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Usability of Ultrasonic Measurements Taken Longitudinal to the Spine in the Assessment of Tissue Composition of Lamb Carcasses[*]

Przydatność pomiarów USG, wykonywanych równolegle do linii kręgosłupa, do szacowania składu tkankowego tuszy jagniąt

The suitability of ultrasonic measurements of the longissimus dorsi muscle cross-section for the assessment of the slaughter value of lambs has been confirmed in numerous studies conducted in Poland and abroad. Such measurements are increasingly frequently used to evaluate the meatiness of sheep (3, 4, 8, 10). At present it is aimed to simplify measurement procedures and to improve the accuracy of these assessments, especially as a result of the automation of measurements and the use of digital image analysis methods. Ultrasonic images taken parallel to the line of the spinal column may prove to be especially useful in this respect (2, 7, 11).

The aim of the studies was to assess the accuracy of estimating the tissue composition of live lambs using the ultrasonic measurements of the longissimus dorsi muscle which were taken longitudinal to the spine.

MATERIAL AND METHODS

Examinations were conducted in the years 2001-2002 on 60 randomly selected Whiteheaded Mutton lambs of both sexes. Lambs were weaned at the age of approximately 70 days and subsequently fattened in individual boxes for 30 days using pelleted balanced feed, 1 kg of which contained 127 g digestible protein and 6.9 MJ energy. Immediately before slaughter lambs were

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weighed and the image of the longissimus dorsi muscle (*m.l.d.*) was monitored - using ultrasonography – on the right side parallel to the line of the spinal column in the thoracic-lumbar segment. The ultrasonic probe was placed on the back of the lamb in such a way so as to obtain the maximum depth of the muscle. Ultrasonic measurements were conducted using the Aloka SSD-210DXII unit with a 5.0 MHz linear probe, connected with a computer equipped with the image analysis software Multi-Scan ver. 8.08 (Computer Scanning Systems Ltd.). In the obtained images fat depth and the depth of the muscle were measured in three points: behind the last rib (P2) and 5 cm in the direction of the head (P1) and 5 cm in the direction of the tail (P3) counting from the last rib (Fig. 1).

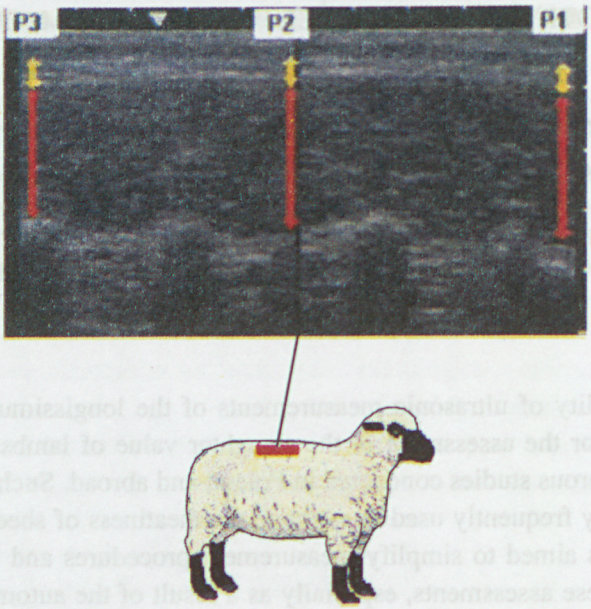

Fig. 1. The diagram showing the positioning of the ultrasonic probe on the barrel of the lamb and the image of the cross-section of the longissimus dorsi muscle with measurement points marked

Slaughter and the assessment of slaughter value of lambs were conducted according to the method developed at the National Research Institute of Animal Science (5). An hour after slaughter the carcass conformation and fatness were evaluated according to the EUROP classification. The percentages of muscle and fat in the half carcass were estimated on the basis of the dissection of the leg and flank with ribs and brisket according to regression equations proposed by Osikowski (6). The method of the multifactor analysis of variance was used to assess the effect of sex, type and year of birth of lambs on the level of the studied traits of fattening performance. Moreover, phenotypic correlations (simple and multiple) were assessed between intravital ultrasonic measurements and major traits characterizing the slaughter value of the studied animals, using the RSQUARE procedure of the SAS ver. 6.12 software.

DISCUSSION

Data presented in Table 1 indicate a good level of slaughter traits of lambs, similar to the results of earlier studies conducted on similar groups of animals (9, 10). No effect was observed of main fixed effects on the basic indexes of slaughter value of the lambs (P>0.05). A significant effect of the sex of lambs on their live body weight prior to slaughter results from biological differences in the development of ram lambs and ewe lambs at this stage of growth. Lambs born in the year 2000 turned out to be slightly heavier (P≤0.05); however, due to the identical number of lambs investigated in both replications and nonsignificant interactions between fixed effects it does not disturb the homogeneity of the system.

Tab. 1. Main indices of lamb slaughter value

Factor	n	Weight before slaughter (kg) LSM±SE	Dressing percentage (%) LSM±SE	Valuable cuts (%) LSM±SE	Content in halfcarcass (%)	
					meat LSM±SE	fat LSM±SE
μ	60	31.4 ± 0.4	50.9 ± 0.5	41.9 ± 0.3	65.6 ± 0.9	18.1 ± 0.6
Sex (S)		**	ns	ns	ns	ns
Males	32	33.3 ± 0.6	50.8 ± 0.5	41.6 ± 0.4	65.3 ± 1.1	17.4 ± 0.9
Females	28	29.2 ± 0.6	51.1 ± 0.7	42.1 ± 0.4	65.7 ± 1.4	18.8 ± 0.7
Type of birth (T)		ns	ns	ns	ns	ns
1	40	31.8 ± 0.4	51.0 ± 0.5	41.7 ± 0.3	65.1 ± 1.1	18.5 ± 0.7
2	20	30.9 ± 0.8	50.7 ± 0.8	42.1 ± 0.4	66.9 ± 1.7	17.2 ± 1.4
Year of birth (Y)		*	ns	ns	ns	ns
2000	30	33.1 ± 0.5	51.0 ± 0.6	41.7 ± 0.3	65.1 ± 1.0	18.4 ± 0.7
2001	30	29.9 ± 0.8	50.9 ± 1.0	42.2 ± 0.5	66.2 ± 1.8	17.7 ± 1.4
Interactions		ns	ns	ns	ns	ns

*(**) – P≤0.05 (P≤0.01), ns – nonsignificant

An increase in the fat depth was observed over the loin eye area in the direction of the tail (P3>P2>P1 – P1≤0.05; Table 2). This result confirms the earlier observations by Szymanowski (8). The diversification in the fat depth along the line of the spinal column is also found in pigs (1). These differences may thus prove the usefulness of taking measurements in several spots. Fat depth measured using ultrasonography behind the last rib (point P2) was similar to the result obtained after the slaughter of lambs (P>0.05; Table 2).

Tab. 2. Descriptive statistics of traits

Trait			Mean	*SD*	Min.	Max.	Significance of difference
Live ultrasound measurements of *m.l.d.* longitudinal to the spine							
Fat thickness	P1	(mm)	2.65	0.76	1.10	4.30	Aa
Fat thickness	P2	(mm)	3.09	0.76	2.00	5.20	*b*
Fat thickness	P3	(mm)	3.65	0.97	2.00	5.90	ABbc
Average fat thickness		(mm)	3.12	0.73	1.90	4.70	*ac*
Muscle depth	P1	(mm)	24.66	2.75	19.20	29.30	C
Muscle depth	P2	(mm)	25.25	2.76	19.50	30.40	*D*
Muscle depth	P3	(mm)	23.91	3.26	18.40	29.10	*E*
Average muscle depth		(mm)	24.49	2.65	19.10	28.90	*F*
Post mortem measurements of *m.l.d.* over last rib							
Fat thickness		(mm)	2.87	1.17	2.00	6.00	B
Muscle depth		(mm)	32.67	2.26	29.00	37.00	D C E F

abc (ABC) – means designated with the same small (capital) letters differ at P≤0.05 (P≤0.01)

The depth of the longissimus dorsi muscle measured after slaughter behind the last rib was by approx. 23% bigger than the corresponding measurement taken in the same spot using ultrasonography (P≤0.01; Table 2). This difference may result from the change in the shape of the muscle caused e.g. by the impact of the pressed probe, the movement of the animal and rigor mortis. Limited consistency of the intravital and post-slaughter measurements of the muscle depth may thus reduce the usability of this index in the assessment of the slaughter value of lambs. As opposed to the fat depth, no clear differences were found between muscle depth in the segment between the 10^{th} thoracic vertebra and the 3^{rd} lumbar vertebra (P>0.05).

High accuracy of the ultrasonic measurement of fat depth is confirmed by a high correlation (r_p=0.895) between the live and post-slaughter measurements taken in the same spot (P2) – Table 3. Fat depth behind the last rib was significantly correlated e.g. with the dressing percentage, the meat percentage in the half carcass (0.503 and 0.516, respectively) and especially with the weight and percentage of fat in the half carcass (0.620 and 0.616, respectively). The values of the correlation coefficients were considerably bigger than the results found in points P1 and P3. Thus, it may be assumed that fat depth in point P2 best characterizes the value of lamb carcass. The obtained correlations do not deviate from those given by other authors for the traditional positioning of the ultrasonic probe (at the same measurement point), i.e. transverse to the line of the spinal column (4, 8, 10).

Tab. 3. Simple and multiple (R) correlation coefficients between live ultrasound measurements and slaughter value of lambs

Slaughter value indices	Fat thickness					Muscle depth				
	at the point:			mean	R P1+P2+P3	at the point:			mean	R P1+P2+P3
	P1	P2	P3			P1	P2	P3		
EUROP – fat score	.510*	.547*	.428	.539*	.574	.467*	.491*	.447*	.489*	.528
EUROP – conformation	-.192	.075	.124	.011	.122	-.247	-.313	-.118	-.128	-.492
Dressing percentage	.404	.503*	.443	.477*	.524	.388	.416	.267	.340	.420
Share of valuable cuts	-.069	-.099	-.028	-.023	-.232	.109	.224	.124	.098	.379
Weight of valuable cuts	.422	.507*	.526*	.494*	.533	.592*	.638**	.525*	.632**	.647
Share of meat in half-carcass	-.437	-.516*	-.494*	-.473*	-.542	.178	.227	.360	.287	.367
Weight of meat in half-carcass	.499*	.397	.414	.413	.515	.406	.497*	.436*	.482*	.505
Share of fat in half-carcass	.576*	.616**	.555*	.606**	.704	.018	-.046	-.072	-.025	.113
Weight of fat in half-carcass	.579*	.620**	.491*	.619**	.722	.419	.414	.422	.444	.447
Fat thickness over *m.l.d.*	.579*	.895**	.654**	.754**	.903	-.134	-.184	-.205	-.193	-.213
Muscle depth	.282	.156	.164	.201	.299	.421	.477*	.438	.471*	.494

However, it needs to be emphasized that the value of simple correlations for the measurement in point P2 was in each case considerably lower that in case of corresponding multiple correlations – combining the P1, P2 and P3 measurements (Table 3). It shows the advisability of taking measurements in various spots and including them in the assessment of trait value, which is considerably easier in case of the positioning of the ultrasonic probe suggested in this study, i.e. parallel to the line of the spinal column. In this case one image of the longissimus dorsi muscle cross-section is obtained, facilitating automatic taking of linear measurements in several points.

In the conducted investigations limited usability of the ultrasonic measurement of the longissimus dorsi muscle depth was found for the assessment of the composition of the lamb carcass (Table 3). The obtained correlation coefficients were generally low and non-significant, except for the interdependence of this measurement with the weight of valuable cuts and the weight of meat in the carcass (0.638 and 0.497, respectively). Similar low correlation coefficients were obtained in earlier studies by Ślósarz et al. (9, 10) at the transverse positioning of the probe in relation to the spine.

WNIOSKI

1. Taking three measurements of fat depth in several points of the thoracic-lumbar segment of the spinal column makes it possible to assess quite accurately the tissue composition of lambs.

2. The suggested method of measurement makes it possible to evaluate the fatness of the carcass with better accuracy than the meatiness of the carcass.

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STRESZCZENIE

Badania przeprowadzono w latach 2001–2002 na 60 losowo wybranych jagniętach typu mięsnego. Przed ubojem w wieku 100 dni jagnięta ważono i metodą USG monitorowano obraz mięśnia najdłuższego grzbietu po prawej stronie, równolegle do linii kręgosłupa na odcinku piersiowo-lędźwiowym. Głowicę ultrasonografu przykładano do grzbietu jagnięcia w taki sposób, by uzyskać maksymalną głębokość mięśnia. Na uzyskanych obrazach mierzono grubość warstwy tłuszczu oraz głębokość mięśnia w 3 punktach: za ostatnim żebrem (P2) oraz 5 cm dogłowowo (P1) i 5 cm doogonowo (P3) od ostatniego żebra. Uzyskana wartość korelacji prostych cech poubojowych i pomiaru w punkcie P2 była w każdym wypadku wyraźnie mniejsza od analogicznych korelacji wielokrotnych, łączących pomiary P1, P2 i P3. Wykonanie trzech pomiarów grubości tłuszczu w różnych punktach piersiowo-lędźwiowego odcinka kręgosłupa umożliwia szacowanie składu tkankowego jagniąt, jednakże z większą dokładnością można oceniać w ten sposób otłuszczenie niż mięsność tuszy.