Non-invasive, ultrasound evaluation of lamb carcass quality

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SUMMARY

The purpose of the study was to evaluate carcass quality on lambs of two local breeds (Palas Merino- PM and Palas Meat Breed- PMB), using non-invasive ultrasound method. We used ultrasound measurements on live animals to determine the properties of Longissimus Dorsi muscle (depth, area and perimeter) and the thickness of the subcutaneous fat layer, on a number of 45 PM lambs aged 165 days and 32.29 kg average weight, and on 45 PMB lambs, aged 210 days and 42.38 kg average body weight. The ultrasound measurements were performed with an Echo blaster 64 using LV 7.5 65/64 probe, supplied by Telemed ultrasound medical systems. The ultrasound images were recorded using Echo Wave II software version 1.32/2009. The first measurement point was 5 cm from the spine, at the 12th rib; the second measuring point was between 3rd and 4th lumbar vertebrae. There were significant phenotypic correlations between the body weight and the properties of LD muscle (depth, area and perimeter), the correlation coefficients ranging between 0.44 and 0.61. The results revealed very significant differences ($P<0.001$) between the lambs from the two breeds. The LD muscle characteristics from these two breeds have been further compared with another local breed, with the same body weight, and the comparison has shown that PMB lambs had the best performance. This conclusion supports the possibility of using Palas Meat Breed rams to improve the meat production of other local breeds.

Keywords: lamb, local breeds, carcass quality, *Longissimus dorsi* muscle, ultrasonic measurement

INTRODUCTION

The improvement of carcass composition is a factor with high impact on the demand for lamb meat (Ward, 1995; Purcell, 1998). Leaner, larger carcasses are the two factors with a positive influence on the acceptation of lamb meat by the consumers (Ieremia et al., 1993). The producers of lamb meat which market high-quality carcasses, more attractive for the

consumers, expect higher earnings. The expectation of higher incomes from lambs with superior carcass meat traits motivates the producers to develop strategies for the improvement of carcass quality by selecting animals with superior genetic traits.

The selection for carcass quality is limited by the fact that the carcass measurements are not possible in the animals which are candidates to selection. Therefore, the genetic merit of the candidates to selection must be estimated by carcass measurements on related animals, or from correlated traits that can be measured on live animals. Using genetic selection we can change the traits measured on carcasses with traits that can be measured on live animals. However, the progress achieved by the selection of correlated traits can provide substantial changes in time (Waldron D.F., 2001).

The purpose of measurements on live animals is to estimate carcass traits, the factors important for carcass value. The measurement of traits on live animals and the methods used to predict carcass composition in lambs progressed during the past 50 years. The choice of the prediction method with higher impact depends on its accuracy, cost and availability. The methods with the highest potential in the terms mentioned above are: real time ultrasound (RTUS), bioelectric impedance analysis (BIA), magnetic resonance imaging (MRI), and x-ray computer tomography (CT) (Waldron D.F., 2001). A review of the researches, made by Stanford et al. (1998), reached the conclusion that the rather high costs of MRI and CT will limit their use on large numbers of animals. Because the genetic merit is evaluated by a combination of own performances and kin performance, the lack of a large number of performances measured on kin animals is a disadvantage for these two methods, even if CT and MRI have advantages in terms of accuracy. Nevertheless, CT was used to evaluate the body composition in elite rams (Simm, 1992; Jopson et al., 1995), while, in UK x-ray computed tomography (CT) is routinely implemented in UK terminal sire breeding (Lambe N.R., 2016).

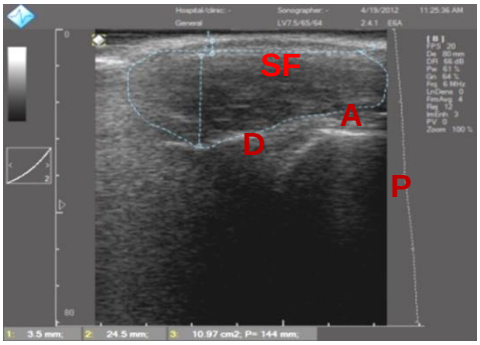
BIA and RTUS are less costly and more portable than CT and MRI, which means that it is possible to make measurements on larger numbers of animals. The cost of CT used by Jopson et al., (1997) was 90 times higher than the cost of RTUS. Because of the low costs of scanning, and because the equipment is portable, although RTUS has lower accuracy, it has the highest potential of being used in the selection for the improvement of carcass value (Wilson et al., 2000).

The purpose of the study was to evaluate carcass quality on lambs of two local breeds, using non-invasive ultrasound method on live lambs.

MATERIAL AND METHODS

The methods for sheep carcass evaluation are subjective mainly, being performed by trained professionals. However, these days, the ultrasound technique is used to evaluate *longissimus dorsi* muscle and the subcutaneous fat layer on live animals. This is an accurate method, delivering fast and objective information required to evaluate carcass structure, with the purpose to meet market demands, being non-invasive and providing an objective and precise evaluation of live animals (Silva, 2006). This method is used for reproduction rams in Germany, being integrated in the sheep breeding programs from Great Britain, New Zealand, Denmark and in other countries (Karamichou, 2006).

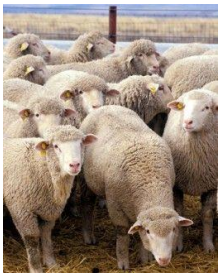
In this experiment the ultrasound measurements were performed on 45 Palas Merino lambs, aged 165 days, and on 45 Palas meat breed lambs, aged 210 days.



Ultrasound image of Longissimus Dorsi


Performing measurements


Palas Merino lambs


Palas meat breed lambs

In Romania, the stock of Merino sheep decreased after the price and the local demand for wool decreased very much, so that the Merino breeds account now for just 5.86% from the total sheep stock. The farmers who kept these breeds make incomes only from selling the lambs or growing sheep for meat. Palas Merino sheep is a mixt, fine wool-meat breed, homologated in 1965. The main production characteristics for meat

production are: weight of lambs at birth, 3.8-4.4 kg; weight at weaning, 18-20 kg; average daily weight gain during fattening, 220-240 g/day; adult ram weight, 90-100 kg; adult ewe weight, 54-60 kg; prolificacy, 122-128%. The Palas meat breed is a newly created breed specialized for meat production, obtained by crossing the Palas Merino with Ile de France, followed by reproductive isolation and selection to increase the meat production; it was homologated in 2012. This is the first breed specialized for meat in Romania. The main production characteristics for meat production are: weight of lambs at birth, 4.5-5.5 kg; lamb weight at 3 month, 28-30 kg; lamb weight at 5-6 months, 35-40 kg; average daily weight gain, 280-300 g/day; adult ram weight, 95-110 kg; adult ewe weight, 60-65 kg; prolificacy, 125-132%. The males are fit for mating with ewes from local breeds, to improve the rate of growth, the efficiency of feed utilization and the slaughter yield. Although the breed has better aptitudes for meat production compared to the other local breeds, it is reared in very low numbers in SE Romania.

The ultrasound method was used for the in vivo evaluation of carcass quality, one of the most used investigation methods in EU countries with tradition in meat sheep rearing The ultrasound measurements were performed with an Echo blaster 64 with LV 7.5 65/64 probe, from TELEMED ultrasound medical systems. All ultrasound images were recorded and analysed using Echo Wave II software, version 1.32 /2009.

The first measurement point is located 5 cm from the spine, at the 12th rib, and the second measurement point is located between the 3rd and 4th lumbar vertebrae. Most of the *Longissimus Dorsi* (LD) muscle, which gives information about the meat production in sheep, lies between these two points. The following dimensions were measured at these two points: fat layer thickness (G12, G34), muscle depth (M12, M34), muscle eye area (A12, A34) and Longissimus Dorsi muscle perimeter (P12, P34).

After measurements on live animals, the images were stored in computer and subsequently processed in laboratory to determine the dimension of these traits. The basic data were processed statistically, determining the average values of the traits, the standard deviation and the regression coefficients, as well as the phenotypic correlations between the ultrasound measurements and the body weight at the time of measurement. The Student test (t) was used for data analysis, to determine the significance of the differences between the average performances determined on lambs from different local sheep breeds.

RESULTS AND DISCUSSION

The data on the live weight at the moment of measurement, and the determination of the ultrasound parameters were recorded on Palas

Merino lambs with an average age of 165 days (5.5 months) and an average body weight of 32.29 kg, and on Palas meat breed lambs, with an average age of 210 days (7 months) and an average body weight of 42.38 kg. The results obtained after statistical processing were tested for the homogeneity of the means with the performance of lambs from other breed, with a similar body weight (not significant differences). The ultrasound parameters of the Palas Merino lambs (Table 1) were compared, using the t test (Student test) with the parameters obtained on the first group of Teleorman Blackhead lambs (TBH).

Table 1 Ultrasound parameters in Palas Merino lambs and Teleorman Blackhead lambs, G1

Item	MU	$X \pm s_x$ Palas Merino	CV (%) PM	$X \pm s_x$ Teleorman Blackhead, G1	p
Body weight	kg	32.293 ± 0.485	9.501	30.951±0.760	NS
Fat layer thickness, 12th rib	mm	2.158 ± 0.042	12.190	2.439±0.076	FS
Fat layer thickness between 3rd – 4th lumbar vertebrae	mm	2.255 ± 0.052	14.447	2.386±0.062	S
LD muscle depth, 12th rib	mm	22.668 ± 0.343	9.579	21.443±0.375	S
LD muscle depth, between 3rd – 4th lumbar vertebrae	mm	22.785 ± 0.342	9.490	22.307±0.423	S
LD muscle eye, 12th rib	cm^2	10.742 ± 0.217	12.759	8.857±0.205	FS
LD muscle eye, between 3rd – 4th lumbar vertebrae	cm^2	10.676 ± 0.212	12.584	9.003±0.226	FS
Muscle perimeter, 12th rib	mm	135.198 ± 1.232	5.764	123.894±1.463	FS
Muscle perimeter, between 3rd – 4th lumbar vertebrae	mm	135.863 ± 1.000	5.764	124.542±1.463	FS

NS – not significant (p >0.05%); S-significant differences (p < 0.05%); DS- distinctly significant differences (p < 0.01); FS – highly significant differences (p < 0.001).

Data analysis shows significant (p >0.05%) differences in the body weight of PM and TBH lambs. Also, the thickness of the subcutaneous fat layer is significantly (p >0.05%) higher in TBH lambs, LD muscle depth is significantly higher in PM lambs, while LD muscle eye and perimeter are highly significantly (p < 0.001%) different in favour of PM lambs.

The ultrasound parameters for the Palas meat breed lambs (Table 2) were compared with the parameters obtained on the second group of Teleorman Blackhead lambs (TBH), which had similar body weight.

Table 2 Ultrasound parameters in Palas meat breed lambs and Teleorman Blackhead lambs, G2

Item	MU	X ± sx Palas meat breed	CV (%) PMB	X ± sx Teleorman Blackhead, G2	P
Body weight	kg	42.383 ± 0.421	6.285	41,000±1,26	NS
Fat layer thickness, 12th rib	mm	2.440 ± 0.049	12.786	2,026±0,09	SH
Fat layer thickness between 3rd – 4th lumbar vertebrae	mm	2.450 ± 0.055	14.230	2,183±0,08	SH
LD muscle depth, 12th rib	mm	26.755 ± 0.309	7.299	22,74±0,64	HS
LD muscle depth, between 3rd – 4th lumbar vertebrae	mm	26.433 ± 0.287	6.872	23,21±0,48	HS
LD muscle eye, 12th rib	cm^2	11.963 ±0.180	9.536	9,831±0,29	HS
LD muscle eye, between 3rd – 4th lumbar vertebrae	cm^2	11.811 ± 0.185	9.908	10,09±0,21	HS
Muscle perimeter, 12th rib	mm	139.925 ± 0.856	3.870	131,29±1,68	HS
Muscle perimeter, between 3rd – 4th lumbar vertebrae	mm	138.593 ± 0.903	4.119	131,81	HS

The t test shows no significant differences in the body weight of the two groups; differences were noticed, however, in LD muscle characteristics, as follows:

- The subcutaneous fat layer is significantly ($p < 0.01\%$) thicker in Palas meat breed lambs than in TBH lambs;
- LD muscle depth, area and perimeter are significantly higher in Palas meat breed lambs than in TBH lambs.

The meat production traits, both measured by weighing (body weight) and those measured by the ultrasound method (subcutaneous fat layer thickness, LD muscle depth, muscle eye area and muscle perimeter) were analysed in terms of the interdependence between them, by calculation of the phenotypic correlations (Tables 4 and 5) between the above-mentioned pairs of traits.

The strongest correlations were determined between body weight and muscle eye area (0.59-0.61) in Palas meat breed lambs, and between body weight and LD muscle depth (0.52-0.61) in Palas Merino lambs. The weakest correlations, in both breeds, were determined between body weight and fat layer thickness, which shows that this trait is poorly correlated, being mainly influenced by traits specific to each breed.

Table 4 Phenotypic correlations between the live weight and the ultrasound parameters determined in Palas meat breed lambs

Trait	GV	G34	G12	M34	M12	A34	A12	P34	P12
GV	1.00								
G34	0.23	1.00							
G12	0.21	0.08	1.00						
M34	0.46	0.18	0.28	1.00					
M12	0.50	0.12	0.30	0.45	1.00				
A34	0.61	0.15	0.26	0.73	0.47	1.00			
A12	0.59	0.06	0.17	0.44	0.75	0.56	1.00		
P34	0.48	0.26	0.05	0.50	0.36	0.82	0.50	1.00	
P12	0.52	0.17	0.02	0.28	0.52	0.39	0.81	0.49	1.00

GV-body weight; G12- Fat layer thickness, 12th rib*; G34-* Fat layer thickness between 3rd – 4th lumbar vertebrae*; M12-* LD muscle depth, 12th rib*; M34-* LD muscle depth, between 3rd – 4th lumbar vertebrae*; A12-* LD muscle eye, 12th rib*; A34-* LD muscle eye, between 3rd – 4th lumbar vertebrae*; P12-* Muscle area perimeter, 12th rib*; P34-* Muscle area perimeter, between 3rd – 4th lumbar vertebrae*; LD-Longisimus dorsi.*

Table 5 Phenotypic correlations between the live weight and the ultrasound parameters determined in Palas Merino lambs

Trait	GV	G34	G12	M34	M12	A34	A12	P34	P12
GV	1.00								
G34	0.07	1.00							
G12	0.18	0.03	1.00						
M34	0.52	0.07	0.10	1.00					
M12	0.61	0.23	0.10	0.67	1.00				
A34	0.54	0.05	0.03	0.76	0.53	1.00			
A12	0.51	0.25	0.07	0.59	0.74	0.75	1.00		
P34	0.50	0.01	0.01	0.60	0.43	0.90	0.69	1.00	
P12	0.44	0.27	0.05	0.46	0.59	0.65	0.88	0.73	1.00

Data analysis show that Palas meat breed lambs have better LD muscle properties than the other two local breeds, which means that this breed has the best traits for meat production. Palas Merino breed ranks second, with lower performance than the Palas meat breed. The Teleorman Blackhead lambs have poorer LD muscle characteristics than the other two studied breeds. The Palas meat breed showed higher values of the subcutaneous fat layer thickness, than the other two breeds, the Palas Merino breed having the lowest values. This means that the Palas Merino lambs produce carcasses with thinner subcutaneous fat layers than the other two breeds. There are consumers who prefer leaner lamb carcasses (Western Europe), while the consumers from Arabian countries prefer fatter carcasses. The sheep producers can select the breed they are rearing according to the market where they will sell their production.

Worldwide, the evaluation of carcass quality using non-invasive methods started back in the 1950s, and the methods improved continuously up to the current high-accuracy methods. In Romania, however, the non-invasive study of carcass quality started only in 2012, at INCDBNA-IBNA Balotesti.

Ultrasound studies of carcass quality were performed on many sheep breeds from Europe, USA, Australia, etc. analysing the characteristics of the Romanian breeds compared to the breeds reared abroad (Table 6), one can notice interesting aspects. In the group of meat breeds, where the fattened lambs reach 41-63 kg bodyweight, the Romanian PMB has the same LD muscle depth as the Spanish CTQ breed, (26.4 mm) and the Latvian LD breed (26.8 mm), but with thinner subcutaneous fat layer. The Romanian TBH breed, which is a mixed breed, has lower LD muscle depth, and also thinner subcutaneous fat layer. In the group of meat breeds with 28.94 - 32.29 kg bodyweight, the two Romanian mixed breeds, PM and TBH, have higher LD muscle depth and subcutaneous fat layer thickness intermediary between two foreign breeds, Awassi and Kivircik.

Table 6 – Ultrasound measurements of LD muscle in different sheep breeds

Breed/authors	Bodyweight (kg)	Fat layer thickness (mm)	LD muscle depth (mm)	LD muscle eye area (cm^2)
♂Suffolk x ♀Rambouillet (SxR) / Leeds T.D. /2008	63.0	6.73	31.9	15.9
Latvian Dark Head (LD) Daina Kairisa 2016	50.7	4.0	26.8	-
Churra de Terra Quente (CTQ) / Silva R.S. / 2006	41.4	2.98	26.4	16.0
Palas meat breed (PMB)/ Ghita E. 2017	42.38	2.45	26.43	11.81
Teleorman Blackhead (TBH) / Ghita E. 2017	41.00	2.18	23.21	10.09
Palas Merino (PM)/ Ghita E. 2017	32.29	2.25	22.78	10.67
Teleorman Blackhead (TBH) / Ghita E. 2017	30.95	2.38	22.30	9.00
Awassi (A) / Orman A. /2010	30.35	2.50	17.87	7.93
Kivircik (K)/ Ibrahim C. /2007	28.94	1.4	19.9	7.06

The comparative analysis of these breeds shows that Longissimus Dorsi muscle properties differ significantly in relation with the type of

breed (meat, milk or dual-purpose), bodyweight and lamb age. The local Romanian breeds, except for the Palas meat breed, are dual-purpose breeds, with lower meat production potential.

Conclusions

The studies to evaluate carcass quality in lambs and fattened lambs from the local breeds, gives the opportunity to select the breeds for meat production, according to the desired traits. Carcass quality improvement is the main objective of the sheep meat producers for national or international markets, being closely related to the delivery price. This price has decisive influence on the profitability of rearing sheep for meat.

Of the studied local breeds, the Palas meat breed lambs displayed the best performance for meat production. This breed can be used directly for meat production, or it can be reared as pure breed for the production of rams which can be used for industrial crosses with local breeds for the production of commercial hybrids.

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