumen, have no effect on nutrient performance. Similarly, in study conducted in cows by Assunção (10), the six-week use of PG and calcium propionate as indirect sources of energy may have been due to nutrient duration. The study confirms Chanjula et al. (9) idea that PG does not have an effect on LW during the first 70 days of the nutrient. This finding is also consistent with Lane and Hogue (11) conclusion that PG was not effective in terms of LW increases as a result of a 3-month pregnancy in females. DWG values in the first week of the feeding were 222 g in group Con, 334 g in PG1.5 and 365 g in group PG3 (P<0,001), which showed that PG had a positive effect on DWG at the first week of feeding. However, this effect disappeared after the first week, and a positive effect of PG on DWG was not detected until approximately the 60th day of the feeding. This can be confirmed by LW data. However, PG groups have shown better DWG values than Con groups from the 90th day of the feeding. This suggests that PG, which is thought to be used as an indirect source of energy, will have a positive effect on nutrient performance after at least 3 months of use. In a study conducted by Teke and Unal (12) on the Akkaraman breed, the live weight (LW) values on the 90th days were 41.8 kg. In contrast, our results showed LW values of 49.92 kg, 52.63 kg, and 54.70 kg from the 99th day of feeding for the Con, PG1.5, and PG3 groups, respectively. This difference can be explained by the thought positive effect of PG on LW.

During the study, the DWGs in group Con varied between 193 and 416 g weekly, which were either consistent with or better than many studies on Akkaraman lambs (13, 14). The observation that PG groups consistently showed better values suggests that PG can be a significant source of energy in feeding.

Table 10 - Means (±SEM) of slaughter characteristics on the 120th day of feeding.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Slaughter weight (kg)	54,01±1,98[a]	57,66±1,46[ab]	60,05±1,18[b]	**0,025**
Hot carcass weight (kg)	29,22±1,10[a]	30,72±0,88[ab]	32,97±0,58[b]	**0,023**
Hot carcass ratio (%)	54,31±0,49	53,36±0,65	54,90±0,35	0,161
Skin weight (kg)	6,05±0,35	6,44±0,26	6,40±0,23	0,670
Skin ratio (%)	11,25±0,46	11,19±0,35	10,67±0,37	0,543
Head weight (kg)	2,17±0,62	2,26±0,78	2,32±0,37	0,166
Head ratio (%)	4,05±0,10	3,92±0,04	3,88±0,07	0,398
Feet weight (kg)	1,17±0,33[a]	1,30±0,45[b]	1,27±0,27[ab]	**0,039**
Feet ratio (%)	2,19±0,05	2,26±0,03	2,11±0,04	0,061
Heart weight (g)	209,25±5,70	221,71±14,56	233,00±7,30	0,081
Herat ratio (%)	0,39±0,01	0,38±0,02	0,39±0,01	0,937
Lung weight (g)	1127,00±58,48	1214,85±86,80	1311,75±84,71	0,247
Lung ratio (%)	2,09±0,06	2,11±0,14	2,18±0,13	0,843
Liver weight (g)	937,00±49,71	980,85±38,19	1006,75±29,29	0,511
Liver ratio (%)	1,73±0,05	1,70±0,04	1,67±0,05	0,719
Kidney weight (g)	142,37±4,90	145,71±9,32	143,25±4,79	0,953
Kidney ratio (%)	0,27±0,01	0,25±0,01	0,24±0,01	0,108
Spleen weight (g)	84,75±2,50	99,42±8,73	93,75±4,81	0,193
Spleen ratio (%)	0,16±0,01	0,17±0,01	0,16±0,01	0,709
Testicles weight (g)	254,25±21,13[a]	325,14±29,59[b]	269,00±17,47[ab]	**0,045**
Testicles ratio (%)	0,47±0,03[a]	0,56±0,04[b]	0,45±0,03[a]	**0,046**

[a,b]: Groups with different letters in the same line are different.

No differences were noted in daily concentrate feed intake (DCFI) across all groups. Feed consumption started at around 700 grams per day in the initial weeks and increased to 2500 grams. Despite similar feed consumption across groups, the higher live weight (LW) values in PG groups confirm PG's positive effect on feeding performance. However, it is evident that a period of at least three months is required for this effect to be realized.

The consumption of feed for Con group during the first week of the feeding was higher than PG groups for 1 kg of CFCLWG (P<0,001). In fact, this is because the DWG values were higher in the PG groups than in the Con group, despite the consumption of similar amounts of feed (approximately 700 g, P>0,05) in all groups during the first week of the feed. Overall, 1 kg of CFCLWG increased by the fattening progressed. This can be explained by the growth rate curve in Akkaraman lambs as many farm animals. The growth rate curve draws a parabolic graph over time, which is explained by the slowing of metabolism during growth (15). Since PG could be used as an energy source in this study, significantly lower values were obtained in PG groups compared to Con group 1 kg of CFCLWG, especially after 70th days of the feeding. The PG groups consumed significantly less feed than the Con group for their 120 day of feeding values. This shows that PG contributes significantly to fattening performance with long-term (at least 4 months) using.

In terms of 1 kg of CFCLWG, the Akkaraman lambs in this study were similar to the Morkaraman, Awassi and Akkaraman (14, 16, 17). This suggests that PG could potentially be used by other indigenous breeds in the lamb meat production system.

Slaughter and Carcass Characteristics

In this study, slaughter weights at day 60 varied between 36.60 and 38.81 kg. Although PG3 group had the highest slaughter weight, there was no significant difference between the groups. Hot carcass yields, which are considered as one of the most important slaughter characteristics, were determined as 51.01%, 50.73% and 50.37% in Con, PG1.5 and PG3 groups, respectively, and there was no significant difference between the groups. The determined values were higher than the values reported in different studies on Akkaraman lambs ahin and Akmaz (13) and similar to the values reported by Teke and Unal (12). In the slaughtering carried out on the 60th day of fattening, the most striking point among the slaughter traits was the testicle weights and ratios. Testis weights and ratios in PG3 group were significantly higher than Con and PG1.5 groups with values of 101 g and 0.26%, respectively (P<0.001). The reason for this is thought to be that PG, which is indirect energy, accelerates the metabolic activity in reaching puberty. It is known that feeding rations high in energy or easily digestible carbohydrates in livestock has the effect of early puberty (15, 18). The higher back fat depths observed in the PG groups compared to the Con group may be attributed to the positive effect of PG on fattening performance. Analysis of carcass characteristics on the same slaughter day revealed that the meat ratios in the leg (P<0.01), foreleg (P<0.05), back (P<0.01), neck (P<0.01), and breast+flank (P<0.001) were significantly higher in the PG groups. Conversely, the fat ratios in the leg (P<0.01), neck (P<0.05), and breast+flank (P<0.001) were significantly lower in the PG groups. This shows that PG increases the edible meat ratio, which is the most important carcass element, and this can be considered as an important advantage in fattening. On the other hand, tail ratio in the carcass was higher in PG3 group than in Con and PG1.5 groups. While it can be considered as an advantage for regions where fat tail lamb is preferred by consumers, it is not possible to consider it as an advantage for regions where it is not preferred. In a study conducted by Tufan and Akmaz (19) on South Karaman, Kangal Akkaraman and Akkaraman breed lambs slaughtered at 30, 35 and 40 kg LW, the meat ratios (between 57.01 and 65.72%) in the leg and foreleg were higher than those found in this study. On the other hand, the fat ratios (between 13.98 and 25.56%) determined in the leg and foreleg in the same study were lower than those determined in this study. It was thought that this may be due to the lipogenic effect of PG.

On the 90th day of fattening, the slaughter weight was 47.13, 48.63 and 49.38 kg in Con, PG1,5 and PG3 groups, respectively, and there was no difference between the groups. Similar to the slaughter weights, there was no difference in hot carcass yields. Kim et al. (7) reported that PG had no effect on carcass weight at 4 months of fattening in Korean domestic cattle. The values determined in this study are similar to the findings of Kim et al. (7). However, the most important point that draws attention here is that the hot carcass yields determined in Akkaraman lambs slaughtered on the 90th day of fattening (55.84%, 54.66% and 55.58% in Con, PG1.5% and PG3 groups, respectively) were higher than other studies (12, 13, 19) and even higher than German Black Headed Akkaraman and Hampsihre DownxAkkaraman cross lambs (20). The reason for this is thought to be the continuation of the « National Project for Animal Breeding in Folk Hands» project carried out by the Ministry of Agriculture and Forestry since 2007 in Kayseri region where the material for this study was obtained. Because it is known that Akkaraman has made significant progress in terms of fattening performance and fertility in the hands of breeders within the scope of this project. On the other hand, Vargas et al. (4) reported hot carcass yields ranging from 56.40% to 58.32% in Katahdin-Black Belly lambs that were fed PG during fattening. The findings of this study are consistent with those of Vargas et al. (4). Additionally, while the groups were similar in terms of tail fat weights at slaughter on the 90th day of fattening, the proportional value for this trait was higher in the Con group compared to the PG1.5 group. This difference is likely due to the higher live weight (LW) values observed in the PG1.5 and PG3 groups compared to the Con group. On the 120th day of fattening, the highest slaughter weight was 60.05 kg in PG3 group and the lowest was 54.01 kg in Con group (P<0.05). It was shown that the dose of PG used at 3% of metabolic body weight had a positive effect on slaughter weight, which is one of the most important parameters in lamb fattening. The findings on slaughter weight at 60 and 90 days of fattening were similar to those reported by Chanjula et al. (9) and Lane and Hogue (11), while the data obtained at 120 days of fattening showed that PG was effective. This led to the idea that the duration and dose of exposure to PG in fattening may influence slaughter weight. While this effect on slaughter weight was similarly observed in hot and cold carcass weights (P<0.05 and P<0.01), there was no difference between the groups in terms of hot carcass yield. This effect observed for PG3 group on hot and cold carcass weights was also observed on leg, foreleg and neck weights (P<0,05 and P<0,01). On the other hand, when the proportional values of carcass traits were analyzed, differences in all parameters except for the meat and fat ratios

Table 11 - Means (±SEM) of individual cuts of carcass on the 120th day of feeding#.

Items	Groups			P
	Con (n=8)	PG1,5 (n=8)	PG3 (n=8)	
Cold carcass weight (kg)	28,32±0,96[a]	29,92±0,71[ab]	32,05±0,52[b]	**0,012**
Cold carcass ratio (%)	52,67±0,29	52,01±0,64	53,38±0,43	0,229
Leg weight (kg)	3,98±0,09[a]	4,12±0,04[a]	4,34±0,03[b]	**0,002**
Leg ratio in carcass	28,25±0,68	27,59±0,46	27,15±0,35	0,384
Lean weight (kg)	2,18±0,06	2,22±0,07	2,33±0,07	0,190
Lean ratio (%)	55,13±0,66	55,29±0,45	54,21±0,24	0,406
Fat weight (g)	1068,50±38,55[a]	1063,14±52,08[a]	1203,50±39,08[b]	**0,048**
Fat ratio (%)	27,04±0,88	26,19±0,21	27,96±0,62	0,426
Bone weight (g)	704,75±25,82	751,42±24,47	765,00±20,03	0,228
Bone ratio (%)	17,81±0,47	18,51±0,48	17,82±0,50	0,537
Foreleg weight (kg)	2,27±0,09[a]	2,46±0,02[ab]	2,59±0,05[b]	**0,004**
Foreleg ratio in carcass	16,08±0,40	16,54±0,32	16,18±0,21	0,604
Lean weight (kg)	1,31±0,04[a]	1,38±0,03[ab]	1,45±0,04[b]	**0,042**
Lean ratio (%)	57,51±0,64	56,42±0,72	55,77±0,94	0,311
Fat weight (g)	599,25±34,11[a]	660,85±22,58[ab]	732,00±36,88[b]	**0,048**
Fat ratio (%)	26,15±0,67	26,89±0,97	28,11±1,00	0,318
Bone weight (g)	372,25±12,75	410,57±20,59	417,50±7,09	0,056
Bone ratio (%)	16,33±0,19	16,68±0,76	16,11±0,36	0,779
Back weight (kg)	1,69±0,11	1,75±0,08	1,85±0,05	0,405
Back ratio in carcass	11,92±0,48	11,71±0,40	11,59±0,41	0,882
Lean weight (g)	720,12±41,74	763,71±53,34	813,50±30,60	0,244
Lean ratio (%)	43,60±1,07	44,17±1,58	44,48±0,68	0,799
Fat weight (g)	468,75±60,48	444,28±19,31	542,00±44,47	0,190
Fat ratio (%)	27,55±2,12	26,17±1,75	29,43±1,63	0,435
Bone weight (g)	472,15±19,60	513,00±37,39	472,12±27,50	0,631
Bone ratio (%)	28,85±1,16	29,65±1,14	26,07±1,70	0,269
Loin weight (kg)	0,868±0,08	0,965±0,04	1,017±0,07	0,432
Loin ratio in carcass	6,06±0,41	6,47±0,31	6,31±0,35	0,752
Lean weight (g)	420,25±0,04	434,00±0,02	436,12±0,02	0,957
Lean ratio (%)	48,31±1,32	45,53±0,46	43,68±1,42	0,277
Fat weight (g)	346,50±38,50	395,42±19,20	433,25±48,08	0,389
Fat ratio (%)	39,56±1,89	41,62±1,59	42,18±1,86	0,605
Bone weight (g)	102,50±9,92	123,14±15,70	140,25±13,50	0,123
Bone ratio (%)	12,12±1,18	12,84±1,34	14,13±1,48	0,597
Neck weight (kg)	0,858±0,04[a]	0,933±0,09[ab]	1,048±0,04[b]	**0,028**
Neck ratio in carcass	6,06±0,25	6,19±0,48	6,53±0,17	0,347
Lean weight (g)	390,50±18,85[a]	466,00±18,37[b]	499,25±21,01[b]	**0,006**
Lean ratio (%)	46,55±0,88	48,71±0,40	48,52±1,14	0,140
Fat weight (g)	198,75±10,34[a]	231,42±13,17[b]	240,75±13,09[b]	**0,049**
Fat ratio (%)	23,86±1,24	24,19±1,17	23,41±0,95	0,880
Bone weight (g)	248,00±13,25	259,71±17,83	288,50±12,37	0,122
Bone ratio (%)	29,58±0,84	27,08±1,29	28,05±0,77	0,261
Breast+ flank weight (kg)	1,85±0,14	1,86±0,06	2,04±0,09	0,380
Breast+ flank in carcass	12,99±0,62	12,52±0,50	12,70±0,53	0,849
Lean weight (g)	649,50±58,41[a]	696,28±36,87[a]	839,75±33,82[b]	**0,016**
Lean ratio (%)	34,85±0,90[a]	37,18±1,44[a]	42,13±1,41[b]	**0,004**
Fat weight (g)	981,75±85,07	939,14±43,27	926,75±82,28	0,888
Fat ratio (%)	52,65±1,02[b]	50,19±1,60[ab]	45,64±1,91[a]	**0,026**
Bone weight (g)	223,00±9,04	236,57±13,14	240,50±5,46	0,310
Bone ratio (%)	12,49±1,06	12,61±0,45	12,21±0,71	0,902
Pelvic fat weight (g)	104,75±14,90	111,71±9,88	127,25±11,38	0,760
Pelvic fat ratio in carcass (%)	0,71±0,09	0,75±0,07	0,78±0,12	0,934
Tail weight (kg)	2,51±0,19	2,83±0,29	2,98±0,18	0,256
Tail ratio in carcass (%)	17,63±1,05	18,07±1,44	18,53±1,01	0,838
Eye muscle area (cm^2)	26,75±0,85	24,79±0,28	26,40±0,51	0,775
Back fat deep (mm)	10,87±1,01	10,57±0,64	10,05±0,80	0,823

[a,b]: Groups with different letters in the same line are different.
[#]: Since the dissection was performed on the half carcass, the carcass parts were shown on the half carcass.

were no longer observed. This indicates that while PG influenced slaughter weight, it did not affect the overall carcass composition, specifically the meat, fat, and bone ratios.

CONCLUSION

While PG had no effect on fattening performance in the first 70 days of fattening, it was found to increase fattening performance thereafter. Over a four-month fattening period, the use of PG at a dose of 3% of metabolic body weight (PG3) positively impacted fattening performance. This suggests that the effectiveness of PG is dose-dependent, with the PG3 dose potentially serving as the starting dose to influence metabolism. It was concluded that PG significantly affected carcass characteristics during the initial 60 days of fattening; however, this effect may have diminished in later periods due to metabolic homeostasis. Additionally, the impact of PG on slaughter characteristics varied with different slaughter weights, likely due to the duration of metabolic exposure.

Ethical Approval

This study was approved by Erciyes University Animal Experiments Local Committee (Protocol no: 19/044).

Author Contributions

AY: Investigation, project director, theorical framework and writing of original draft; HÖ, BA, KA, SS and AA: Investigation and project planning; BÇ, HHK, UK, K and GG: Animal experimental; NU and CÖ: Theorical framework and final control of original draft.

Conflict of Interest Statement

The authors declare no financial or personal conflicts of interest that could influence any aspect of this project. No commercial company or industry is involved in this project.

Funding

This study was financially supported by The Scientific and Technological Research Council of TURKEY (TUB TAK) with 119R076 project number.

References

1. Chiofalo, V., Todaro, M., Liotta, L., Margiotta, S., Manzo, T. and Leto, G. 2005. Effect of propylene glycol on pre-and postpartum performance by dairy ewes. Small Ruminant Research, 58(2): 107-114.
2. Ferraro, S., Mendoza, G., Miranda, L., and Gutiérrez, C. (2009). In vitro gas production and ruminal fermentation of glycerol, propylene glycol and molasses. Animal Feed Science and Technology, 154(1-2): 112-118.
3. Russell, J. and Wallace, R. 1996. Energy-yielding and energy-consuming reactions (Vol. pp: 246-282). Blackie Academic& Professional.
4. Vargas, A. L., Tristán, T. Q., Segura, C. U. H., Barragán, R. M., Flores, A. G. V., Martínez, R. O., and Millán, C. L. H. 2022. Effect of Propylene Glycol on blood metabolites, ruminal and productive parameters of growing-finishing lambs. Tropical and Subtropical Agroecosystems, 25(2), 080.
5. Ferraro, S., Mendoza, G., Miranda, L. and Gutiérrez, C. 2016. In vitro ruminal fermentation of glycerol, propylene glycol and molasses combined with forages and their effect on glucose and insulin blood plasma concentrations after an oral drench in sheep. Animal Feed Science and Technology, 213: 74-80.
6. Nielsen, N. I. and Ingvartsen, K. L. 2004. Propylene glycol for dairy cows: A review of the metabolism of propylene glycol and its effects on physiological parameters, feed intake, milk production and risk of ketosis. Animal Feed Science and Technology, 115(3-4): 191-213.
7. Kim, Y., Choi, H. and Myung, K. 2005. Effects of propylene glycol on carcass traits and its related gene expression in Korean native steers. Journal of Animal Science, 83(2): 344-349.
8. Colomer-Rocher, F., Morand-Fehr, P. and Kirton, A. 1987. Standard methods and procedures for goat carcass evaluation, jointing and tissue separation. Livestock Production Science, 17: 149-159.
9. Chanjula, P., Raungprim, T., Yimmongkol, S., Poonko, S., Majarune, S. and Maitreejet, W. 2016. Effects of elevated crude glycerin concentrations on feedlot performance and carcass characteristics in finishing steers. Asian-Australasian Journal of Animal Sciences, 29(1): 80-88.
10. Assunção, J. M. P. 2012. Influence of slaughter season, muscle type and gluconeogenesis precursors on intramuscular fat quality of ruminant meats, PhD Thesis, Universidade Tecnica de Lisboa (Portugal).
11. Lane, S. and Hogue, D. 1981. Effects of butylene and propylene glycols on body composition and fatty acid synthetase in lambs. Journal of Animal Science, 53(6): 1473-1481.
12. Teke, B., Unal, N. (2009). The effects of slaughter weight and sex on some slaughter traits of Akkaraman and Morkaraman and Turkish Merino lambs. Ank Univ Vet Fak Derg, 56: 289-296.
13. Şahin, E. H. and Akmaz, A. 2002. Farklı kesim ağırlıklarında Akkaraman kuzuların besi performansı, kesim ve karkas özellikleri. Eurasian Journal of Veterinary Sciences, 18(3-4): 29-36.
14. Tekin, M., Akmaz, A., Kadak, R. and Nazlı, M. 1993. Akkaraman, İvesi ve Merinos erkek kuzuların besi ve karkas özellikleri. Hayvancılık Araştırma Dergisi, 3(2): 98-102.
15. Akçapınar, H. and Özbeyaz, C. 1999. Hayvan yetiştiriciliği temel bilgileri. Kariyer Matbaacılık Ltd. Şti., Ankara.
16. Akçapinar, H. 1981. Daglic, Akkaraman ve Kivircik kuzularinin farkli kesim agirliklarinda karkas kompozisyonu ve kalitesi uzerinde karsilastirmali arastirmalar. Lalahan Zootekni Arastirma Enstitusu Dergisi, 21(3-4): 80-99.
17. Kadak, R. 1983. Akkaraman, morkaraman ve ivesi ırkı kuzuların farklı kesim ağırlıklarında besi performansı ve karkas özelliklerinin karşılaştırılması, PhD Thesis, Fırat University, Department of Animal Science.
18. Greyling, J. 2010. Applied reproductive physiology (Vol. 1 pp: 140-155). Wiley- Blackwell, Iowa, USA.
19. Tufan, M. and Akmaz, A. 2001. Slaughter and carcass traits of Güney Karaman, Kangal-Akkaraman and Akkaraman lambs at different slaughter weights. Turk J Vet Anim Sci, 25(4): 495-504.
20. Akmaz, A., Tekin, M. E., Tepeli, C. and Kadak, R. 2000. Alman siyah başlı x Akkaraman ve Hampshire down x Akkaraman melezi (F1 ve G1) erkek kuzuların besi performansı ve karkas özellikleri. Turk J Vet Anim Sci, 24: 7-15.

FONDO SANITARIO ANMVI

GARANZIE

PER LA TUA

SALUTE

E PER LA TUA FAMIGLIA

Campagna sottoscrizioni 2025

INQUADRA IL QR E SCOPRI DI PIÙ

ANMVI
ASSOCIAZIONE NAZIONALE MEDICI VETERINARI ITALIANI