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Effect of Changes in Protein Intake under Energy Restricted Conditions on Fattening Performance and Various Organ Weights in Lambs

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Abstract: The aim of the present study was to investigate the effect of changes in protein intake under energy restricted conditions on fattening performance and various organ weights in lambs. Three concentrate feed mixture differing in CP but iso-energetic were prepared for an 84 day study. Lambs in AL group were offered concentrate feed mix (13.15% CP and 2567 kcal ME kg^{-1}) at *ad libitum* level, whereas lambs in RP1 (15.71% CP and 2563 kcal ME kg^{-1}) and RP2 (18.98% CP and 2564 kcal ME kg^{-1}) groups were offered concentrate feed mix at 85% of the daily mean dry matter intake of AL group. The treatments had significant effects on live weight gain, daily feed and nutrients intakes ($p<0.05$), but no effect on feed conversion efficiency ($p>0.05$). Restriction in energy caused a decrease in liver, reticulorumen and heart+lungs weights ($p<0.05$). The results of the present study suggest that restrictions used in this study in energy intake resulted in significant decreases in live weight gain and ration manipulations ensuring fixed or increased protein intake did not elevate this problem.

Key words: Lamb, restricted feeding, protein consumption, fattening

INTRODUCTION

Restricted feeding, which has been used for many years in different areas of animal production and nutritional programmes involving this application method basically aims at ensuring controlled provision of nutrient intake. Dilution of nutrient concentration through the changes in the ratio of roughage to concentrate feed or direct restriction in intake level are known as common procedures in restricted feeding[1]. Prevention of gut disorders occurring often under *ad libitum* feeding conditions in ruminant-based fattening systems[2], improvement in feed conversion efficiency[3] and lean carcass production[4] are the expected benefits of restricted feeding. The effects of the level of restriction and of the nutrient compositions under restricted feeding conditions on performance are a dispute point. This study aimed at investigating the effects of changes in protein intake on performance under energy restricted conditions.

MATERIALS AND METHODS

This study was carried out at Research Unit of Tekirdag Agriculture, Trakya University. Forty three male lambs weaned at 2.5 months of age were used in an 84 day fattening study. Lambs were housed in individual paddocks. The study involved three treatments where three concentrate feed mixtures differing in CP but had similar energy contents were prepared. Lambs in AL group were offered a concentrate mix (88.46% DM, 13.15% CP and 2567 kcal ME kg^{-1}) *ad libitum*. On the other hand, RP1 and RP2 groups were given concentrate feed mixtures (88.53% DM, 15.71% CP and 2563 kcal ME kg^{-1} for RP1 and 88.30% DM, 18.98% CP and 2564 kcal ME kg^{-1} for RP2) at 85% of the AL group. No roughage was used throughout the study. In order to control dry matter intake in treatment groups, the amount of feed consumed by the AL group overnight was taken as the basis in the morning feeding and the amounts to be given to RP1 and RP2 were thus calculated. For this purpose, the dry matter and nutrient compositions of concentrate feed mixtures were routinely controlled[5]. The metabolizable energy contents of the concentrate feed mixtures were calculated as described by Cullison and Lowrey[6]. Feed intake in groups was determined daily and live weight changes were determined at the beginning, 42nd and 84th days of the study. In order to describe the effects of treatments on various organ weights, 5 lambs from each group were slaughtered at 42nd (1st period) and 84th (2nd period) days of the study where heart+lungs, spleen, kidney, liver, reticulorumen, omasum, abomasum, small intestine, large intestine and ceacum weights were determined. The analysis of the data was carried out via $y_{ij} = \mu+G_i+e_{ij}$ statistical model. In the model, y_{ij} was the observed value for the trait, μ was expected population mean for the trait, G_i was effect of

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feeding method and e_{ij} was the random error. Statistical analyses were made by packet programme[7].

RESULTS AND DISCUSSION

Feeding treatments had significant effects on live weight gain and thus live weight values at periods (Table 1). The level of restriction in daily energy intake resulted in significantly lower live weight gain in the RP1 and RP2 groups ($p<0.05$), treatments providing increases in protein intake under energy restricted feeding conditions did not cause any significant effect on live weight gain.

One of the discussion points in restricted feeding regimens is the level of restriction and the level of dilution in nutrients compositions. Murphy and Loerch[3] reported that restricted feeding at 90 and 80% of *ad libitum* feeding resulted in 12.7 and 20.1% decreases in live weight gain in beef steers, respectively. In a study carried out with lambs, a 15% reduction in feed intake caused an 8% decrease in live weight gain[2]. In the present study, the live weight gain in RP1 and RP2 groups fell down by 17.3 and 21.7%, respectively (Table 1).

The nutrient intakes were calculated from the daily intakes and the nutrient compositions of the concentrate mixtures (Table 2). Daily nutrients intakes with the results of statistical analysis indicated that intended conditions in terms of intake traits throughout the study were obtained.

Glimp *et al.*[2] reported that improvements in feed conversion efficiency can affect production efficiency positively in contrast to decreases in live weight gain under restricted feeding conditions. However reports on the effect of restricted feeding on feed conversion efficiency are conflicting. Fluharty and McClure[8] looking at the effect of a 15% reduction in dry matter intake and different protein levels as compared to *ad libitum* intake level found no effect of restriction level on feed conversion efficiency. In the present study, the treatments had no significant effect on feed conversion efficiency (Table 1). In spite of the lack of difference, numerically lower feed conversion efficiency in RP1 and RP2 groups than in AL group (Table 1) throughout the 1st period is worth noting in describing the priority of energy in terms of the corresponding parameter.

Different explanations on describing the positive effects in feed conversion efficiency of restricted feeding are present in the literature. Glimp *et al.*[2] for example point out that digestive disturbances as a consequence of *ad libitum* feeding of concentrates and fluctuations in feed intake negatively affect feed conversion efficiency. The weight of metabolically active organs such as liver and

Table 1: Mean±SE of fattening performance and feed intake

		Groups			
Parameter[1]	Periods	AL	RP1	RP2	p[2]
LW (kg)	I (initial)	22.0±0.85	21.2±0.65	21.7±0.72	0.768
	II (42nd day)	30.1±1.45a	27.2±0.43b	28.0±0.52ab	*
	III (84th day)	41.1±1.73a	37.0±0.48b	37.2±0.75b	*
LWG (kg day^{-1})	I (0-42nd day)	0.19±0.02a	0.14±0.01b	0.15±0.01b	*
	II (42-84th day)	0.26±0.01a	0.23±0.01b	0.22±0.01b	**
	III (0-84th day)	0.23±0.01a	0.19±0.01b	0.18±0.01b	**
FI (g day^{-1})	I (0-42nd day)	1083.0±60.2a	908.3±0.35b	906.3±4.96b	***
	II (42-84th day)	1435.9±76.1a	1265.6±2.59b	1265.2±7.21b	**
	III (0-84th day)	1259.4±66.9a	1086.9±1.33b	1085.8±4.00b	***
FCR	I (0-42nd day)	5.84±0.56	6.48±0.33	6.23±0.41	0.601
	II (42-84th day)	5.43±0.17	5.50±0.14	5.78±0.14	0.267
	III (0-84th day)	5.57±0.30	5.86±0.20	5.90±0.12	0.536

[1]LW: Live Weight; LWG: Live Weight Gain; FI: Feed Intake; FCR: Feed Conversion Ratio
[2]*p<0.05; **p<0.01; ***p<0.001; Means with different superscripts within the same row are significantly different (p<0.05)

Table 2: Mean±SE of nutrient intakes at periods

		Groups			
Parameter[1]	Periods	AL	RP1	RP2	p[2]
DMI	I (0-42nd day)	961.6±53.4a	805.5±0.31b	800.2±4.37b	***
	II (42-84th day)	1272.9±67.4a	1119.8±2.29b	1116.1±6.37b	**
	III (0-84th day)	1117.3±59.3a	962.7±1.17b	958.2±3.53b	***
EI	I (0-42nd day)	2790.7±155.00a	2332.1±0.90b	2325.5±12.69b	***
	II (42-84th day)	3694.1±195.66a	3242.0±6.63b	3243.5±18.51b	**
	III (0-84th day)	3242.4±172.10a	2787.1±3.40b	2784.5±10.26b	***
CPI	I (0-42nd day)	142.9±7.94b	142.9±0.05b	171.9±0.94a	***
	II (42-84th day)	189.1±10.02b	198.6±0.41b	239.8±1.37a	***
	III (0-84th day)	166.0±8.81b	170.7±0.21b	205.9±0.76a	***

[1]DMI: Dry Matter Intake, g d^{-1}; EI: Energy Intake, kcal ME d^{-1}; CPI: Crude Protein Intake, g day^{-1}
[2]**p<0.01; ***p<0.001; Means with different superscripts within the same row are significantly different (p<0.05)

Table 3: Mean±SE of organ weights (gram) at periods of the study

Period	Organ	Groups AL	RP1	RP2	p[1]
I (42nd day)	Heart+Lungs	844.2±25.07a	656.4±13.76b	633.6±16.10b	***
	Spleen	70.2±7.25	55.8±4.96	57.4±4.00	0.177
	Kidney	101.6±2.37a	89.2±0.58b	99.2±2.81b	**
	Liver	633.4±13.40a	517.2±19.23b	504.4±14.75b	***
	Reticulorumen	614.0±36.52a	588.6±28.12ab	519.2±11.94b	*
	Omasum	60.6±2.50b	70.8±4.14a	72.6±2.93a	*
	Abomasum	157.2±2.95a	159.0±14.02a	119.6±6.00b	*
	Small intestine	790.8±30.52	696.6±13.76	730.6±45.69	0.161
	Large intestine	202.8±26.49	253.8±29.31	243.8±20.65	0.363
	Caecum	122.6±15.72	162.0±12.33	118.2±6.24	0.061
II (84th day)	Heart+Lungs	1044.4±59.08a	870.6±49.03b	807.6±23.02b	**
	Spleen	90.0±23.75	74.4±6.87	78.4±6.83	0.746
	Kidney	115.4±5.51	107.4±5.85	113.6±3.04	0.509
	Liver	777.2±31.32a	629.2±26.36b	591.4±21.23b	***
	Reticulorumen	814.2±28.20a	669.6±29.22b	688.8±30.85b	**
	Omasum	91.8±10.29	85.4±5.09	114.2±13.34	0.152
	Abomasum	219.4±19.49	223.0±8.68	221.2±36.88	0.994
	Small intestine	712.4±42.21	772.0±75.17	779.2±77.12	0.745
	Large intestine	296.6±10.30	262.2±12.67	282.2±12.66	0.150
	Caecum	152.0±10.11	154.6±18.60	204.4±19.83	0.081

[1] *p<0.05; **p<0.01; ***p<0.001; Means with different superscripts within the same row are significantly different (p<0.05)

gut organs and the relationships between maintenance energy requirements and feeding level is another explanation in the evaluation of the effect of restricted feeding on feed conversion efficiency. The results of various studies reveal that feeding level dependent-changes in maintenance energy requirements are strongly associated with the weights of metabolically active organs and restrictions in nutrients intakes lead to reductions in metabolic rate and the weights of the organs[9-14]. In the present study, the feeding treatments at slaughter periods had significant effects on the weights of various organs (Table 3). Especially the response of liver, reticulorumen and heart+lungs weights to restriction in energy intake is consistent with the findings of the studies (Table 3). However, the interesting finding in terms of the relations between restriction in feed intake and, organ weights and feed conversion efficiency is that the reductions in various organ weights due to restricted feeding did not take place in conjunction with improvement in feed conversion efficiency.

In conclusion, restrictions in energy intake under the conditions of the present study resulted in significant decreases in live weight gain and ration manipulations ensuring fixed or increased protein intake did not elevate this problem. The results of the present study suggest that the effects of ration nutrients composition especially on rumen fermentation and intermediate metabolism in addition to the level of restriction in growing lambs should be considered.

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