QUALITY EVALUATION OF FATTENING LAMBS USING ULTRASONIC SCANNER *MINDRAY DP-50 VET*

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Abstract. In Europe, including Latvia, the issue – quality of sheep mutton production becomes more and more significant. Therefore, many research institutions around the world are engaged in research of the meat quality of different breeds and the factors affecting it. Currently, the market research shows that there is lack of mutton in the European Union (EU), therefore, the EU has to look for opportunities to produce more. The aim of Latvian sheep breeding specialists is to create a sustainable sheep breeding and processing sector, which is able to produce high – quality, competitive products for domestic and foreign markets. The aim of the research was to find the fattening efficiency of different breed lambs. The study was done with 97 Latvian Dark head bred, Germany Merino local, Suffolk, Dorper, Heidschnucke grey horned, Jacob and Romanov male lambs. Before slaughter of lambs the measurements of muscle tissue and fat tissue layer depth were carried out with the ultrasonic scanner at the 13th rib. After slaughter, weighing of lamb carcasses, evaluation of muscle development and fat tissue layering following SEUROP classifications was carried out. The average age of lambs before the slaughter was four to seven months. The average live weight of the fattened lambs before slaughter was 56.8 kg. *Longissimus Dorsi* muscle and fat thickness depth measurements carried out with the ultrasonic scanner were, respectively, an average 25.2-28.6 mm and 2.8-4.4 mm. Visual assessment of the carcass showed even muscular development, and average score of the groups was R class, but of fat tissue layer – 2 points.

Keywords: lambs, fattening, age, carcass quality, ultrasound measurements

Introduction

The first sheep slaughtering standards were adopted already in 1960 [1]. They based on the age of the slaughtered animal, breeding direction and class of assessment. Assessment of the constitution, exterior, fat tissue and amount of meat were considered when determining the class of assessment.

The methods for sheep carcass evaluation are mainly subjective and the process is done by trained professionals. However, nowadays in sheep breeding the evaluation process of live animal dorsal muscle and subcutaneous fat layer thickness is done with ultrasound technologies. It is a precise method that provides fast, objective information to predict the fraction of the carcass structure aiming to meet the market demand as well as it is a non-invasive technology that provides an objective and accurate evaluation of live animals [2]. In Germany the ultrasound method is used in ram control stations and this method is integrated in sheep breeding programs in the UK, New Zealand, Denmark and elsewhere [3].

The aim of the research was to determine the ultrasound equipment use possibilities in evaluation of results of lamb fattening. Research hypothesis: from lambs with a large *Longissimus Dorsi* muscle depth higher quality carcasses will be obtained.

In order to achieve the aim we raised the following tasks:

1. weight the lambs and with ultrasound evaluate the muscle and fat tissue layer behind the 13th rib the day before slaughtering;
2. weight carcasses and evaluate carcass dressing of the slaughtered lambs;
3. evaluate carcasses after SEUROP classification;
4. determine correlations between the ultrasound scores and results of lamb fattening, and the carcass quality.

Materials and methods

A study carried out in the Ministry of Agriculture funded project "Different breeds of sheep and their crosses suitability for high-quality carcasses and lamb meat production" framework, in collaboration with the association "Latvian Sheep Breeders Association" (hereafter LSBA). In the study used Latvian Dark Head (LD), German Merino Local (GML), Oksford Down (OX), Suffolk (S), Dorper (DOR) (MB), Romanov (R) Heidschnucke Grey Horned (HGH), Jacob (J) are extensive breed (EB) lambs and LT crossings with meat type breeds (XX). In 2015 ram (hereafter – lamb) fattening was carried out in LSBA ram breeding control station “Klimpas”. During the study lambs were fed with unlimited combined silage and hay, in addition mineral feed and licks were ensured. Water was provided from automatic waterers.

The lambs were weighed with an electronic scale, with the accuracy of 0.01 kg. Twelve hours before slaughtering the lambs were kept underfed, providing them with free access to water.

The day before slaughtering the lambs were measured with ultrasonic equipment *Mindray Dp-50 Vet* by *Longissimus dorsi* the muscle depth and fat thickness depth of the 13th rib. After slaughtering lamb carcasses were weighted and evaluated after the SEUROP classification system. In assessment of musculature development letter designations EUROP with the following meaning are used: E – perfectly developed, U – very well developed, R – well developed, O – medium-well developed, P – weakly developed musculature. The level of fat stratification is designated by numbers from 1 to 5, where 1 – very low, 2 – low, 3 – medium high, 4 – high, 5 – very high. In order to subject assessment of muscular development to biometric processing, the following numerical values were used: E – 1, U – 2, R – 3, O – 4 and P – 5.

From the obtained slaughtering data carcass dressing (K) was calculated by using formula:

$$K = \frac{Km}{Wk} x100, \quad (1)$$

where Wk – weight before slaughtering, kg
Km – carcass weight, kg.

The analysis of the obtained data was conducted according to the research scheme (Table 1).

Table 1

Research scheme

Research groups	Origin (used abbreviation)	Number of lambs
1.	Latvian Dark Head (LD)	62
2.	Suffolk, Dorper, German Merino Local, Oksford Down (MB)	15
3.	Latvian Dark Head with meet breed crossings (XX)	12
4.	Romanov, Heidschnucke Grey Horned and Jacob (EB)	8

The collected data were analyzed with mathematical data processing methods and there were determined trait mean values, standard deviation and the coefficient of variation. Before analysis of the obtained results there was performed detection of factors affecting the ultrasound measurements. The significance between differences of mean values was determined with *t*-test. The significance between different groups was marked with small Latin letters: a, b, c, and between the age groups within the breed – the capital letters A, B and C ($p \leq 0.05$). Correlation between the ultrasound score with the results of lamb fattening and the carcass quality was determined.

Results and discussion

As the factors that influence ultrasound measurements were selected: lamb breed, age and live weight at the end of fattening. In the study it was found that they significantly influenced the results (Table 2).

Table 2

Factors influencing ultrasound measurements

Marks	Breed	Live weight at the end of fattening	Age at the end of fattening
	p-value		
Longissimus dorsi muscle depth at the 13th rib, mm	***	***	***
Fat thickness depth at 13th rib, mm	***	***	***

***$p < 0.001$

The average age before slaughtering of the lambs used in the study was 166.9 days or 5.6 months. Individual age of lambs was 128 days (group 3 – XX) and 240 days (group 4 – EB), difference – 112 days that is more than 3.5 months (Table 3). The other authors' studies show that the average age before slaughtering reached even 220 days [4]. The average live weight before slaughtering of fattened lambs was 50.7 kg. The LD breed lambs (group 1 – LD) and Jacob breed (group 4 – EB) lambs – 40.0 kg were the lightest, but the heaviest were German Merino Local breed lambs – 66.8 kg (group 2 – MB). The oldest was the extensive breed group of lambs, on average 194.3 days, but significant differences in the age were obtained only by the 3rd group (XX) (36.8 days, $p < 0.05$), but the live weight of the lambs in these groups was similar to 46.7 and 46.4 kg.

Table 3

Average age and live weight of lambs before slaughtering

Research groups	Number of lambs	Age at the end of fattening, days				Live weight at the end of fattening, kg			
		$x \pm Sx$	min.	max.	V, %	$x \pm Sx$	min.	max.	V, %
1. (LD)	62	165.0 $\pm 2.25^{ab}$	132	214	10.8	50.7 $\pm 0.51^{b}$	40.0	62.8	7.9
2. (MB)	15	166.0 $\pm 6.56^{ab}$	130	196	15.3	56.8 $\pm 1.94^{c}$	43.5	66.8	13.2
3. (XX)	12	157.5 $\pm 6.04^{a}$	128	173	13.3	46.7 $\pm 1.35^{a}$	41.3	54.0	10.0
4. (EB)	8	194.3 $\pm 9.24^{b}$	164	240	13.5	46.4 $\pm 1.56^{a}$	40.0	51.7	9.5

$^{a, b,c} - p \leq 0.05$

Significant differences in live weight before slaughtering were obtained of the first group (LD) and the rest of the groups of the lambs ($p < 0.05$%). The lambs of meat-type breeds were significantly heavier before slaughtering, in average of 56.8 kg. In other authors' studies about Suffolk breed the live weight of lambs at the end of fattening reached 51.6 kg [5].

The measurements taken with ultrasound showed that the *Longissimus dorsi* muscle and fat thickness depth in the studied Latvian Dark Head breed lambs varied between 20.1 to 33.7 mm and 2.2-5.8 mm (Table 4). The average *Longissimus dorsi* muscle depth of LD breed lambs was 26.8 mm, which for about 1.6 mm exceeded the extensive breed group lambs *Longissimus dorsi* muscle depth ($p > 0.05$), but it was significantly less than for the meat type breeds (group 2 – MD) and LD crossing lambs (group 3 – XX), the difference was respectively 1.8 and 1.5 mm ($p < 0.05$).

Table 4

Lamb ultrasonic measurement results at 13th rib

Research groups	Number of lambs	***Longissimus dorsi* muscle depth, mm**				Fat thickness depth, mm			
		$x \pm Sx$	min.	max.	V, %	$x \pm Sx$	min.	max.	V, %
1. (LD)	62	26.8 $\pm 0.31^{a}$	20.1	33.7	9.1	4.0 $\pm 0.09^{b}$	2.2	5.8	17.8
2. (MB)	15	28.6 $\pm 0.55^{b}$	23.3	32.2	7.5	4.4 $\pm 0.23^{c}$	3.4	6.7	20.1
3. (XX)	12	28.3 $\pm 0.54^{b}$	25.1	30.8	6.6	4.0 $\pm 0.19^{b}$	2.6	4.9	16.3
4. (EB)	8	25.2 $\pm 0.75^{a}$	21.6	28.7	8.4	2.8 $\pm 0.23^{a}$	2.1	3.9	23.5

$^{a, b, c} - p \leq 0.05$

From the meat breeds the smallest *Longissimus Dorsi* muscle depth was for Dorper breed lambs – 23.3 mm, but the deepest – German Merino Local breed lamb – 32.2 mm. In Germany by research with the German Blackheads breed lambs it was found that breeding rams in control station at 105.7 days of age and weighed 45.5 kg with muscle depth between ¾ lumbar vertebra was 29 mm, and the fat thickness depth was 6.2 mm. Of the same breed lambs in the farm for 167.5 days on average the live weight was 52.2 kg, muscle depth was 30.4 and fat thickness depth – 7.0 mm [6].

From the extensive breed group the deepest *Longissimus Dorsi* muscle measurements were for Heidschnucke Gray Horned breed lamb – 28.7 mm, which was 6 months old, at the end of fattening and weighed 51.7 kg.

Significantly deeper fat thickness was obtained from the second group (MB) lambs – 4.4 mm. In this group the smallest fatty tissue was for 4.5 months old and 58.7 kg heavy Suffolk breed lamb – 3.4 mm, and the deepest fatty tissue – 5.5 months old 49 kg heavy Dorper breed lamb – 6.7 mm, coefficient of variation of 20.1%. The results are similar to published results in the literature, where intensively fattened meat-type breed lamb fat thickness depth is in the range of 2.0 - 11.0 mm [7; 8].

Like in other authors' studies [9], in spite of substantial larger age extensive breed lambs obtained substantial less fat thickness depth – 2.8 mm ($p < 0.05$).

After slaughtering the calculated dressing percentage is summarized in Figure 1. As shown by the results obtained, the smallest dressing percentage is obtained in the first group (LD) lambs – 44.8 %, which coincides with the previously published results [10; 11]. Compared to the first lamb group (LD), significantly larger dressing percentage is obtained in the meat breed group (group 2 – MB) – 48.2 %, which was slightly behind the other scientists' studies, showing that the meat-type varieties can reach 50 % or more of dressing percentage [4; 5; 12]. Also Latvian studies on intensive Texel breed lamb fattening confirm the foreign authors' opinion, in some cases, gaining 55.3 % dressing percentage [13].

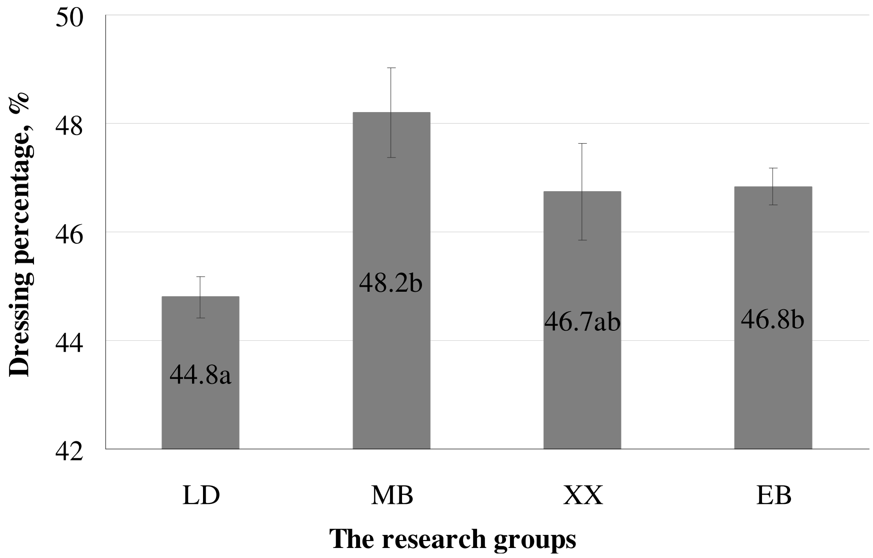

Fig. 1. **Dressing percentage by research groups, % ($^{a, b, c}$ – $p \leq 0.05$)**

Visual score of the carcass muscular development by the groups varied between 2.5 (group 2 – MB) to 3.9 points (group 4 – EB), the best carcass muscular development was in the second group – meat type breeds of lamb carcasses, from which 53.3 % corresponded to the U – class evaluation.

Table 5

Evaluation of lamb carcass quality

Research groups	Number of lambs	Score of the carcass muscular development				Score of the carcass fat tissue layering			
		$x \pm Sx$	min.	max.	V, %	$x \pm Sx$	min.	max.	V, %
1. (LD)	62	2.9 ±0.05^a	2.0	3.5	12.4	2.3 ±0.06^a	1.0	3.0	21.6
2. (MB)	15	2.5 ±0.13^b	2.0	3.0	20.9	2.6 ±0.12^b	2.0	3.5	18.2
3. (XX)	12	2.8 ±0.13^a	2.0	3.0	16.4	2.3 ±0.13^a	2.0	3.0	20.1
4. (EB)	8	3.9 ±0.05^c	3.5	4.0	4.5	2.6 ±0.32^b	1.0	4.0	34.9

$^{a, b, c}$ – $p \leq 0.05$

Also, in the first and third group carcasses were obtained, which ranked in the U class, but most of this group of carcasses were evaluated in the R class (Fig. 2). All extensive breed group lamb carcasses were evaluated with the class O – medium well developed. The obtained results are similar to the results of the study carried out in Estonia, where the largest proportion of lamb carcasses were evaluated in the R class and 2 to 3 point fatty [14].

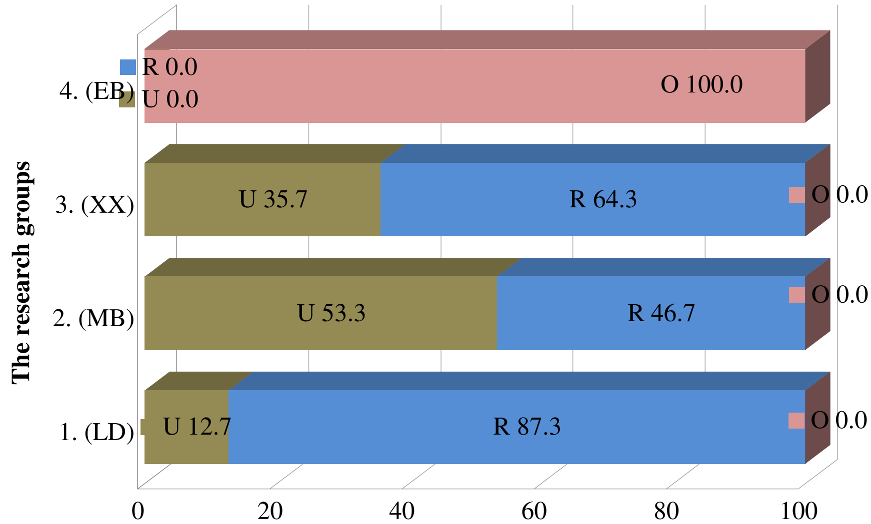

Fig. 2. **Lamb carcasses evaluating by SEUROP classification, %**

The evaluation of carcasses by fat tissue layering shows that significantly larger fat layer was obtained in the second group (MB) and the fourth group (EB) lamb carcasses. The resulting evaluation with ultrasonography measurement matches with the second group (MB) lambs, which had the largest fat thickness depth measurement, but does not match the fourth group (EB) lambs, where the ultrasonic measurement results were the smallest.

The studied trait correlation results are summarized in Table 6. Medium tight positive correlation was obtained with the *Longissimus Dorsi* muscle depth and lamb live weight before slaughtering ($r = 0.35$), but weakly positive withthe fat thickness depth ($r = 0.18$), and weakly negative with the age before slaughtering ($r = -0.14$), medium tight negative with the score of carcass muscular development ($r = -0.27$).

Table 6

Correlations results of studied traits

Marks	**Age, end of fattening, days**	**Live weight before slaughter, kg**	**Dressing percentag e, %**	***Longissimus dorsi* muscle depth, mm**	**Fat thickness depth, mm**
Live weight before slaughter, kg	0.15	1	-	-	-
Dressing percentage, %	0.08	-0.05	1	-	-
Longissimus dorsi muscle depth, mm	-0.14	0.35	0.00	1	-
Fat thickness depth, mm	-0.07	0.24	0.16	0.18	1
Score of carcass muscular development	0.35	-0.25	-0.22	-0.27	-0.37

The results indicate that the deeper *Longissimus Dorsi* muscle was gained from the younger lambs ($r = -0.14$) with a higher live weight ($r = 0.35$). From the lambs with deeper *Longissimus Dorsi* muscle, carcasses with a better muscular development were obtained.

Conclusions

1. The measurement results with ultrasonic scanner were influenced by lambs belonging to the breed or group of breeds, as well as the age and live weight at the time of measurement.

2. From meat type breeds as well as Latvian Dark head and meat type breeds crossing lambs with ultrasonic scanners the deepest *Longissimus Dorsi* muscle measurements, an average of 28.6 mm and 28.3 mm, were obtained.
3. The depth of *Longissimus Dorsi* muscle had a weakly positive correlation with the fat thickness (r = 0.18), medium positive with the live weight before slaughtering (r = 0.35), weakly negative with the score of the carcass muscular development after SEUROP classification, where the correlation coefficient with muscular development was r = -00.27, but with fat tissue layering development r = -0.37. The older lambs showed weakly negative correlation with the *Longissimus Dorsi* muscle depth.

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