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Effects of Different Protein Levels on Fattening Performance and Meat Parameters in Merino Lambs

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ABSTRACT

Background: A correct supply of protein in the feed diets is required for the efficient conversion of feed and better fattening performances in lambs. This study aimed to investigate the effects of the increase in the protein level of the diets by approx. 20% on fattening performance and meat parameters in Merino lambs.

Methods: The study was performed during the year 2020. Forty-two lambs (aged 2.5-3 months) were divided randomly into three groups (14 lambs/group). The groups were fed with diets of compound feed and corn silage differentiated by the level of protein. All diets were isoenergetic. The experiment has lasted for 68 days.

Result: The results of this study showed that the protein supplementation of diets by approx. 20% determined an increase in the average daily gain ($P<0.05$) in the first phase of fattening and an improvement in dry matter and protein consumption when the protein supplementation was done only in the first phase of fattening in Merino lambs. Also, the findings of this study indicated that this increase in protein level affected carcass quality and led to higher proportion of muscles and significantly lower fat in the carcass.

Key words: Carcass, Consumption, Daily gain, Fattening, Protein level.

INTRODUCTION

Intensive fattening of lambs requires their maintenance in a nutritious balance, through food with a complex and complete value that meets the physiological requirements and ensures high economic efficiency. In this regard, an important role in the balance of the diet belongs to protein (Milton and Paterson, 2001). The correct supply of protein is required to maintain good rumen function for the efficient conversion of feed and if the protein in the diet is low, the microbial population declines and consequently less microbial protein is available to the lambs for growth (Milton and Paterson, 2001). The increase in crude protein level increases digestibility and intake of feed because the higher protein supply is capable of providing more substrate for the formation of rumen microbes that play a role in digesting feed (Yang *et al.*, 2016). For young animals protein supply is most limiting to growth and increases in the intake of protein lead to linear increases in protein deposition (Titgemeyer, 2003).

These physiological changes, regarding the metabolism of proteins, have a positive effect on obtaining better growth and fattening performances (weight gain, feed consumption, carcass quality, *etc*.), as recorded from other research in the literature (Rocha *et al.,* 2004).

The need for protein depends largely on the breed, body weight and digestibility of protein in feed. In the finishing period, the need for crude protein (CP) level differs from 10-14.7% according to live weight and growing potential (Kaya *et al*., 2009). In other studies, it is suggested that the optimum CP level required in fattening lamb's diets is usually in the range of 14 to 16% (Milton and Paterson, 2001).

The present study aimed to investigate the effects of the increase in the protein level of the diets above the normal requirements and in particular the increase with approx. 20% of the level of digestible protein at the intestinal level of food origin, on fattening performance and meat parameters in Merino lambs fattened in an intensive system.

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MATERIALS AND METHODS

Location, animals and feeding

The animals in this experiment have been cared for according to the Romanian Law 43/2014 for handling and protection of animals used for experimental purposes. and the EU Council Directive 98/58/EC concerning the protection of farmed animals. The experiment was conducted in 2020 within the experimental halls of the National Research-Development Institute for Animal Nutrition and Biology, Balotesti, Romania (IBNA-Balotesti), according to the provisions on animal study protocol approved by the Ethical Committee of the IBNA-Balotesti (approval no. 232/22.07.2019). All animals remained healthy during the experimental period and no veterinary drugs were used.

The research works were carried out on 42 lambs which were randomly assigned into three groups (14 lambs/group) for a total fattening period of 68 days until the delivery body weight of about 35 kg was reached. The fattening of lambs was divided into two phases (first 30 days and second 38 days). The groups were fed with diets of compound feed and corn silage differentiated by the level of protein, respectively T_1 group with normal protein requirements, T_2 group with normal protein plus 20% in the first phase of fattening (30 days) and T_3 group with normal protein plus 20% for the entire period of fattening (68 days).

In the experiment, the increase in the protein level of diets was obtained by increasing the proportion of sunflower meal in compound feed recipes (Table 1). All diets were isoenergetic. The structure of compound feed (CF) recipes was established taking into account the needs in the energy and nutrient requirements of the lambs in the two fattening phases. The compound feed, as well as corn silage, were administered restricted, according to the daily feed diets, established for each group according to the fattening phases.

Calculation of nutritional value (Table 2) was done based on the French system (INRA,1988). The biological material under investigation consisted of lambs belonging to the Palas Merino breed which is a semi-precocious breed specializing in fine wool and meat. Only male lambs from simple births, that were weaned at the age of 2.5-3 months and weighed between 17-20 kg, were chosen for the experiment. Lambs were housed in collective pens (14 lambs/pen) during the experimental period and the pen was fitted with a suitable drinker and feeder for all 14 lambs (each pen had an area of 24 m^2).

Growth performances and feed consumption

The feeds used in lambs feeding were produced within the institute and their chemical analysis was done through classical methods. Feeds were administered twice a day (at 8.00 hr and 16.30 hr) and the control of their consumption was done by weighing them at the moment of distribution and the refusals at every morning before feeding. Animals had *ad libitum* access to water throughout the whole study. The consumption of UFV (French meat nutritional unit for energy), DM (dry matter), PDIN (protein digestible in the intestine allowed by the nitrogen content of the ration) and PDIE (protein digestible at the intestinal level allowed by the energy content of the ration)/per kg of gain was calculated for the entire fattening period. Individually weighing of lambs was performed at different stages of fattening based on the daily feed consumption to highlight the dynamics of lambs' growth and fattening. The evolution of body weight (BW) and average daily gain (ADG) based on these data were established throughout the fattening period.

Meat parameters

Five lambs from each group (selecting lambs had a body weight close to the average of the group) were slaughtered at the end of the fattening period and slaughter weight, carcass weight, slaughter yield, muscle surface area and carcass tissue structure were established. Animals were slaughtered by exsanguination in an EU-licensed abattoir according to the EU Council Directive 2010/63/CE.

The slaughter of the animals was done after 12 hours of fasting and the weight of the carcass was determined after a cooling period of 24 hours at a temperature from 0 to + 4°C (cold carcass). Based on the ratio between carcass weight and live weight were calculated the slaughterhouse yield and commercial yield (internal organs were added at carcass). The surface of muscle (section of Longissimus dorsi muscle at the level of lumbosacral joint) was determined using the planimetric method and the tissue structure of the carcasses was determined by deboning and respectively the separation and weighing of the three tissues (meat, fat and bones) on half of the carcass.

Statistical analysis

The results were presented as mean values ± standard errors of the mean. Microsoft Office Excel 2016 was used to calculate all statistical parameters (mean, standard deviation, coefficient of variability and standard error of the mean) and t-test (Student) for determination of significance difference between the mean values. The differences were considered statistically significant at $P<0.05$ and indicated by superscripts.

RESULTS AND DISCUSSION

Growth performances and feed consumption

At the end of the experiment, the lowest value of average BW (Table 3) was registered by lambs from the T1 group (33.99±0.59 kg) and the highest by lambs from the T3 group (35.60±0.68 kg). In this study, it was observed that the final BW of lambs increased with the increase in the protein level of the feed diets although the differences between groups were not statistically significant ($P>0.05$). This can probably be explained by the fact that a higher intake of protein increased the amount of non-degradable protein in the rumen, which was degraded into peptides and amino acid and directly absorbed and utilized in the small intestine (Yang *et al.,* 2016). Also, the increase of protein levels improved the number and activity of ruminal microorganisms, maximizing ruminal fermentation (Kerry *et al.,* 1993).

In general, it was found that in all experiments where protein supplementation of diets was encountered, the final BW of the groups that received an increased protein level was higher compared to that of the groups that did not benefit from this increase, even if this difference was not always statistically assured (Rocha *et al.*, 2004). Contrary to our results, other authors find that the final BW of the groups that benefited from the increase of protein level in diets was significantly higher compared to that of control groups (Ebrahimi *et al.*, 2007).

In our experiment, the protein supplementation of diets does not negatively influence the ADG and feed

consumption, but on the contrary there was a significant increase of the ADG in the first phase of fattening and an improvement in dry matter and protein consumption when the protein supplementation is done in the first phase at fattening (Table 3). Similar results are obtained by Yang *et al.* (2016), who found that the appropriate protein level of diets (13.40%) can improve ADG and FCE (feed conversion efficiency) compared with other groups (11.17 and 12.06%). Also, Dabiri and Thonney (2004) found a little difference in average daily gain and feed efficiency between lambs fed

Table 1: Structure of compound feed recipes used (%).

Specification	Maize	Sunflower meal	Calcium carbonate	Premix	Salt	Total
T_1						
First fattening phase	66.0	30.0	2.0	1.0	1.0	100
Second fattening phase	76.0	20.0	2.0	1.0	1.0	100
T_2						
First fattening phase	52.0	44.0	2.0	1.0	1.0	100
Second fattening phase	76.0	20.0	2.0	1.0	1.0	100
T_3						
First fattening phase	52.0	44.0	2.0	1.0	1.0	100
Second fattening phase	66.0	30.0	2.0	1.0	1.0	100

Table 2: Chemical composition and nutritional value of feeds and fodder (per kg DM).

Specification		Chemical composition			Nutritional value				
		CP (g)	EE (g)	CC (g)	UFV	PDIN (g)	PDIE (g)	Ca (g)	P (g)
Corn silo		81	23	228	0.84	51	66	3.4	2.4
Compound feed in the	T_1	180	37	86	1.07	127	117	10.2	3.4
first fattening phase	T_2	219	33	114	1.02	135	118	9.1	3.8
	T_3	219	33	114	1.02	135	118	9.1	3.8
Compound feed in the	T_1	152	39	66	1.09	110	115	10.9	3.0
second fattening phase	T_2	152	39	66	1.09	110	115	10.9	3.0
	T_3	179	37	86	1.03	130	117	11.2	3.3

DM: Dry matter; CF: Compound feed; CP: Crude protein; EE: Rther extract; CC: Crude cellulose.

UFV - French meat nutritional unit for energy; PDIN - Protein digestible in the intestine allowed by the nitrogen content of the ration; PDIE - Protein digestible at the intestinal level allowed by the energy content of the ration.

Table 3: Effect of dietary protein level on growth performance and feed consumption.

Specification	Treatments		
	T_1	T_2	T_3
Growth performance			
Initial weight (kg)	18.34±0.23	18.25±0.27	18.22±0.25
Intermediate weight (kg)	24.84±0.36	25.72±0.37	25.65±0.41
Final weight (kg)	33.99±0.59	35.49±0.57	35.60±0.68
ADG in first phase (g/day)	216.67±7.60[a]	249.0±5.83[b]	247.60±7.86[b]
ADG in second phase (g/day)	240.97±8.25	257.10±6.47	261.80±8.09
ADG on total period (g/day)	230.25±7.64	253.50±6.17	255.50±7.92
Feed consumption			
Dry matter (kg/kg gain)	4.25	3.95	3.96
UFV (UFV/kg gain)	4.06	3.74	3.71
PDIN (g/kg gain)	350.5	346.0	378.2
PDIE (g/kg gain)	381.6	362.0	370.0
Compound feed (kg/kg gain)	2.21	2.21	2.35
FCE	23.5	25.3	25.2
PER	2.85	2.89	2.64

FCE: Feed conversion efficiency, growth as percent of DM intake (ADG×100/DMI); PER: Protein efficiency ratio (ADG/PDIN).

[a,b] Within a row, means without a common superscript differ ($P<0.05$).

the diets with 15 or 17% crude protein, suggesting that a protein level near 15% would be optimal for 25 to 40 kg growing lambs. In other studies, there was found no effect of protein level on DM intake, daily gain and feed efficiency (Kaya *et al*., 2009; Rocha *et al.,* 2004).

The results obtained in this experiment allow us to conclude that the increase of the protein level of lambs feed diets was beneficial and advisable to be realized in the first phase of fattening, as the increase of protein level on the entire fattening period did not lead to a BW and an ADG to justify the additional consumption of nutrients and especially protein.

Meat parameters

Dietary treatments had no effect on carcass traits (slaughter weight, carcass weight, slaughter yield and commercial yield), as the results obtained indicated that between groups there were no significant differences (Table 4). Referring to the muscle surface it was found that there were significant differences between T_2 and T_3 groups compared to T_1 group. As a result, the surface area of the muscle was influenced by the protein level of the diets which led to a higher amount of meat at this level.

The results of our research regarding the influence of protein level of diets on slaughter parameters are similar to those obtained by Ortiz *et al.* (2005) who found that the use of rations in the feeding of lambs with different protein levels (15, 20 and 25%) did not significantly influence slaughter weight, carcass weight and slaughter yield. The same conclusion emerges from the research conducted by Rios-Rincon *et al.* (2014) who found that the protein level in rations did not induce significant differences between groups in terms of carcass weight and slaughter efficiency. On the other hand, Ebrahimi *et al.* (2007) found that the weight of the hot and cold carcass increased significantly with the increase of the protein level in the rations (10.5, 12.5 and 14.5%), but the yield at slaughter was similar.

The observed results of the muscle surface in this study corroborated with those of Ruiz Nuno *et al.* (2009) who found that the protein concentration in the diet (14, 16 and 18%) increased the diameter of muscle ($P<0.05$). In contrast, research conducted by Rios-Rincon *et al.* (2014) showed that the protein level in rations (14.5 and 17.5%) did not induce significant differences between groups in terms of muscle surface area.

Analyzing the absolute and relative values of muscle, bones and fat at all three groups, we found differences among groups (Table 5). Thus, we found that increasing the protein level of diets influenced the amount of muscle in the carcass, in the sense of increasing it although the differences between groups were not statistically significant ($P<0.05$). The possible explanation for the insignificant proportion of muscle in the carcass is that the higher feed intake causes a faster feed flow through the rumen and, therefore, the degradation process of the feed in the rumen is shorter (Lee *et al*., 2010). Regarding the percentage of fat in the carcass, the increase in the protein level of rations used in fattening influenced the amount of fat in the carcass, in the sense of reducing it ($P<0.05$).

Table 4: Effect of dietary protein level on carcass traits and muscle surface.

Specification	Treatments		
	T_1	T_2	T_3
Weight at slaughter (kg)	34.52±0.91	35.65±0.83	35.45±0.82
Carcass weight (kg)	16.26±0.45	17.02±0.64	16.89±0.66
Slaughter yield (%)	47.10±0.95	47.74±1.58	47.65±1.21
Commercial yield (%)	52.14±0.74	53.07±0.46	53.37±0.55
Muscle surface (cm^2)	9.75±0.36[a]	11.81±0.52[b]	11.92±0.47[b]

[a,b] Within a row, means without a common superscript differ ($P<0.05$).

Table 5: Effect of dietary protein level on tissue structure of carcasses (kg).

Specification	Treatments		
	T_1	T_2	T_3
Muscle			
x±sx	9.77±0.30	11.13±0.35	11.10±0.35
% of the carcass	60.09	65.39	65.72
Fat			
x±sx	3.18±0.09[a]	2.73±0.08[b]	2.64±0.07[b]
% of the carcass	19.56	16.04	15.63
Bones			
x±sx	3.31±0.07	3.16±0.08	3.15±0.07
% of the carcass	20.35	18.57	18.65
Ratio			
Muscle:fat	3.07	4.08	4.20
Muscle:bones	2.95	3.52	3.52

[a,b] Within a row, means without a common superscript differ ($P<0.05$).

Increasing the protein level in Merino lambs feed diets in this study led to a higher proportion of muscles and lower fat in the carcass, which is probably due to an adequate supply of protein to maintain good rumen function and to the efficient conversion of feed into meat (Milton and Paterson, 2001).

The results obtained in the present experiment are in agreement with those found by Pajak *et al.* (1993) who observed a significant increase of muscle in the carcass (from 55.3 to 58.0%), as well as a significant reduction in the fat content (from 16.6 to 14.7%) by increasing around approx. 21% protein level in fattening lamb's rations (14 and 17%). Results different from ours are obtained by Prima *et al.* (2019) who found that the effect of protein level (14, 16 and 18%) was not significant on meat, fat and bone weight, meat-fat ratio, meat-bone ratio and meat-protein content.

CONCLUSION

The results of this study showed that the protein supplementation of diets by approx. 20% determined a

significant increase in the ADG in the first phase of fattening and an improvement in dry matter and protein consumption when the protein supplementation was done only in the first phase of fattening in Merino lambs. Moreover, the findings from this study indicated that this increase in protein level led to higher proportion of muscles and significantly lower fat in the carcass, which recommends this additional feeding especially when attracts the improvement of carcass quality.

Conflict of interest: None.

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