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IMPROVEMENT OF GROWTH RATE AND CARCASS QUALITY IN LAMBS FROM TSIGAI BREED - RUSTY VARIETY

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Abstract

The objective of the research was to assess the impact of diet on the growth rate and carcass quality of Tsigai lambs, specifically the rusty variety, fed with different diets to enhance meat production and quality. A total of 24 male lambs (L1 and L2, n = 12 lambs per group) were subjected to a 100-day fattening trial following weaning. Notable differences (p<0.01) were observed between the two groups regarding final weight, total gain, and average daily gain. However, the diet did not have a significant effect (p>0.05) on carcass quality characteristics between the L1 and L2 groups (warm carcass yield, cold carcass yield and commercial yield), but had significantly influenced (p<0.001) the share of the main parts of carcasses (cutlet and shoulder + arm). The diet administered to the two lots of lambs influenced significantly (p<0.05) the share of bone and fat in carcasses, also, the carcasses from L1 were fatter, while the ones from L2 were more bony. No significant differences were recorded with regard at meat share in carcasses (p>0.05).

***Key words**: bone, fat, lamb, meat, Tsigai – rusty variety.*

INTRODUCTION

The improvement of lamb meat production to enhance the efficiency and competitiveness of the meat sheep industry requires considering a variety of factors. The primary factors influencing producer profits are the volume of lamb meat produced and the efficiency of its production, both of which are impacted by reproductive efficiency and growth rates. Carcass quality also plays a significant role in producer profits, especially in many countries where penalties are imposed for excessive fatness or poorly shaped carcasses. Additionally, carcass quality is important for processor efficiency and consumer preference, as many prefer leaner meat than what is typically found in lamb carcasses (Macfarlane & Simm, 2008).

Warm and cold carcass weights are the main factors used to assess carcass quality, as they influence other important attributes such as fat content, carcass conformation, and the weight of various cuts (Díaz, 2001; Carter and Gallo, 2008; Lambe et al., 2009). Fat content is especially important because it directly influences the market value of the carcass (Díaz et al., 2002). Important measurements for this criterion include dorsal fat thickness, the weight of renal pelvic fat, and visual assessments of the carcass's fat content (Díaz et al., 2002; Carrasco et al., 2009). Conformation, another important indicator of carcass quality, is assessed both visually and through objective measurements, including the depth and width of the thorax, gigot length, width of the rump, and rib eye area (Díaz, 2001).

While payment systems generally focus on the quantity of meat, with some consideration of fatness and carcass shape, producers are rarely directly rewarded for producing lambs with superior eating quality. Nevertheless, meat-eating quality significantly affects consumer satisfaction, which is crucial for the sheep industry to maintain and potentially grow its share in the global meat market. These traits of interest can be enhanced through adjustments in management and nutrition. Altering the quality or quantity of feed provided can influence carcass composition and growth rates.

Genetic enhancement of the characteristics that contribute to produce lamb meat is a ongoing, progressive, economical, and long-lasting process.

The Tsigai breed – rusty variety is an unimproved sheep in central Transylvania. In recent years, many efforts have been made at Experimental Base Reghin, in order to improve this sheep variety in purebred, in the direction of meat production, by selecting and adapting feed technologies based on the goals of the selection process (Ilișiu et al., 2022).

Feeding is a significant cost in animal production and can impact both the composition of the carcass (Lewis et al., 2002) and the level of fattening. While breed and feed type individually play a crucial role in determining carcass quality, the interaction between these factors, along with others, it may also impact the quality and traits of lamb carcasses (Díaz et al., 2002; Mustafa et al., 2008).

Management strategies, such as slaughtering lambs at lighter weights, can help reduce carcass fatness, though this approach has its drawbacks, including potential management challenges and a decrease in overall lamb meat production. Furthermore, changes in management and nutrition typically lead to short-term improvements that need to be implemented each season for continued benefits.

The purpose of the present research was to evaluate the influence of different diets on the growth rate and carcass quality of Tsigai lambs – rusty variety, with the goal of enhancing meat production and meat quality.

MATERIALS AND METHODS

The research made at the Experimental Base Reghin, located in Mureș. 24 lambs of Tsigai breed – rusty variety, assigned to two groups (L1 and L2, n = 12 heads/group) were summited to an intensive fattening experiment for 100 days. Lambing took place between January and March. The lambs were identified at birth (with farm ear tags) and weighed. All details regarding the sex of lambs, birth date and type, were recorded. Ewes and their lambs were housed together in the shelter and managed under the same conditions.

The feeding of lambs were made *ad libitum* (122.71 g DP/kg DM and 11.77 MJ NE/kg DM) until weaning, which took place at an average of 57.75 days for L1 and 53.17 for L2. The concentrated fodder was composed of 55% corn flour, 30% barley flour, 12% sunflower groats, 2% calcium, and 1% salt. The lambs were raised in a shelter, and the diet was provided *ad libitum*. For L1, the concentrated feed remained unchanged during the suckling and fattening period, while for L2, the fodder was the same as for L1 only during the first two weeks, but starting with the 3rd week after weaning, the diet was different up to 100 days-fattening (Table 1). Additionally, hill hay was added to the ration for both lots.

Table 1. The composition of the concentrated feed used in the experiment

Items	L1 5 April – 13 July	L2 5 April – 19 April	L2 20 April – 13 July
Corn flour (%)	55.0	55.0	65.0
Barley flour (%)	30.0	30.0	20.0
Sunflower groats (%)	12.0	12.0	12.0
Calcium (%)	2.0	2.0	2.0
Salt (%)	1.0	1.0	1.0
DM/kg feed	850	850	850
DP/kg DM	122.71	122.71	125.46
NE MJ/kg DM	11.77	11.77	11.88

The calculated composition was based on tabular values derived from the ingredient composition of the experimental diet (NRC, 2007).

From each group, 3 Tsigai lambs were slaughtered at the end of fattening period, to the small and large animal abattoir in Reghin City. The lambs were weighed after a 24-hour fast, and then slaughtered following electrical stunning. The live weight, hot and cold (chilled at 4°C for 24 hours) carcasses weight were determined, and then the warm and cold slaughter yields were calculated .

After the lamb carcasses were separated into half-carcasses, the main parts were identified, including the gigot, shoulder and arm, cutlet, and the remaining carcass. For each of these parts, the tissue composition (meat, fat, and bone) was determined. To determine the sectional areas of the *Longissimus dorsi* (*LD*) and gigot muscles, they were traced onto tracing paper (for *LD*, between the D12-D13 dorsal vertebrae, and for gigot, perpendicular to its longitudinal axis), and then the area sizes were measured using a computer.

The traits investigated were weight at beginning of fattening (WBF), weight at end of fattening (WEF), total gain (TG), average daily gain (ADG), DMI (dry matter intake), NE (net energy), DP (digestible protein), live weight at slaughtering (LWS), carcass traits included warm carcass weight (WCW), cold carcass weight (CCW), warm slaughter yield (WSY), cold slaughter yield (CSY) and commercial yield (CY), *Longissimus dorsi* section area (*LD*) and leg of mutton muscle section area (LM). To measure the impact of feed on growth rate and carcass quality, the mean comparisons between the two groups for the variables were performed using the independent samples T-test in JASP software.

RESULTS AND DISCUSSIONS

The fed ration effects on lamb growth rate are presented in Table 2.

Although the two lots had approximately the same weight at the start of fattening, the weight registered at the final of fattening was noticeably greater ($p<0.01$) for L2, compared to L1, the TG and ADG being significantly higher ($p<0.01$) in L2 (which is approximately 4 days younger than in the case of L1).

Table 2. Means ± SE (standard errors) of WBF, WEF, TG and ADG of lambs

Items	L1 (n = 12)	L2 (n = 12)	P value
WBF, kg	15.96 ± 0.96	16.63 ± 0.27	0.091
WEF, kg	35.04 ± 1.08[a]	39.33 ± 0.93[b]	< 0.01
TG, kg	19.08 ± 0.99[a]	22.71 ± 0.96[b]	< 0.01
ADG, g	190.83 ± 9.98[a]	227.08 ± 9.64[b]	< 0.01
Age at beginning of fattening, days	57.75 ± 1.93	53.17 ± 3.27	0.24

[a, b]Average in the same row with different leter are significantly different (p< 0.01).

The results obtained show that the group of lambs fed with concentrated feed in which corn flour accounted for 65% had a higher growth rate, compared to the group in which the diet with corn flour accounted for 55%.

In a fattening experiment with lambs of the Tsigai breed - rusty variety, the study of Ilisiu et al., (2021) showed, that two diets, L1 was fed the entire fattening period with 135 g DP and 10.89 MJ NE, and L2 was fed with different diets along the fattening period (with 100 g DP and 11.29 MJ NE in the first months and then with 118 g DP and 10.89 MJ NE) had led to an average daily gain of 225.83 g by L1 and 225.33, respectively by L2.

Studying the effect of diet on two lots of Tsigai lambs – rusty variety (L1 coming from young sheep 14-15 months age and L2 from adult sheep), Ilișiu et al. (2022b) showed that a diet assuring 130.34 g DP/kg dry matter with 8.97 NE MJ/kg dry matter in the first period of fattening (30 days) and 90.52 g DP/kg dry matter with 9.50 NE MJ/kg dry matter in the second period (31 day up to 100 days), the lambs from young sheep has achieved a average daily superior to lambs from adult sheep (190.53 g *vs.* 181.32 g).

Table 3 presents the values for daily dry matter intake, net energy, and digestible protein. The data indicate that the highest dry matter intake during the fattening was observed in L2.

Table 3. DMI, NE, and DP in the fattening experiment

Characteristics	L1	L2
DMI kg/animal	0.86	0.91
NE MJ/animal	9.46	10.10
DP g/kg animal	105.39	113.40

The economic efficiency of feed conversion, measured by the amount of feed required to achieve live weight gain, is reflected in costs, and consequently, is associated with the profitability of lamb production (Table 4). Lambs that grow rapidly tend to have high feed conversion efficiency, since lower energy is needed to produce muscle compared to fat tissue (Jacob & Calnan, 2018).

Compared to the two lots, it is noticed that L1 exhibited the greatest protein and energy intake.

Table 5 displays the effects of the ration on carcass quality characteristics. The diet did not have a considerable influence ($p>0.05$) on carcass characteristics and on section area LD and LM.

Table 4. Feed conversion efficiency for the lambs from L1 and L2

Items	L1	L2
Total NE consumption (MJ)	11379.32	12119.14
Total price NE		
- Lei	1315.20/	1573.38/
- Euro	264.25	316.12
NE consumption (MJ)/kg gain	49.69	44.44
DP g/kg gain	552.37	499.33
Price/MJ:		
- Lei	0.12	0.13
- Euro	0.03	0.03
Total gain, kg	228.96	272.52
Price/kg gain		
- Lei	5.96	5.78
- Euro	1.49	1.33

*The price calculation in euro has been made taking into account 1 Euro = 4.9772 lei.

The lambs from L1 presented higher LWS, WCW, CCW, WSY, CSY, CY, and *LD* muscle section area than L2.

Table 5. Carcass quality features (means ± SE)

Items	L1 (n = 3)	L2 (n = 3)	P value
LWS, kg	34.67 ± 0.33	34.33 ± 0.67	0.678
WCW, kg	15.27 ± 0.35	15.00 ± 0.20	0.547
CCW, kg	14.87 ± 0.35	14.60 ± 0.20	0.547
WSY, %	44.05 ± 1.17	43.70 ± 0.27	0.787
CSY, %	42.90 ± 1.16	42.54 ± 0.25	0.777
CY, %	52.13 ± 1.28	51.88 ± 0.44	0.863
LM, cm^2	107.07 ± 14.80	111.33 ± 6.13	0.804
LD, cm^2	16.89 ± 0.21	16.59 ± 2.06	0.905

In order to improve meat quality in lambs from the Tsigai breed – rusty variety, through selection and feeding, Ilisiu et al. (2022) showed that lambs coming from young females (14-15 months age) selected for their positive growth rate, the lambs achieved superior value in terms of ADG, HCW, CCW, LM, and LD muscle section area.

Carcass quality was evaluated by assessing the proportion of cut sections (leg of mouton, shoulder and arm, cutlet, and rest carcass) as well as the proportion of the tissues that make up the carcass, specifically muscle mass, bones, and adipose tissue. Measurements taken for the main parts of carcasses are given in Table 6, and for tissue composition, in Table 7. Statistical analysis indicate substantial variations ($p<0.001$) in the weight of the cutlet, and shoulder + arm relative to the mass of the half-carcass, as well as the weight of the rest of the carcass ($p < 0.05$). However, the study found no notable differences ($p>0.05$) between the two lots regarding the gigot weight or the proportions of meat, bone, and fat in the gigot.

Table 6. The main carcass cut sections of lambs subjected to fattening

Items	L1 (n = 3)	L2 (n = 3)	P value
CCW, kg	14.87 ± 0.35	14.60 ± 0.20	0.547
Leg of mutton, kg	4.67 ± 0.41	4.46 ± 0.19	0.659
Cutlet, kg	2.51 ± 0.07	3.25 ± 0.07	0.002***
Shoulder + arm, kg	2.50 ± 0.06	2.80 ± 0.06	0.021***
Carcass rest, kg	5.18 ± 0.41	4.09 ± 0.24	0.082*

* – significant differences ($p < 0.05$);*** - very significant differences ($p < 0.001$).

The cutlet weight in L2 was considerably greater than in L1 ($p<0.001$) and there were recorded higher amounts of meat and bone ($p<0.001$), while L2 recorded more fat at the cutlet level ($p<0.01$) (Figures 1 and 2).

Figure 1. Cutlet with bone from L1 (original)

Figure 2. Cutlet with bone from L2 (original)

The results obtained from Ilișiu et al. (2010) with regard to the main cut sections of the carcass showed a similar share with those obtained in L1 in this experiment, respectively

31.15% the share of gigot from the carcass mass, 16.43% for cutlet, 17.75 % for shoulder + arm and 34.67% for carcass rest. In contrast with this, the share of the main cut section of the carcass in L2 in the study showed approximately close percent to those found by Ilișiu et al. (2010) for gigot (30.54%), but higher for cutlet (22.26%), shoulder + arm (19.18%) and reduced for rest carcass (28.02%).

No relevant differences (p>0.05) were shown when analyzing the amount of bone and meat at shoulder + arm level between the two lots, but the diet had significantly influenced the amount of fat (p<0.001).

According to Jacob & Calnan (2018), rapidly growing lambs that reach slaughter weight at an earlier age of maturity tend to have lower fat and more muscle, resulting in a carcass with superior yield compared to those from lambs slaughtered at a later phase of maturity.

The percentage of meat in the half-carcass is approximately similar in the 2 lots, the differences recorded being not relevant (p>0.05), but substantial differences (p<0.05) were observed in the share of bones and fat in the half-carcass weight.

Table 7. The tissue composition of lambs carcasses (means ± SE)

Items	L1 (n = 3)	L2 (n = 3)	T-Test	Significance of the differences
Half-carcass, kg, from wich:	7.43 ± 0.18	7.30 ± 0.10	0.658	ns, p > 0.05
Leg of mutton, kg:	2.34 ± 0.20	2.23 ± 0.10	0.476	ns, p > 0.05
- meat, kg	1.52 ±0.05	1.46 ± 0.01	1.224	ns, p > 0.05
- bone, kg	0.49 ± 0.04	0.48 ± 0.02	0.143	ns, p > 0.05
- fat, kg	0.33 ± 0.17	0.28 ± 0.10	0.214	ns, p > 0.05
Meat/bone ratio	3.10	3.04	-	-
Meat/fat ratio	4.61	5.21	-	-
Cutlet, kg	1.27 ± 0.04	1.63 ± 0.04	-7.272	***, p < 0.001
- meat, kg	0.49 ± 0.04	0.77 ± 0.03	-5.407	***, p < 0.001
- bone, kg	0.38 ± 0.04	0.62 ± 0.01	-6.227	***, p < 0.001
- fat, kg	0.38 ± 0.04	0.24 ± 0.02	2.898	**, p < 0.01
Meat/bone ratio	1.29	1.24	-	-
Meat/fat ratio	1.29	3.21	-	-
Shoulder + arm, kg:	1.25 ± 0.03	1.40 ± 0.03	-3.674	***, p < 0.001
- meat, kg	0.79 ± 0.03	0.84 ± 0.02	-1.289	ns, p > 0.05
- bone, kg	0.29 ± 0.01	0.29 ± 0.01	-0.447	ns, p > 0.05
- fat, kg	0.17 ± 0.02	0.27 ± 0.01	-5.48	***, p < 0.001
Meat/fat ratio	4.65	3.11	-	-
Carcass rest, kg:	2.59 ± 0.21	2.04 ± 0.12	2.306	*, p < 0.05
meat, kg	1.35 ± 0.16	1.08 ± 0.04	1.582	ns, p > 0.05
bone, kg	0.40 ± 0.12	0.42 ± 0.04	-0.137	ns, p > 0.05
fat, kg	0.84 ± 0.05	0.55 ± 0.16	1.739	ns, p > 0.05
Meat/bone ratio	3.38	2.57	-	-
Meat/fat ratio	1.61	1.96	-	-
Total meat, kg	4.15 ± 0.13	4.15 ± 0.04	0.048	ns, p > 0.05
Total bone, kg	1.55 ± 0.15	1.81 ± 0.06	-1.6	ns, p > 0.05
Total fat, kg	1.73 ± 0.19	1.34 ± 0.08	1.92	ns, p > 0.05
Total meat, %	56.01 ± 3.05	56.82 ± 0.53	-0.26	ns, p > 0.05
Total bone, %	20.83 ± 1.56	24.83 ± 0.63	-2.378	*, p < 0.05
Total fat, %	23.16 ± 2.16	18.35 ± 0.95	2.036	*, p < 0.05
Items	L1 (n = 3)	L2 (n = 3)	T-Test	Significance of the differences
Meat/bone ratio	2.69	2.29	-	-
Meat/fat ratio	2.42	3.10	-	-

ns – insignificant differences (p > 0.05); * - significant differences (p < 0.05); ** - distinct significantly differences (p < 0.01) ; *** - very significant differences (p < 0.001).

Thus, it is found that the carcasses from L2 had a higher share of bones in the half-carcass, while in L1 the carcasses are fatter, the values being higher with 4.81 percentage points, compared to those from L2. The diets administered to the two lots have led to the obtaining of fatter carcasses in L1 and bony carcasses in L2.

Ilișiu et al. (2022) found that lambs fed higher protein levels throughout the fattening period had greater meat/bone and meat/fat ratio compared to lambs fed lower protein levels.

CONCLUSIONS

The research highlighted that incorporating corn flour at a 55% proportion during the first two weeks of fattening, and then increasing it to 65% for the remaining period, resulted in reduced specific consumption of digestible protein and metabolizable energy. Consequently, this improved feed conversion efficiency and reduced the cost per kilogram of gain.

On the other hand, lambs fed higher levels of barley flour throughout the fattening period had more fat in their carcasses compared to those fed higher level of corn flour.

The results obtained are valuable in sheep farming practice, guiding farmers towards feeding technologies that can help reduce the cost of producing a kilogram of lamb meat, as well as allowing them to target the type of carcass they wish to achieve (fatty or leaner carcasses).

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