The effect of final weight on slaughtering and carcass quality characteristics of lambs in concentrate-based or pasture-based production systems

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SUMMARY

In lamb finishing for meat production, determination of optimal slaughter weight is an important issue for the provision of a profitable and high-quality lamb production. Aim of the study was to investigate the effect of final weight (LOW: 25-26 kg, MEDIUM: 30-31 kg and HIGH: 35-36 kg) on the slaughtering and carcass quality characteristics of Kivircik lambs, which were finished with concentrate-based diet (CON) or on pasture (PAS). CON lambs (n = 27) were weaned at 76-d and then finished on concentrate feed and alfalfa hay until slaughter in sheepfold. PAS lambs (n = 25) were on native pasture in the day-time with their mothers and allowed to suck their mothers until the slaughter. In the CON system, commercial and real dressing percentages were lower in the LOW group compared to MEDIUM and HIGH groups. In MEDIUM and HIGH weight groups, CON system yielded higher commercial dressing than PAS system. CON lambs had higher liver percentage than PAS lambs in all final weight groups. LOW lambs had lower values for carcass measures and indices, except chest roundness index than HIGH lambs. CON lambs a had higher buttock width and circumference, carcass width, carcass compactness and chest roundness index in all final weight groups. Lambs from LOW group in PAS system had a higher yellowness than that in CON system. In conclusion, CON system can be preferred to produce a higher amount of lamb meat in a shorter time. Final weight of 35-36 kg might be preferred in both production systems to increase lamb production, without any adverse effect on carcass quality.

KEY WORDS

Carcass quality, fat colour, lamb, production system.

INTRODUCTION

Most of the sheep farms in Turkey are small-scale family farms as in other the Middle East and some of the Mediterranean countries. Sheep farming is usually conducted in rural areas by low-income villagers. Lamb sales constitute an important part of the income generated in these enterprises[1]. Moreover, lamb and sheep meat are consumed with pleasure in Middle Eastern countries and it also makes an important contribution to meeting the animal-based food needs of low-income people[2].

Feed cost forms an important part of a livestock enterprise's expenditures. If the pasture areas are sufficient and pasture conditions are favourable, grazing on pasture is usually the cheapest way for lamb feeding. Therefore, in the traditional production systems, lambs are kept in the sheepfold until 75-90 days of age and then finished at natural pastures in the daytime by supplementing with roughage at nights[1]. However, the amount of milk sold is reduced as the lamb sucks their mothers in this production system. On the other hand, pasture areas have gradually decreased, and uncontrolled and excessive grazing has caused the quality of existing pastures to decline in recent years. As a result, natural pastures are no longer sufficient to meet the nutritional requirements of lambs for finishing nowadays. These adversities led sheep farmers to search for alternative systems for lamb finishing. Nowadays, many sheep farmers prefer the concentrates-based lamb finishing system, in which lambs are weaned at 75-90 days of age and fed with concentrates until slaughter[1]. Slaughtering characteristics and carcass quality of lambs may vary due to production systems[3,4,5,6]. Final or slaughter weight may also influence these characteristics[7,8,9,10]. Therefore, the deciding the appropriate production system and the final weight of lambs in commercial lamb production is of great importance in obtaining high-quality lamb carcasses.

Many sheep breeds are bred in Turkey, and the majority of these breeds are fat-tailed. However, the most preferred sheep breed by consumers is Kivircik, which is a thin-tailed breed. Kivircik and its crossbreds are also bred in Greece, Bulgaria and some Balkan countries[11]. The aim of the current study was to determine the growth rate, slaughtering and carcass quality traits of Kivircik lambs at three final weights (LOW: 25-26 kg, MEDIUM: 30-31 kg and HIGH: 35-36 kg) in pasture-based and concentrate-based production systems.

MATERIALS AND METHODS

Handling, feeding and housing procedures applied in the current study were approved by the local Ethics Committee of Istanbul University Faculty of Veterinary Medicine (No: 05-109).

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Animal material and production systems

The study was conducted at sheep farm of the Veterinary Faculty. The first week after birth the lambs were fed only with dam's milk. Thereafter, the lambs were given alfalfa hay in addition to their mother's milk until 76-day of age. Fifty-four male lambs born as a single in early February were selected for the animal material of the study when the average lamb age attained about 76 days (76.5 ± 0.6 days). These lambs were randomly divided into two production systems with 27 lambs in each group. Afterwards, lambs of each production system were randomly allocated into LOW (25-26 kg), MEDIUM (30-31 kg) and HIGH (35-36 kg) final weight groups. Handling, housing and feeding procedures in production systems were:

Concentrate-based (CON) lamb production

The lambs, which selected for the CON system, were weaned at 76-day immediately after grouping. Afterwards, three separate pens (5.0 × 3.2 m each) were built in the sheepfold for LOW, MEDIUM and HIGH final weight groups, and lambs were placed in these pens. During the whole finishing period, lambs had free access to the concentrate feed, alfalfa hay and fresh clean water. Concentrate feed consumptions of each weight group was determined at weekly basis. Mean daily concentrate consumption was 0.73 kg, 0.92 kg and 1.01 kg in LOW, MEDIUM and HIGH final weight groups, respectively.

Pasture-based (PAS) lamb production

PAS lambs were not weaned until slaughter. These lambs were grazed with their dams in the natural pasture during the day and fed free access with alfalfa hay in the sheepfold during the night. Composition of pasture (on dry matter basis) was: 52% Gramineae (Lolium spp. and Festuca spp.), 22% Leguminosae (Vicia spp., Medicago spp. and Trifolium spp.) and 26% other families (mainly Conium spp., Viola spp., Geranium spp., Plantago spp. and Rumex spp.)[1]. The composition of the alfalfa hay, concentrate feed and pasture are given in Table 1.

Table 1 - Chemical composition of concentrate feed, alfalfa hay and pasture used in the study.

Chemical composition	Concentrate feed[3]	Alfalfa hay	Pasture
Dry matter (%)	90.30	92.14	37.95
Crude protein[1] (%)	16.90	15.85	11.5
Ether extract[1] (%)	3.14	2.10	5.46
Crude cellulose[1] (%)	14.65	26.50	24.4
Ash[1] (%)	6.92	8.49	10.43
Neutral detergent fibre[1] (%)	29.41	46.16	42.67
Acid detergent fibre[1] (%)	10.30	33.92	35.97
Metabolizable energy[2], (MJ ME/kg DM)	11.81	8.67	9.21

[1] As a percentage of dry matter.
[2] Calculated values.
[3] Concentrate feed contained: wheat bran 40%, barley 15.5%, corn 15.3%, soybean meal 8%, sunflower meal 6%, DDGS (dried distillers grains with solubles) 5%, molasses 4%, Safflower meal 3%, $CaCO_3$ 2.5%, NaCl 0.5%, vitamin/mineral premix 0.2%.

Two lambs in HIGH group of PAS system were excluded from the study since they had laminitis and therefore could not graze on the pasture. Hence, 25 lambs in PAS system and 27 lambs in CON system were slaughtered in the study.

All lambs were weighed every Wednesday morning before feeding. Lambs reaching the target weight in weekly weighings were transferred to Istanbul University experimental slaughterhouse for slaughtering.

Slaughter procedures and determination of carcass characteristics

Lambs were kept overnight at lairage unit of the slaughterhouse with free access to water but not feed. After recording the pre-slaughter live weight, the lambs were electrically stunned and then slaughtered. Afterwards, head, skin, feet, lungs and trachea, liver, heart, spleen, testicles and gastro-intestinal tract were removed and weights of these tissues were recorded. After the removal of these tissues, hot carcass weight was recorded. Afterwards, the carcasses were kept in cold storage (4°C) for 24 h.

At 24 h post-mortem, colour variables of subcutaneous fat were measured by using a colorimeter (Minolta CR-400) from the tail root. Afterwards, following carcass measurements were also determined on the intact carcass as reported by Ekiz et al.[12]: buttock width, buttock circumference, leg length, carcass length, carcass width, chest depth and chest circumference. Next, carcasses were split along the vertebral column into right and left parts. Left parts of the carcasses were used to measure hind limb length and internal carcass length[12]. Once the carcass measurements have been determined, hind limb compactness, carcass compactness and chest roundness index were calculated as reported by Ekiz et al.[12]. After all carcass measurements were recorded, the right sides of carcasses were separated into ribs, thoracic and pelvic limbs, neck and flank joints at 24 h post-mortem[13].

Statistical analyses

The effects of production system, final weight group and their interaction on slaughtering and carcass characteristics were analysed using the General Linear Model (GLM) procedures in SPSS 13.0 programme. Moreover, one-way ANOVA and Duncan's multiple range test were applied to compare the final weight groups for each production system. The comparison of PAS and CON systems for each final weight group was performed by independent sample t-test.

RESULTS

As planned in the experimental design, initial ages and weights of lambs in six sub-groups (2 production system × 3 final weight groups) were similar (Table 2). Finish duration was lower in lambs of CON system in both LOW and HIGH weight groups than lambs of the PAS system. In the CON system, commercial and real dressing percentages were lower in the LOW group compared to MEDIUM and HIGH groups. However, differences among final weight groups in terms of commercial and real dressing percentages were not significant in the PAS system. In MEDIUM and HIGH weight groups, CON system yielded higher commercial dressing than PAS system, but such a difference was

Table 2 - Performance traits and slaughtering characteristics of lambs in different final weights[1] due to production systems.

Characteristics	Concentrate-based system			Pasture-based system			SEM	P-Value		
	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH		WG	PS	WG×PS
Initial age, days	76.67	76.11	76.78	77.89	75.56	77.43	1.539	0.914	0.887	0.970
Initial weight, kg	17.37	17.93	17.91	17.49	17.80	17.91	0.230	0.573	0.878	0.912
Finishing duration, days	43.78 ^{c,x}	75.67 ^{b}	94.67 ^{a,x}	60.33 ^{f,y}	85.00 ^{e}	107.57 ^{d,y}	2.555	<0.001	0.015	0.840
Pre-slaughter weight, kg	24.09 ^{c}	28.46 ^{b}	33.26 ^{a}	24.11 ^{f}	27.98 ^{e}	32.47 ^{d}	0.161	<0.001	0.071	0.173
Hot carcass weight, kg	11.56 ^{c}	14.26 ^{b,x}	16.82 ^{a,x}	11.24 ^{f}	13.19 ^{e,y}	15.07 ^{d,y}	0.131	<0.001	<0.001	0.035
Commercial dressing[2], %	48.03 ^{b}	50.10 ^{a,x}	50.57 ^{a,x}	46.68	47.05 ^{y}	46.46 ^{y}	0.346	0.267	<0.001	0.272
Real dressing[3], %	54.69 ^{b}	56.11 ^{a}	56.37 ^{a,x}	53.87	54.24	54.20 ^{y}	0.272	0.261	0.005	0.571
Non-carcass parts, %										
Head	6.62 ^{y}	6.52 ^{y}	6.80	7.08 ^{x}	7.10 ^{x}	6.91	0.048	0.905	0.001	0.140
Feet	3.04 ^{a,y}	2.81 ^{b,y}	2.68 ^{c,y}	3.22 ^{d,x}	3.02 ^{e,x}	2.86 ^{f,x}	0.019	<0.001	<0.001	0.962
Skin	10.23	10.66	10.77	10.92	11.09	11.47	0.141	0.297	0.037	0.903
Lungs and trachea	1.84 ^{a}	1.56 ^{b,y}	1.49 ^{b,y}	1.80	1.73 ^{x}	1.73 ^{x}	0.022	<0.001	0.007	0.210
Liver	2.39 ^{x}	2.29 ^{x}	2.18 ^{x}	2.06 ^{y}	2.02 ^{y}	2.05 ^{y}	0.028	0.269	<0.001	0.340
Heart	0.52 ^{y}	0.50	0.50 ^{y}	0.56 ^{x}	0.53	0.54 ^{x}	0.005	0.110	<0.001	0.850
Spleen	0.23	0.21	0.20	0.22	0.24	0.22	0.005	0.209	0.165	0.245
Empty stomachs	3.57	3.45	3.34	3.55	3.55	3.53	0.049	0.584	0.392	0.687
Empty intestines	6.83 ^{a}	6.04 ^{b}	5.42 ^{c}	6.38 ^{d}	5.83 ^{e}	5.41 ^{f}	0.086	<0.001	0.206	0.572
Gastro-intestinal content	13.96	12.02 ^{y}	11.51 ^{y}	15.59	15.46 ^{x}	16.83 ^{x}	0.455	0.635	<0.001	0.271

[1] Final weight groups: LOW = 25-26 kg, MEDIUM = 30-31 kg, HIGH = 35-36 kg.
WG: Final weight group; PS: Production system.
$^{a, b, c}$ Mean values with different superscripts in the same line for concentrate-based system are significantly different ($P < 0.05$).
$^{d, e, f}$ Mean values with different superscripts in the same line for pasture-based system are significantly different ($P < 0.05$).
$^{x, y}$ Mean values for CON and PAS systems with different superscripts within the same final weight group are significantly different ($P < 0.05$).
[2] (Hot dressing percentage / pre-slaughter weight) × 100.
[3] (Hot dressing percentage / empty body weight) × 100.

not observed in LOW weight group. A decrease in percentages of feet and empty intestines were determined with the increase in final weight in both CON and PAS systems. Lambs of CON system had higher liver percentage than PAS lambs in all final weight groups.

In both CON and PAS systems, LOW lambs had lower mean values in terms of carcass measures and indices, except chest roundness index than HIGH lambs (Table 3). MEDIUM group had also higher values than LOW group for the majority of carcass measures. Lambs in CON system a had higher buttock width and circumference, carcass width, carcass compactness and chest roundness index in all final weight groups compared with PAS lambs.

Lightness and redness values of subcutaneous fat were not

Table 3 - Carcass measures and indices of lambs in different final weights[1] due to production systems.

Characteristics	Concentrate-based system			Pasture-based system			SEM	P-Value		
	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH		WG	PS	WG×PS
Carcass length, cm	65.32	66.11	68.50	64.64 ^{e}	68.93 ^{d}	72.13 ^{d}	0.557	0.002	0.091	0.251
Internal carcass length, cm	55.06 ^{c}	57.46 ^{b}	60.02 ^{a}	56.10 ^{f}	58.42 ^{e}	60.09 ^{d}	0.212	<0.001	0.110	0.594
Leg length, cm	19.44 ^{b}	20.39 ^{a}	20.90 ^{a}	19.84 ^{e}	20.78 ^{d}	21.01 ^{d}	0.095	<0.001	0.120	0.794
Hind limb length, cm	26.94 ^{b}	27.81 ^{ab}	28.58 ^{a}	27.02 ^{e}	28.13 ^{de}	28.46 ^{d}	0.182	0.005	0.800	0.886
Buttock width, cm	19.20 ^{c,x}	20.18 ^{b,x}	20.94 ^{a,x}	18.10 ^{e,y}	18.96 ^{de,y}	19.80 ^{d,y}	0.107	<0.001	<0.001	0.972
Buttock circumference, cm	54.99 ^{c,x}	58.32 ^{b,x}	60.51 ^{a,x}	53.56 ^{f,y}	55.80 ^{e,y}	58.79 ^{d,y}	0.204	<0.001	<0.001	0.520
Carcass width, cm	19.02 ^{b,x}	20.68 ^{a,x}	20.98 ^{a,x}	17.73 ^{e,y}	18.51 ^{de,y}	19.64 ^{d,y}	0.146	<0.001	<0.001	0.380
Chest depth, cm	23.60 ^{c}	24.64 ^{b}	26.40 ^{a}	23.87 ^{e}	25.24 ^{d}	26.07 ^{d}	0.099	<0.001	0.371	0.175
Chest circumference, cm	64.38 ^{c}	69.08 ^{b}	72.67 ^{a}	65.47 ^{f}	68.38 ^{e}	70.97 ^{d}	0.218	<0.001	0.322	0.039
Carcass compactness, g/cm	203.34 ^{c,x}	241.33 ^{b,x}	272.65 ^{a,x}	192.55 ^{f,y}	217.30 ^{e,y}	236.85 ^{d,y}	1.969	<0.001	<0.001	0.045
Hind limb compactness, g/cm	69.46 ^{c}	82.06 ^{b,x}	90.81 ^{a,x}	68.40 ^{e}	73.47 ^{e,y}	83.49 ^{d,y}	0.922	<0.001	0.004	0.203
Chest roundness index	0.74 ^{x}	0.78 ^{x}	0.75 ^{x}	0.69 ^{y}	0.68 ^{y}	0.71 ^{y}	0.006	0.482	<0.001	0.116

[1] Final weight groups: LOW = 25-26 kg, MEDIUM = 30-31 kg, HIGH = 35-36 kg.
WG: Final weight group; PS: Production system.
$^{a, b, c}$ Mean values with different superscripts in the same line for concentrate-based system are significantly different ($P < 0.05$).
$^{d, e, f}$ Mean values with different superscripts in the same line for pasture-based system are significantly different ($P < 0.05$).
$^{x, y}$ Mean values for CON and PAS systems with different superscripts within the same final weight group are significantly different ($P < 0.05$).

Table 4 - Fat colour characteristics and proportions of carcass joints of lambs in different final weights[1] due to production systems.

Characteristics	Concentrate-based system			Pasture-based system			SEM	P-Value		
	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH		WG	PS	WG×PS
Fat colour										
Lightness	69.96	69.58	69.09	70.04	69.99	69.64	0.148	0.230	0.246	0.801
Redness	4.64	3.89	4.09	4.40	4.20	4.01	0.100	0.089	0.980	0.486
Yellowness	6.81 ^{y}	7.31	7.48	7.75 ^{x}	7.81	7.96	0.119	0.315	0.010	0.667
Chroma	8.26	8.29	8.54	8.96	8.88	8.92	0.129	0.890	0.036	0.888
Hue	55.55 ^{b}	61.96 ^{a}	61.46 ^{a}	60.82	61.56	63.11	0.572	0.010	0.063	0.123
Proportions of carcass joints, %										
Pelvic limb	34.24 ^{a}	33.23 ^{ab}	32.20 ^{b,y}	34.03 ^{d}	32.64 ^{e}	34.18 ^{d,x}	0.146	0.003	0.186	0.002
Ribs	25.38	26.41	26.95 ^{x}	24.79 ^{e}	26.44 ^{d}	24.73 ^{e,y}	0.198	0.024	0.023	0.073
Thoracic limb	19.23 ^{y}	18.69 ^{y}	18.78 ^{y}	20.30 ^{x}	20.14 ^{x}	20.28 ^{x}	0.086	0.228	<0.001	0.531
Neck	7.47 ^{b,y}	8.12 ^{ab}	8.58 ^{a}	8.33 ^{x}	8.81	8.65	0.116	0.043	0.033	0.385
Flank	10.32	10.01	9.91	10.05	9.40	9.73	0.144	0.360	0.230	0.821
Tail	1.17	1.26	1.33 ^{x}	1.01	1.04	0.96 ^{y}	0.037	0.748	0.001	0.494

[1] Final weight groups: LOW = 25-26 kg, MEDIUM = 30-31 kg, HIGH = 35-36 kg.
WG: Final weight group; PS: Production system.
$^{a, b}$ Mean values with different superscripts in the same line for concentrate-based system are significantly different ($P < 0.05$).
$^{d, e}$ Mean values with different superscripts in the same line for pasture-based system are significantly different ($P < 0.05$).
$^{x, y}$ Mean values for CON and PAS systems with different superscripts within the same final weight group are significantly different ($P < 0.05$).

influenced from neither by the weight group nor by the production system (Table 4). Lambs from LOW group in PAS system had a higher yellowness than that in CON system. In CON system, hue value was lower in LOW group compared to MEDIUM and HIGH groups. In CON system, HIGH lambs had lower pelvic limb proportion and higher neck proportion than LOW lambs. Proportion of thoracic limb was higher in PAS lambs than CON lambs in all final weight groups.

DISCUSSION

In lamb finishing for meat production, determination of optimal slaughter weight is an important issue for the provision of a profitable and high-quality lamb production. In Turkey, pricing of lamb carcasses is usually based on carcass weight, so marketing of overweight lambs may be considered by sheep farmers. In LOW and HIGH weight groups, lambs of CON system reached the final weight earlier than the PAS lambs. This may be due to the discrepancy between the two production systems in terms of food resources. CON lambs were fed *ad-libitum* with concentrate and alfalfa hay, while pasture grass, alfalfa and mothers' milk were main feed resources of PAS lambs. Supporting the current results, Ekiz et al.[2] for Kivircik lambs and Borton et al.[14] for Targhee × Hampshire lambs found lower growth rate in pasture lambs than lambs fattened with concentrates. On the other hand, if pasture conditions are favourable, studies found similar growth rate for grazing and stall lambs were also available[6,15]. In MEDIUM and HIGH weight groups, CON lambs had higher hot carcass weight than lambs reared under PAS system. One possible explanation for higher hot carcass weights of CON lambs might be their higher dressing percentages. The results that higher carcass weights in lambs finished with concentrates than pasture lambs were also observed for Targhee × Hampshire lambs[14] and Kivircik lambs[2], previously. In MEDIUM and HIGH weight groups, a higher commercial and real dressing percentages observed in CON lambs might be due to the higher percentages of head, feet, lungs and trachea, and gastro-intestinal content in PAS lambs.

In lambs of PAS system, commercial and real dressing percentages were not affected by final weight group. Similar results were reported for suckling lambs by Santos et al.[16]. On the other hand, in CON lambs, commercial and real dressing percentages were lower in lambs of the LOW group than that of MEDIUM and HIGH weight groups. Majdoub-Mathlouthi et al.[17] also found an increase in dressing percentage with increasing slaughter weight in lambs fattened with concentrates. The authors explained this result by reduced gut content percentage with increasing slaughter weight. Oliveira et al.[18] explained a higher dressing percentage in Sante Ines lambs, which slaughtered at heavier weights by higher deposition of muscle and fat in carcasses of these lambs. Borton et al.[14] also found higher dressing percentage for concentrate-fed lambs than pasture lambs and attributed this result to a decrease in the size of gastrointestinal tract. Indeed, in the current study, there was a tendency in CON lambs to decrease in the percentage of gastrointestinal content with the increase in the final weight for lambs ($P = 0.06$).

Feet percentage dropped as final weight increased in both CON and PAS systems. These results might be explained by the fact that bone is the most precocious tissue followed by lean, while fat tissue develops later[6]. In the current study, lambs from different final weight groups were slaughtered at 4-6 months of age, therefore weight gains of lambs at these ages might have been based on mainly an increase in muscle and fat tissues rather than bone tissues. The higher head, feet, lungs and trachea, and heart percentage in PAS lambs were expected because CON lambs reached to the target final weight about 13 days earlier than PAS lambs. In the previous study, where Kivircik lambs were slaughtered at a constant weight of 30 kg, the percentages of feet and lungs and trachea of the older ones were found to be higher[2].

CON lambs had higher liver percentages than PAS lambs in all final weight groups. McClure et al.[19] also found higher

liver weight for lambs fed concentrate-based diet than lambs of grazing-based system. Similarly, Ekiz et al.[2] reported a higher liver percentage for weaned lambs finished with concentrates compared with lambs of grazing-based systems. Kochewad et al.[20] also found higher liver percentage for Deccani lambs finished with concentrates than lambs finished at pasture.

When carcass measurements are evaluated, a significant increase in the majority of carcass measures and indices were observed with increased final weight group in both CON and PAS systems. Similar trend regarding carcass measurements were reported previously for several breeds[7,10,16]. Conformation and body/carcass measurements of healthy and well-fed animals are expected to rise with increasing age and weight until reaching the mature age[7]. Therefore, the current results regarding effects of final weight group on carcass measurements and indices might be evaluated as expected results. Moreover, carcass measures and indices determined for LOW and MEDIUM groups were comparable with the previous results by Ekiz et al.[21] for Kivircik lambs slaughtered at 26.6 and 30.3 kg, respectively.

Production system did not affect length measures (lengths of carcass, internal carcass, leg and hind limb), and depth and circumference of chest in all final weight groups. But, CON lambs had higher mean values regarding width measures (buttock width and carcass width) and buttock circumference in all final weight groups. Hence, a higher width and circumference measurements of CON lamb carcasses caused the objective carcass indices (carcass compactness, hind limb compactness and chest roundness index) in these lambs to be higher than in PAS lambs. Supporting the current result, Carrasco et al.[5] reported lower transversal measures, and decreased hindquarters compactness, chest rounded index, pelvic limb compactness and carcass compactness for Churra Tensina light lambs reared under grazing compared with drylot lambs with dams fed in confinement. Gallo et al.[22] found higher carcass compactness index in feedlot lambs that fed a diet composed of 20% of roughage and 80% of concentrate than lambs raised on pasture. In that study, internal carcass length and leg length were also similar in pasture and feedlot lambs.

Final weight group had no significant influence on subcutaneous fat colour parameters in both CON and PAS systems, except hue value in CON system. Ripoll et al.[23] also reported no significant influence of carcass weight on subcutaneous fat lightness and chroma values. Fat of lamb carcasses in LOW group had lower hue value compared to that of MEDIUM and HIGH groups. Moreover, significant production system effect was only observed in LOW weight group for the yellowness of carcass fat. PAS lambs had more yellow fat colour with higher b* value compared with CON lambs. This may be attributed to the greater intake of herbage (and therefore pigments) in PAS lambs. Similarly, Carrasco et al.[24] observed higher b* values in lambs from grazing groups than drylot lambs and explained this by more carotenoids deposition in grazed lambs due to pasture intake. In the other study, Dıaz et al.[6] also found higher b* value for subcutaneous fat in lambs finished at pasture than that of sheepfold ones.

The proportion of thoracic limb was higher in PAS lambs. With regard the pelvic limb proportion, PAS lambs in HIGH group had also higher mean values than that of CON lambs. Ekiz et al.[2] also observed lower proportions of thoracic and pelvic limbs in unweaned lambs finished with concentrates compared with lambs from grazing-based systems. Borton et al.[14] noted that proportions of leg and foreshank joints, which are related to motor function, might be increased consistently in forage-finishing systems. Higher proportions of ribs and tail in HIGH weight group of CON lambs may be related to the higher fatness level of these lambs and/or lower proportions of the thoracic limb in these lambs compared to PAS lambs. Proportions of carcass joints found in the current study were comparable with the results of Aksoy et al.[25] for Kivircik lambs finished with concentrate based system.

CONCLUSIONS

In the conditions of the current study, CON lambs were significantly younger at slaughter. Moreover, CON lambs had higher dressing percentage, better carcass conformation with greater width measurements. Therefore, CON system can be preferred to produce a higher amount of lamb meat in a shorter time. Final weight did not influence on dressing percentage and subcutaneous fat colour. Therefore, among the groups investigated in the current study, final weight of 35-36 kg might be preferred to increase lamb production, without any adverse effect on carcass quality for Kivircik lambs.

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References

1. Ekiz B., Yilmaz A., Ozcan M., Kocak O. (2012). Effect of production systems on carcass measurements and meat quality of Kivircik lambs. Meat Sci, 90: 465-471.
2. Ekiz B., Yilmaz A., Demirel G., Yalcintan H., Kocak O., Ozcan M., Altinel A. (2013). Slaughter characteristics, carcass quality and fatty acid composition of lambs under four different production systems. Small Rum Res, 114: 26-34.
3. Boughalmi A., Araba A. (2016). Effect of feeding management from grass to concentrate feed on growth, carcass characteristics, meat quality and fatty acid profile of Timahdite lamb breed. Small Rum Res, 144, 158-163.
4. Cañeque V., Velasco S., Díaz M.T., de Huidobro F.R., Perez C., Lauzurica S. (2003). Use of whole barley with a protein supplement to fatten lambs under different management systems and its effect on meat and carcass quality. Anim Res, 52(3): 271-285.
5. Carrasco S., Ripoll G., Sanz A., Álvarez-Rodríguez J., Panea B., Revilla R., Joy M. (2009). Effect of feeding system on growth and carcass characteristics of Churra Tensina light lambs. Livest Sci, 121: 56-63.
6. Díaz M.T., Velasco S., Caneque V., Lauzurica S., Huidobro F., Perez C., Gonzales J., Manzanares C. (2002). Use of concentrate or pasture for fattening lambs and its effect on carcass and meat quality. Small Rum Res, 43: 257-268.
7. Abdullah A.Y., Qudsieh R.I. (2008). Carcass characteristics of Awassi ram lambs slaughtered at different weights. Livest Sci, 117: 165-175.
8. Díaz M.T., Velasco S., Pérez C., Lauzurica S., de Huidobro R.F., Cañeque V. (2003). Physico-chemical characteristics of carcass and meat Manchego-breed suckling lambs slaughtered at different weights. Meat Sci, 65(3): 1085-1093.
9. Lloyd W.R., Slyter A.L., Costello W.J. (1980). Effect of breed, sex and final weight on feedlot performance, carcass characteristics and meat palatability of lambs. J Anim Sci, 51: 316-320.

10. Peña F., Cano T., Doménech V., Alcalde Ma J., Matos J., Garcia-Martinez A., Herrera M., Rodero E. (2005). Influence of sex, slaughter weight and carcass weight on “non-carcass” and carcass quality in Segureña lambs. Small Rum Res, 60: 247-254.
11. Anonymous (2009). Republic of Turkey, Ministry of Food, Agriculture and Livestock, General Directorate of Agricultural Research and Policies. Turkish Farm Animal Genetic Resources Catalogue. https://www.tarim.gov.tr/TAGEM/Belgeler/yayin/Katalog%20T%C3%BCrk%C3%A7e.pdf
12. Ekiz B., Ozcan M., Yilmaz A., Tölü C., Sava T. (2010). Carcass measurements and meat quality characteristics of dairy suckling kids compared to an indigenous genotype. Meat Sci, 85: 245-249.
13. Colomer-Rocher F., Morand-Fehr P., Kirton A.H. (1987). Standard methods and procedures for goat carcass evaluation, jointing and tissue separation. Livest Prod Sci, 17: 149-159.
14. Borton R.J., Loerch S.C., McClure K.E., Wulf D.M. (2005). Comparison of characteristics of lambs fed concentrate or grazed on ryegrass to traditional or heavy slaughter weights. I. Production, carcass, and organoleptic characteristics. J Anim Sci, 83; 679-685.
15. Atti N., Mahouachi M. (2009). Effects of feeding system and nitrogen source on lamb growth, meat characteristics and fatty acid composition. Meat Sci., 81: 344-348.
16. Santos V.A.C., Silva S.R., Mena E.G., Azevedo J.M.T. (2007). Live weight and sex effects on carcass and meat quality of “Borrego terrincho-PDO” suckling lambs. Meat Sci, 77(4): 654-661.
17. Majdoub-Mathlouthi L., Saïd L., Say A., Kraiem K. (2013). Effect of concentrate level and slaughter body weight on growth performances, carcass traits and meat quality of Barbarine lambs fed oat hay based diet. Meat Sci, 93: 557-563.
18. Oliveira F.G., Sousa W.H., Cartoxa F.Q., Cunha MG.G., Ramos J.P.F., Cezar M.F., Menezes L.M., Oliveira A.B. (2018). Carcass characteristics of Santa Ines sheep with different biotypes and slaughtering weights. Rev Bras Saúde Prod Anim Salvador, 19: 347-359.
19. McClure K.E., Solomon M.B., Loerch S.C. (2000). Body weight and tissue gain in lambs fed an all-concentrate diet and implanted with trenbolone acetate or grazed on alfalfa. J Anim Sci, 78: 1117-1124.
20. Kochewad S.A., Raghunandan T., Sarjan Rao K., Kondal Reddy K., Nalini Kumari N., Ramana D.B.V., Anil Kumar D., Kankarne Y, Kumar S., Meena L.R., Singh M. (2018). Productive performance, body condition score and carcass characteristics of Deccani lambs reared under different farming systems. Indian J Anim Res, 52: 444-448.
21. Ekiz B., Koçak O., Yalcintan H., Yilmaz A. (2016). Effects of suckling duration on growth, slaughtering and carcass quality characteristics of Kivircik lambs. Trop Anim Health Prod, 48: 395-401.
22. Gallo S.B., Arrigoni M.B., da Silva C. Lemos A.L., Haguiwara M.M.H., Bezerra H.V.A. (2019). Influence of lamb finishing system on animal performance and meat quality. Acta Scientiarum Anim Sci, v41i1.44742 (Doi: 10.4025/actascianimsci.v41i1.44742).
23. Ripoll G., Blanco M., Panea B., Joy M. (2019) The effect of carcass weight on fatness and muscle and fat colour of male Ojinegra de Teruel light lambs. Anim Prod Sci, 59: 1168-1175.
24. Carrasco S., Panea B., Ripoll G., Sanz A., Joy M. (2009). Influence of feeding systems on cortisol levels, fat colour and instrumental meat quality in light lambs. Meat Sci, 83: 50-56.
25. Aksoy Y., Uğurlu M., Önenç A., Şirin E., Şen U., Çiçek Ü., Ulutaş Z., Kuran M. (2018). Meat production characteristics of Turkish native breeds: I. Fattening, slaughter and carcass traits of lambs. S. Afr. J Anim Sci, 48: 665-672.