Preliminary Results on Lambs Performances of Tsigai Breed Fed with Different Diets

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Abstract
The present study was conducted to determine the effect of ram, sex and diet on growth performances of Tsigai lambs – rusty variety from birth up to 5 months. The birth weight, weight at 28 days and weaning weight were observed on 212 lambs coming from 10 rams' groups. At 5 months age, the depth, eye muscle area of Longissimus dorsi, muscle perimeter and the backfat thickness covering this muscle at the cross of sectional area between the 12th and 13th ribs, and between 3-4 lumbar vertebrae was determined using ultrasonic measurements from 80 lambs (40 male from two lots - L1 and L2 – 20 heads/lot and 40 female – L3) fed with different diets. At this time, the weights of lambs at 5 months were also recorded. The overall men weight of lambs at 5 months was 42.23 kg at L1, 40.18 kg at L2 and 34.58 kg at L3. The weight at 5 months was found to be significantly affected by sex. The diet had no significant effect on growth performances of the lambs. The means for ultrasonic measurement was significantly affected by sex. The variation observed between lots means were significant for eye muscle depth at 3-4 lumbar vertebrae and for eye muscle area, but not significant for backfat thickness, and muscle perimeter. Regarding the phenotypic correlations between ultrasound measurements with weight at 5 months, from a total of 45 traits couples 57.78% are small correlation (0.00-0.30), 20.00% are medium to high correlations (0.31-0.60) and high correlations recorded 22.22 % (0.61-1.00). Important information on body composition of lambs can be obtained practically by ultrasonic measurements on live animals. When combined in a breeding program with lamb market weights, these measurements will provide a way to increase both meat yield and the quality of Tsigai lambs.

Keywords: diets, eye muscle area, lambs, Tsigai, ultrasonic measurements.

1. Introduction

Romania has 10.4 million sheep, currently ranks the second in the EU in terms of sheep number after Spain [1], the number of sheep increasing by 14.28% compared to 2010.
Tsigai breeds are kept extensively in mountainous and sub-mountainous regions with large pasture areas, it is a multi-purpose breed with focus on cheese production.
In Romania, the type of sheep meat depends largely on the age of lambs to slaughter, traditions and consumer's preferences [2]. Regarding the age of slaughter, there are two categories of lambs: milk lamb and fattened lamb.
Milk lamb is the most requested meat type of sheep in Romania. This meat comes from lambs slaughtered at 6 to 8 weeks and 8 to 15 kg live weight, the carcasses weighing 4 to 8 kg or less. Milk lambs are slaughtered every year in Romania in March to April during the Easter holidays, this shows that sheep meat consumption is seasonal. Meat of fattened lambs is obtained from young males and females who are eliminated from breeding, they are usually 14 to 15 kg at weaning and are fattened under semi-intensive or intensive systems (with high amounts of concentrates).

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They are slaughtered at a live weight of 35 to 40 kg, carcasses weight on average 15 to 22 kg.
Because the Tsigai sheep is a rustic breed, over time research attempted to improve milk and meat production, most work was based on the use of industrial crossings with specialized imported breeds. Research conducted in Romania to improve meat production was focused on increasing prolificacy, improving aptitudes for meat production and carcass quality.
Imported specialized breeds to improve meat production were: Suffolk, Ile de France, Merinofleisch, German Blackface. The obtained results were in all cases higher than those obtained from Tsigai breed [3, 4, 5, 6], but under the potential of improved breeds (for lamb meat).
Lamb production has become of more interest in the last years due export opportunities in the EU. In the period 1994-2019 (26 years), Romania was ranked first place in Europe regarding live animals exported for slaughter. In 2019 the maximum number of exported animals was 2.9 million lambs [7]. The main destination of these exports is the West European countries (Italy, Spain), and Muslim countries (Saudi Arabia, Libya) [7].
The aim of this study was to determine the effect of ram, sex and diet on growth performance of Tsigai lambs.

2. Materials and methods

The present research was conducted in Experimental Base Reghin of Research Institute for Sheep and Goat Palas Constanta, Mures County, 46°46' N/ 22°42'E; 395 m altitude; annual rain fall varies between 650-700 mm; average temperatures 19/–3°C during summer/winter).
A total of 248 Tsigai pure breed ewes was used to natural controlled mating with 10 Tsigai rams (the rapport ewe/ram being calculated 25 ewes/ram) and were observed growth performances of lambs in the 10 rams groups.
In the mating period (19.08.2019-20.10.2019), all ewes were kept in the pastures, and the rams in the shelter organized on pastures.
In the August – November period (mating period and first 3 months of gestation), the sheep grazed on medium quality pastures, whose floristic composition is 90% grasses of spontaneous flora (in which the share of *Deschampsia cespitosa* is over 50%, along with *Festuca pratensis, Dactilylis glomerata* and *Lolium perenne*) and 10% legumes (*Trifolium repens*), and were provided 0.3 kg barley grain per ewe. In the last 2 months of gestation, winter (beginning of December until beginning February), the animals were held in the shelter and provided 0.25 kg maize, 0.25 kg barley and 1.5 kg hill hay per ewe, and in the suckling period (beginning February until beginning April) were provided 0.45 kg corn flour, 0.45 kg barley flour and 2.0 kg hill hay.
Lambs were born in January-March interval. At birth or shortly thereafter, lambs were identified with ear tags and weighed (±0.1 kg). Sex, date of birth, type of birth, dam and ram group were recorded. The lambs were also weighed monthly (±0.1 kg) up to 5-month age. Ewes and their lambs were kept together under the same management condition. Up to weaning, the lambs were creep fed (*ad libitum*, 134 g DP and 25.5 kcal NE) and weaned at 64 days of age. The structure of concentrated fodder was: 30% corn flour, 30% barley flour,
25% corn grain, 11.25%, sunflower groats, 2.25% calcium and 1.5% salt. After weaning, three lots (L1, L2) of lambs from Tsigai breed (L1 and L2 20 heads males/group and L3 80 female) were fed with different diet up to 5 months, the lambs are raised on shelter, and the diet was offer *ad libitum*.
The diet (Table 1) was different between the three groups, and different inside of lot 2, along the fattening period.
For the lot 1, the concentrate fodder was the same like in the suckling period. In the fattening period, the lot 3 had the same ration like the lot 2 in the period 6 April – 6 June. For all lots in the ration was added hill hay.
Water and salt were at discretion.
The research activities were performed in accordance with the European Union' Directive for animal experimentation (Directive 2010/63/EU).

Traits Definition

The traits investigated were classified as pre-weaning and post-weaning growth traits, and *Longissimus dorsi* properties. Pre-weaning growth traits consisted of birth weight (BW); weight at 28 day (W28) and weaning weight (WW). Post-weaning growth traits consisted of weights at 5 months (W5M).

Table 1. Structure of concentrate fodder used in fattening experiment with lambs from Tsigai sheep

Item	After weaning			
	The period			
	6 April - 31 July	6 April - 6 June	7 June - 31 July	6 April - 31 July
	L1	L2	L2	L3
Corn flour (%)	30.0	4.0	20.0	4.0
Barley flour (%)	30.0	4.0	20.0	4.0
Corn grain (%)	25.0	1.5	50.0	1.5
Sunflower groats (%)	11.25	90.0	7.5	90.0
Calcium (%)	2.25	0.3	1.5	0.3
Salt (%)	1.5	0.2	1.0	0.2
Dry matter/kg concentrated fodder	82	83	83	83
Digestible protein g/kg dry matter	134	100	118	100
NE kcal/kg dry matter	25.5	27.02	26.11	27.02

The properties investigated for *Longissimus dorsi* was: depth at 12th rib (LDD12) and 3-4 lumbar vertebrae (LDD34), *Longissimus dorsi* area at 12th rib (LDA12) and at 3-4 lumbar vertebrae (LDA34), Longissimus dorsi perimeter at 12th rib (LDP12) and at 3-4 lumbar vertebrae (LDP34) and backfat thickness at 12th rib (BFT12) and 3-4 lumbar vertebrae (BFT34).

Statistical analyses

In order to determine the effect of ration on lamb's growth performance, the mean comparisons between the variables were carried out using independent samples Student t-test of the JASP procedure.

3. Results and discussion

The reproduction indices of Tsigai sheep are presented in Table 2.

The average body weight of the female is comprised between 41.31 and 45.44 kg, and the average age between 3.18 and 4.89 kg. Significant differences ($p< 0.01$) were found between the groups 7 and 9, and between 2 and 9 ($p< 0.05$) with regard at body weight. Significant differences were found in terms of females age ($p< 0.05$) between the groups 8 and 1, 8 and 10 as between the groups 3 and 4. At the same time, significant differences ($p<0.001$) were found between the groups 3 and 8, with regard at the age of females.

The lowest fertility rate (66.67%) was observed at the females with average weight of 42.67 kg and 3.50 years. At the opposite pole, the highest fertility rate (100%) was observed at the groups of females with average weight of 44.17 kg, 43.08 kg and 4.84, and 4.76 average weight, respectively.

With regard at prolificacy, the highest (116.67%) was recorded at the group of females with 44.00 kg and 3.18 years, while the lowest was observed at the groups 1, 3, 6 and 8.

Evolution of lambs' body weight from birth up to weaning are presented in Tables 3 and 4.

Table 2. Reproduction indices to Tsigai sheep

Rams groups	Females mated n	Females body weight (kg) X ± SEM	Females' age (years) X ± SEM	Fecundity (%)	Prolificacy (%)
1	12	44.17 ± 1.50	4.84 ± 0.80^{acde}	100.00	100.00
2	18	41.83 ± 1.05^{a}	3.58 ± 0.33	72.22	107.69
3	21	43.10 ± 1.53	4.89 ± 0.67^{d}	90.48	100.00
4	47	42.92 ± 0.89	3.58 ± 0.29^{Abde}	91.48	104.65
5	8	44.00 ± 2.17	3.18 ± 0.86^{cde}	75.00	116.67
6	6	42.67 ± 3.69	3.50 ± 0.96	66.67	100.00
7	26	41.31 ± 1.00^{B}	4.31 ± 0.57	92.31	109.09
8	53	43.23 ± 0.89	3.40 ± 0.25^{cde}	92.45	100.00
9	32	45.44 ± 0.96^{Aa}	4.42 ± 0.32	78.13	104.35
10	13	43.08 ± 1.21	4.76 ± 0.67^{Be}	100.00	115.38

Means with different superscripts (^{a}, ^{b}, ^{c}, ^{d}, ^{e}) in each traits differ ($p< 0.05$).
Means with different superscripts (^{A}, ^{B}) in each traits differ ($p< 0.01$).

In the present study, the average weight at birth for all lambs is 4.22 kg and at weaning 17.31 kg, at average weaning age of 63.91 days, with an ADG from birth to weaning of 215 g. Comparatively, between ram groups, the average BW is comprised between 3.99 kg and 4.40 kg and WW was comprised between 15.93 kg and 18.25 kg.

Table 3. Evolution of body weight from birth to weaning (mean ± standard error) of lambs from Tsigai sheep (n = 212)

Item	X ± SEM	Minimum	Maximum
BW, kg	4.22 ± 0.04	2.20	5.90
W28, kg	9.48 ± 0.15	2.00	15.80
WW, kg	17.31 ± 0.22	7.70	25.10
Weaning age (days)	63.91 ± 0.85	41.00	112.00
Total gain, kg	13.09 ± 0.21	4.40	20.20
ADG, g	214.86 ± 5.12	46.81	426.83

Significant differences ($p<0.05$) were found between the groups 1 and 3 with regard at birth weight. In terms of weight at 28 days, between the groups 3 and 9 the differences were significant ($p<0.05$). No differences ($p>0.05$) were recorded with regard at weaning weight, but significant differences ($p<0.05$) were found between the ram group 7 and groups 1, 2, 4, 8, 9, 10 with regard at weaning age. The lambs from the group 7 were weaned at 51.5 days, compared to the others groups, where the weaning age were over 60 days. The variation of total gain in birth-weaning period (Table 5) is comprised between 11.94 kg and 14.08 kg. Significant differences ($p<0.05$) were found between the groups 2 and 3 with regards at total gain. In terms of ADG from birth to weaning, the differences were significant ($p<0.01$) between the group 2 and the groups 3 and 6. At the same time, the differences found between the groups 2 and 4, 3 and 9 and the group 7 compared to the groups 8, 9, and 10 were significant ($p<0.05$).

Table 4. Pre-weaning evolution of lambs from birth to weaning (mean ± standard error) based on rams groups

Ram groups	n	BW (kg) X ± SEM	W28 (kg) X ± SEM	WW (kg) X ± SEM	Weaning age (days) X ± SEM
1	24	4.40 ± 0.13^{a}	9.39 ± 0.40	17.94 ± 0.78	64.50 ± 1.71^{a}
2	23	4.10 ± 0.13	8.98 ± 0.45	16.17 ± 0.67	67.70 ± 2.29^{a}
3	45	4.12 ± 0.08^{b}	10.16 ± 0.36^{a}	17.75 ± 0.46	62.31 ± 1.66
4	49	4.27 ± 0.10	9.74 ± 0.36	17.66 ± 0.46	63.27 ± 1.95
5	15	4.14 ± 0.10	9.15 ± 0.42	17.03 ± 0.65	62.13 ± 2.70^{a}
6	7	3.99 ± 0.20	9.50 ± 0.48	15.93 ± 0.43	61.29 ± 3.44
7	4	4.18 ± 0.13	9.05 ± 0.78	18.25 ± 1.06	51.50 ± 0.96^{b}
8	12	4.26 ± 0.10	8.84 ± 0.71	16.48 ± 1.16	67.08 ± 3.95^{a}
9	14	4.14 ± 0.20	8.49 ± 0.50^{b}	16.57 ± 0.98	65.43 ± 3.91^{a}
10	19	4.38 ± 0.07	9.44 ± 0.57	17.48 ± 0.60	65.89 ± 3.93^{a}

Means with different superscripts (^{a}, ^{b}) in each traits differ ($p< 0.05$)

The analyses of post-weaning body weight (Table 6) have indicated significant effects on weight at weaning and 5 months on sex. Weaning weight of female lambs in L3 were found 1.97 kg and 1.98 kg easier than male lambs in L1 and L2, respectively, the differences being significant ($p<0.01$). At 5 months, male lambs in L1 and L2 were found to be significantly heavier ($p<0.001$) than the females from L3 (7.65 kg and 5.60 kg, respectively). No significant differences were found between the lots of male lambs from Tsigai sheep, therefore the weight at 5 months was not influenced by the diet. The statistics for ultrasonic measurements of the eye muscle properties of lambs are given in Table 7.

The difference observed due to the sex of lambs was significant for muscle depth ($p<0.05$) and eye muscle area ($p<0.01$). Between the means of lots were significant differences ($p<0.01$) for eye muscle area at the lot of females (L3), compared to L1 and L2. The eye muscle area at 12th was higher to female lambs, compared to male lambs

from Tsigai breed (1.08 cm^2 higher to L3 compared to L1 and 1.46 cm^2 higher to L3 compared to L2, respectively). At 3-4 lumbar vertebrae, the differences recorded was significant ($p<0.01$) only between the lots L3 and L2 (13.69 cm^2 at L3 vs. 12.31 cm^2 at L2).

Table 5. Average daily gain of the lambs from Tsigai sheep in pre-weaning period based on rams' groups

Rams groups	n	Total gain from birth to weaning (kg) X ± SEM	ADG from birth to weaning (g) X ± SEM
1	24	13.54 ± 0.71	214.20 ± 12.73
2	23	12.08 ± 0.65^{a}	185.78 ± 13.13^{Aacdef}
3	45	13.64 ± 0.44^{b}	225.34 ± 8.66^{Bcef}
4	49	13.39 ± 0.43	228.06 ± 15.07^{bcdef}
5	15	12.89 ± 0.69	211.96 ± 12.56
6	7	11.94 ± 0.43	198.19 ± 11.78
7	4	14.08 ± 1.08	272.79 ± 17.98^{Be}
8	12	12.23 ± 1.13	195.03 ± 21.78^{f}
9	14	12.43 ± 0.86	202.60 ± 22.39^{df}
10	19	13.10 ± 0.58	209.86 ± 13.17^{f}

Means with different superscripts (^{a}, ^{b}, ^{c}, ^{d}, ^{e}, ^{f}) in each traits differ ($p< 0.05$).
Means with different superscripts (^{A}, ^{B}) in each traits differ ($p< 0.01$).

Table 6. Post-weaning evolution of body weight of the lambs from Tsigai sheep (n = 80)

Characteristics	L1 n = 20	L2 n = 20	L3 n = 40
Weaning weight, kg	20.16 ± 0.48^{A}	20.17 ± 0.51^{A}	18.19 ± 0.41^{B}
Weaning age, days	66.35 ± 1.45^{A}	57.90 ± 2.11^{B}	59.80 ± 1.22^{B}
W5M, kg	42.23 ± 1.07^{A}	40.18 ± 1.41^{A}	34.58 ± 0.77^{B}
ADG^{d} weaning – 5 months, g	225.83 ± 5.93^{A}	225.33 ± 8.80^{A}	166.61 ± 4.65^{B}

Means with different superscripts (^{A}, ^{B}) in each traits differ ($p< 0.01$ and $p< 0.001$).

The diet of lambs were significant sources of variation ($p<0.05$) for the ultrasonic measurements for LD muscle depth between 3 – 4 lumbar vertebra and eye muscle area between 3 – 4 lumbar vertebrae ($p<0.01$).

Regarding the phenotypic correlations (Table 8) between ultrasound measurements with weight at 5 months, from a total of 45 traits couples 57.78% are small correlation (0.00-0.30), 20.00% are medium to high correlations (0.31-0.60) and high correlations recorded 22.22 % (0.61-1.00). The correlation between backfat thickness and *Longissimus dorsi* depth, area and perimeter were found to be negative. Negative correlation was found also between *Longissimus dorsi* depth and perimeter. All others correlation were found to be positive. The correlation between *Longissimus dorsi* area with perimeter were highest (0.67 at 3-4 lumbar vertebrae and 0.60 at 12th rib, respectively). In this study, average lamb weight was comprised between 34.58 kg at L3 (the lot of females from Tsigai sheep) and 42.23 kg at L1 and the average age ranged from 156 to 167 days, depending on the lot.

Animal age at the time of measurement is important, as variation may exist between genetic evaluation programs which are based on ultrasonic measurements, if these scan measurements are ascertained at different time periods.

Table 7. Mean (±SE) for ultrasound measurements of *Longissimus dorsi* properties to lambs from Tsigai sheep

Specification	Group 1 n = 20	Mean Group 2 n= 20	Group 3 n = 40
BF12 (mm)	6.46 ± 0.24[a]	6.96 ± 0.30[a]	6.46 ± 0.18[a]
BF34 (mm)	6.44 ± 0.31[a]	6.55 ± 0.27[a]	6.01 ± 0.14[a]
LDD12 (mm)	23.36 ± 0.58[a]	21.66 ± 0.70[a]	23.27 ± 0.48[a]
LDD34 (mm)	24.24 ± 0.46[a]	22.33 ± 0.53[b]	22.52 ± 0.50[b]
LDA12 (cm^2)	14.25 ± 0.39[A]	13.87 ± 0.56[A]	15.33 ± 0.21[B]
LDA34 (cm^2)	13.78 ± 0.44[A]	12.31 ± 0.52[B]	13.69 ± 0.22[A]
LDP12 (mm)	167.00 ± 3.07[a]	174.25 ± 3.70[a]	171.73 ± 1.69[a]
LDP34 (mm)	164.40 ± 2.56[a]	162.10 ± 4.08[a]	164.43 ± 1.62[a]
W5M (kg)	42.23 ± 1.07[a]	40.18 ± 1.41[a]	34.58 ± 0.77[b]

Means with different superscripts ([a], [b]) in each traits differ (P< 0.05).
Means with different superscripts ([A], [B]) in each traits differ (P< 0.01 and P< 0.001).

Australia's genetic evaluation and performance testing program, LAMBPLAN, allows ultrasonic measurement for lambs to be taken over a wide range of ages, 5 to 18 months [8]. Others, such as Suffolk sire-reference schemes in Canada [9] and Britannia (MLC, 1987) [10] target measurement at 100 and 147 days of age, respectively.

With respect to lamb weight, environmental, and genetic factors, the results observed here show differences between lots, depending on sex and administered diet.

However, the effect of diet had showed significant differences (p<0.05) between lots from Tsigai males (L1 and L2) with regard at LD muscle depth between 3 – 4 lumbar vertebra and eye muscle area between 3 – 4 lumbar vertebrae (p<0.01). The effects of sex and diet were observed in this experiment.

For the three lots of lambs that were assessed, the average backfat thickness, LD depth, LD eye muscle area and perimeter were measured by ultrasound. The average backfat thickness in the two points were slower at the lot of females.

Table 8. Correlation coefficients between ultrasound measurements and weight at 5 months to the lambs from Tsigai sheep (n = 80)

Specification	W5M	BFT12	BFT34	LDD12	LDD34	LDA12	LDA34	P12	P34
W5M	1.00								
BFT12	0.33	1.00							
BFT34	0.22	0.35	1.00						
LDD12	0.19	0.02	-0.01	1.00					
LDD34	0.42***	0.18	-0.03	0.26	1.00				
LDA12	0.08	0.01	-0.01	0.44***	0.20	1.00			
LDA34	0.19	-0.08	-0.04	0.32	0.44***	0.60***	1.00		
P12	0.07	0.18	0.29	-0.07	-0.02	0.60***	0.23	1.00	
P34	0.11	-0.05	0.09	0.07	0.01	0.39***	0.67***	0.36	1.00

BFT12, BFT34: BFT: Backfat Thickness; LDD12, LDD34: Longissimus Dorsi Depth; LDA12, LDA34 – Longissimus Dorsi Area; P12, P34 – Longissimus Muscle Perimeter; W5M - Weight at 5 Months; ***p<0.001

The area of the eye muscle at 12th rib had the highest values at the group of females (15.33 cm2). At 3-4 lumbar vertebra, the L1 has higher values than the L3.

The correlation coefficients obtained in the present study are in the range previously reported in literature [11- 13]. Fernández et al. [11] stated the correlation coefficient of muscle area with muscle depth was reported as 0.56.

Findings in present study were in agreement with their values. [14] had found very close correlations at Tsigai Blackhead of Teleorman between the weight at the age of 2.5 months and subcutaneous fat layer thickness, muscle depth and muscle eye area (0.72, 0.71, and 0.82, respectively). Similar results have been reported in Kivircik lambs by [15], who found strong correlations between body weight at birth and muscle depth (0.609) and muscle eye area (0.649). The same authors also reported strong correlations between the muscle eye area and muscle depth (0.845).

There were small and medium correlations between the weight of lamb at 5 months and the measurements of *Longissimus dorsi* depth, area, perimeter and backfat thickness. Significant differences ($p<0.001$) were found between *Longissimus dorsi* depth at 3-4 lumbar vertebrae with body weight at 5 months.

Significant ($p<0.001$) differences were found also between *Longissums dorsi* depth and area at 12^{th} rib and at 3-4 lumbar vertebrae, like as between *Longissimus dorsi* area at 12^{th} rib with *Longissimus dorsi* area at 3-4 lumbar vertebrae with perimeter at 12^{th} rib and 3-4 lumbar vertebrae. High (0.67) and significant correlation ($p<0.001$) were found between LDA34 with P34.

4. Conclusions

The growth rate of the lambs in the suckling period was affected by the ram. At the same time, the sex of the lambs had significantly influenced the growth rate after weaning as well as the echo graphic parameter of *Longissimus dorsi*. Eye muscle area at the female of Tsigai breed was higher than to the male, although the body weight of females was lower than that of males. On the other hand, the diet of lambs were significant sources of variation for the ultrasonic measurements for LD muscle depth and eye muscle area between 3 – 4 lumbar vertebrae.

Eye muscle area on lambs from Tsigai breed was situated in the limit known for echo graphic parameter specific for meat carcass quality.

Genetic improvement of carcass characteristics of lambs can be done using a specific diet, along with other records, such as live weight or live weight gains in some periods, and selection to keep for reproduction the best animals.

Acknowledgements

This research work was carried out with the support of Ministry of Agriculture and Rural Development of Romania, Department of Research and also was financed from Project ADER 8.1.1/2019.

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