POST-SLAUGHTER EVALUATION OF THE MEAT CONTENT IN PIG CARCASSES. PART I.

Tomasz Bak[1], Jerzy Denaburski[1], Jacek Kondratowicz[1], Paulius Matusevičius[2]
[1]*University of Warmia and Mazury in Olsztyn, Department of Science of Commodities of Animal Raw Materials. M.Oczapowskiego 5, PL–10-975, Olsztyn.*
[2]*Lithuanian Veterinary Academy, Department of Special Zootechnics. Tilžės g 18,LT–3022 Kaunas,. tel:36 35 05*

Abstract. The experiment was performed at the Meat Plant "MORLINY" in Ostróda. 130 carcasses of fattening pigs coming from individual farms, whose appearance resembled the Polish Large White breed and Polish Landrace, constituted the experimental material. The carcass meatiness was estimated by means of electronic devices for a post-slaughter evaluation of the meat content of pig carcasses using the linear (DLC) and ultrasonic (Ultra Fom 100) methods. The percentage of meat in the carcasses estimated with DLC was higher than that determined with Ultra Fom 100. Back fat thickness measured over loin I and II with DLC was similar to the actual values, whereas the thickness of the dorsal muscle (*m. Longissimus dorsi*) measured with Ultra Fom was much lower than the real value.

Keywords: fattening pigs, carcass meatiness, back fat thickness, thickness of *m. longissimus dorsi*.

POSKERDIMINIS MĖSOS SUDĖTIES KIAULIENOS SKERDENOJE ĮVERTINIMAS. I DALIS

Santrauka. Bandymas buvo atliktas mėsos perdirbimo įmonėje "MORLINY", Ostradoje. Bandymui buvo naudotos 130 skirtingų fermų penimų kiaulių, gautų kryžminant lenkų baltąsias didžiąsias ir lenkų landrasų veisles, skerdenų. Skerdenos mėsingumas buvo įvertintas prietaisais linijiniu (DLC) ir ultragarsiniu (Ultra Fom 100). Skerdenos raumeningumo procentas, paskaičiuotas DLC pagalba, buvo didesnis už jų mėsingumą, paskaičiuotą Ultra Fom 100 pagalba. Nugaros lašinių storis, pamatuotas nugarinės I ir II dūrio taške DCL metodu, buvo panašus įi faktines vertes tuo tarpu, kai nugaros raumens (*m. longissimus dorsi*) storis, pamatuotas Ultra Fom, buvo daug mažesnis, negu faktinė vertė.

Raktažodžiai: penimos kiaulės, skerdienos mėsingumas, *m. longissimus dorsi storis.*

Introduction. When joining the European Union, all candidate countries will have to comply with the regulations regarding raw material and product evaluation as well as with the quality standards established in the EU. In the European Economic Community, the value of animals is estimated on the basis of carcass meatiness and fatness, as well as the parameters affecting the suitability of meat for consumption, production of culinary meat and meat processing. Therefore, to achieve the economic level of the EU states within the shortest possible time, it is necessary to increase production efficiency and the quality of raw materials and products. The conditions that must be fulfilled in order to attain this goal include full equality of rights and financial "symbiosis" between the breeder (producer) and the meat plant, representing successive stages of the production process. The most important problem to be solved is to organize the mutual relationships between the breeder and the meat plant in such a way that the profit is shared by both parties. The producer should be paid on the basis of the actual market value of animals, expressed by their position in the carcass grading system.

Material and Methods. The experiment was performed at the Meat Plant "MORLINY" in Ostróda. 130 carcasses of fattening pigs coming from individual farms, whose appearance resembled the Polish Large White breed and Polish Landrace, constituted the experimental material**.**

Slaughter and post-slaughter processing were carried out in accordance with the regulations binding in the meat industry (Internal Regulations, 1973). After ca. 45 minutes from the moment of stunning, the weight of carcasses with butts was determined (accurate to 0.1 kg) using an electronic balance. Back fat thickness was measured with a slide caliper (exact to 1mm), at five points of hanging hot carcasses (over the shoulder, on mid-back, over loin I, II, III), according to the methodology elaborated by the Pig Polish Performance Testing Station (Kielanowski et al. 1977). The meat content of hanging hot carcasses was estimated employing an ultrasonic apparatus Ultra Fom 100 (Instructions for use of Ultra Fom 100, 1993). The measurement of carcass meatiness with Ultra Fom 100 provided the basis for financial settlements with the producer. The EUROP system, i.e. division into commercial classes depending on the percentage of meat in a carcass, was followed in the studies:

55% and more	-class E
- 50 – 54.9%	-class U
- 45 – 49.9%	-class R
- 40 – 44.9%	-class O
- below 40%	-class P

Carcass meatiness was also estimated using an electronic device for a post-slaughter evaluation of the meat content of pig carcasses by the linear method, i.e. DLC. The percentage of lean meat in hot carcasses was calculated on the basis of a regression equation, taking into account measurement of back fat thickness above the mid-part and edge of the gluteal muscle (loin I and II), and the distance between the ending of the gluteal muscle

and the upper edge of the medullar canal, at the level of loin I (Instructions for use of DLC, 1998).

The carcasses were chilled at a temperature of 2 – 4 şC for ca. 24 hours. The loin of cold left sides was cut behind the last thoracic vertebra in order to determine the actual thickness of back fat at points C_7, C (over the loin eye), D (tangent to the loin eye on the belly side), P_2 (between the third and fourth rib from the lumbar side), and the thickness of the dorsal muscle at point C_7.

The results were analyzed statistically, taking into consideration arithmetic means (), standard deviations (s), coefficients of variation (v), and coefficients of simple correlation (r). The differences between the means for groups were determined by an analysis of variance in a non-orthogonal design. A computer program Statistica 7.0 was applied to create a database and do statistical calculations.

Results and Discussion. All carcasses were graded according to the EUROP system and placed in classes P - E. Their weights and positions in the EUROP system constituted the basis for fixing the price of fattening pigs supplied by the producer. For better characterization of the experimental material, Figure 1 and Figure 2 present the percentage of carcasses belonging to particular EUROP classes determined on the basis of measurement with Ultra Fom 100 and DLC respectively. According to DLC, most of the fattening pigs (46.5%) belonged to class U (50.1 - 55%), i.e. twice as much as in the case of measurements taken with Ultra Fom. According to DLC, 3.1% of the experimental animals represented the lowest classes (O and P), whereas according to Ultra Fom 100 – 32.6%.

An analysis of particular carcasses shows that 35.7% of the fattening pigs were classified in the same way by both devices (Figure 3), but as many as 53.5% of them belonged to higher classes in the case of estimation made with DLC, compared with Ultra Fom. Only every tenth animal was classified to a higher class by Ultra Fom, compared with DLC. These results indicate considerable differences in carcass meatiness estimation between the two devices tested.

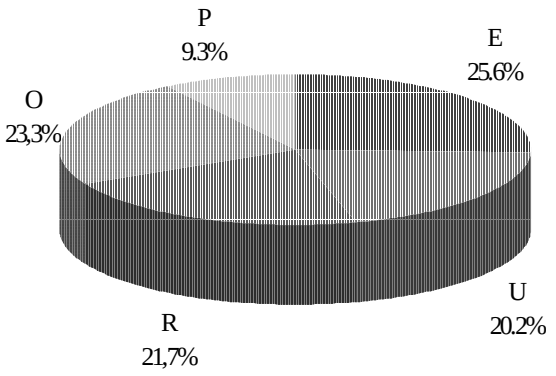

Fig. 1. **Percentage of carcasses belonging to particular EUROP classes, determined with Ultra Fom 100 apparatus.**

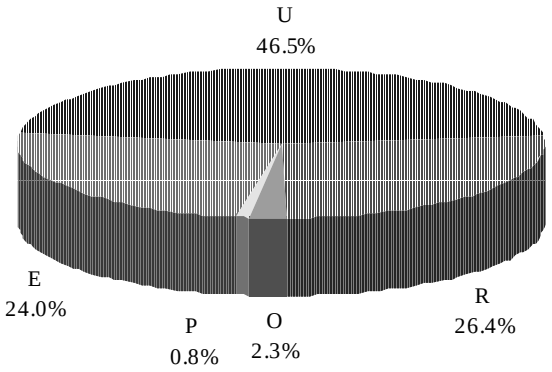

Fig. 2. **Percentage of carcasses belonging to particular EUROP classes, determined with DLC apparatus.**

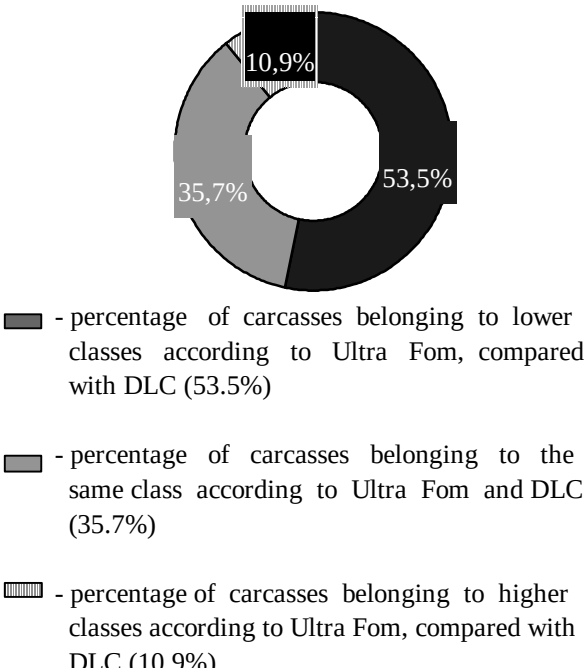

Fig. 3. **A comparison between the percentage of carcasses belonging to particular EUROP classes, determined with Ultra Fom 100 and DLC apparatus**

Table 1 presents also the thickness of back fat, the dorsal muscle (*m. Longissimus dorsi*), and the gluteal muscle (*m. gluteus medius*), measured by means of a slide caliper and the devices +discussed. The average thickness of subcutaneous fatty tissue at point C_7, measured with Ultra Fom, amounted to 19.34 mm, and was. by 1.3 lower than the actual value determined using a slide caliper. However, it should be emphasized that measurement of back fat thickness at point C_7 conducted by means of the ultrasonic device was characterized by a very high variation (33.92%) confirmed by the level of standard deviations.

Table 1. **Arithmetic means (x), standard deviations (s) and coefficients of variation (v) for the traits examined.**

Specification	$\bar{x}$	s	v
Hot carcass weight (kg)	82,44	10,18	12,35
Percentage of meat in carcass estimated by:			
- Ultra Fom apparatus	49,15	6,88	14,00
- DLC apparatus	52,17	4,20	8,05
Backfat thickness (mm) :			
- (C_7) estimated by Ultra Fom apparatus	19,34	6,56	33,92
- DLC apparatus			
- on loin II	21,78	6,04	27,73
- on loin I	29,41	6,54	22,24
-Backfat thickness calculated by a slide caliper (mm) :			
- over shoulder	40,76	7,73	18,96
- on back	25,57	6,2	24,25
- on loin I	29,79	6,47	21,72
- on loin II	22,24	6,52	29,32
- on loin III	29,54	7,17	24,27
- mean of 3 measurement	29,52	4,76	16,12
- mean of 5 measurement	29,58	7,67	25,93
- at point P_2	29,41	6,54	22,24
- at point C_7	20,64	7,10	34,40
- at point C	22,67	7,32	32,29
- at point D	20,70	7,71	37,25
Measurement of loin "eye":			
- *m. longissimus dorsi* thickness calculated by Ultra Fom apparatus	48,45	6,13	12,65
-at point A (widht of loin "eye" calculated by a slide caliper)	93,54	7,74	8,27
-at point A (depht of loin "eye" calculated by a slide caliper)	56,69	5,51	9,72
-loin "eye" area (cm^2)	42,43	4,9	11,55
m. gluteus medius thickness estimated DLC apparatus (mm)	60,81	6,63	10,90

The studies conducted by Blicharski and Ostrowski (1997) show a different relationship, i.e. that the results of post-slaughter ultrasonic measurement of back fat thickness with Piglog and Renco were on average by 2 mm higher than the actual value.

The results of measurement of back fat thickness in the plane perpendicular to the carcass midline, at points C_7 (Ultra Fom and a slide caliper), C and D were lower compared with back fat thickness measured on the mid-back (25.57 mm). A decrease in back fat thickness from the back line to carcass sides may be connected with higher thickness of the dorsal muscle, confirming the well-known fact that back fat thickness is the highest on the back.

In the case of DLC, carcass meatiness is estimated on the basis of back fat thickness measured above the mid-part and edge of the gluteal muscle. The average values of back fat thickness over the loin, determined with a slide caliper and DLC, were similar – the difference between them did not exceed 0.4 mm.

Table 1 presents also the results of measurement of the dorsal muscle, taken after slaughter with a slide caliper and Ultra Fom, and the gluteal muscle, taken with DLC. The data show that the average thickness of *m. longissimus dorsi* determined with the ultrasonic device amounted to 48.45 mm, and was by 8.24 mm lower than the actual value obtained using a slide caliper. A similar relationship was observed by Blicharski and Ostrowski (1996) who analyzed the suitability of an ultrasonic apparatus Piglog 105 for an intravital evaluation of pig carcass quality.

Table 2 shows the correlation between linear measurement of the thickness of back fat and *m. longissimus dorsi*, and the percentage of meat in carcasses estimated with Ultra Fom and DLC. There was a low correlation between hot and cold carcass weight, and carcass meatiness determined with the above devices. The coefficients of correlation between the percentage of meat in a carcass estimated with Ultra Fom and DLC were high (0.8), with a considerable difference in average carcass meatiness determined with both devices. However, it should be stressed that in these two cases the meat content of carcasses was determined on the basis of different measuring points.

A very important index of the applicability of particular linear carcass measurements are correlations between them and the percentage of meat in carcasses estimated with Ultra Fom and DLC. Ultrasonic and electronic devices allow to measure subcutaneous fatty tissue, which provides the basis for estimating carcass meatiness. Back fat thickness at point C_7 , measured with the ultrasonic apparatus and a slide caliper (Table 2), was highly correlated with carcass meatiness determined with Ultra Fom. Similar results were obtained by Borzuta *et al.* (1997), and measurement of back fat thickness at point C_7 was used again in a new regression equation derived for Ultra Fom 100 (in the case of one-point measurement).

All measurements of back fat thickness taken with a slide caliper in the plane perpendicular to the carcass midline (C_7, C, D, P_2) were highly correlated with carcass meatiness determined with Ultra Fom and DLC. The lowest coefficients of correlation were noted between back fat thickness measured with a slide caliper on the mid-back and over the shoulder, and the percentage of meat in carcasses determined with Ultra Fom and DLC.

There was a high negative correlation between the means for three and five measurements of back fat thickness, and carcass meatiness estimated with Ultra Fom (0.73 and 0.77 respectively) and DLC (0.73 and 0.80).

Table 2. **Coefficients of simple correlation between selected carcass parameters and meatiness estimated with Ultra Fom 100 and DLC.**

Specification	Percentage of lean meat in	
	by Utra Fom	by DLC
Percentage of meat in carcass estimated by:		
- Ultra Fom apparatus	1,00	0,80**
- DLC apparatus	0,80**	1,00
Backfat thickness (mm) :		
- (C_7) estimated by Ultra Fom apparatus	- 0,97**	- 0,83**
- DLC apparatus		
- on loin II	- 0,77**	- 0,81**
- on loin I	- 0,79**	- 0,83**
- Backfat thickness calculated by a slide caliper (mm) :		
- over shoulder	- 0,53**	- 0,55**
- on back	- 0,60**	- 0,53**
- on loin I	- 0,77**	- 0,82**
- on loin II	- 0,77**	- 0,80**
- on loin III	- 0,67**	- 0,75**
- mean of 3 measurement	- 0,73**	- 0,73**
- mean of 5 measurement	- 0,77**	- 0,80**
- at point P_2	- 0,84**	-0,79**
- at point C_7	- 0,82**	- 0,78**
- at point C	- 0,82**	- 0,76**
- at point D	- 0,84**	- 0,76**
Measurement of loin "eye": (mm)		
- *m. longissimus dorsi* thickness calculated by Ultra Fom apparatus	0,50**	0,32**
-at point A (widht of loin "eye" calculated by a slide caliper)	0,30**	036**
-at point A (depht of loin "eye" calculated by a slide caliper)	0,48**	,042**
-loin "eye" area (cm^2)	0,48**	0,47**
m. gluteus medius thickness estimated DLC apparatus (mm)	0,25**	0,52**

** – $P \geq 0{,}01$

Apart from back fat thickness, the dorsal muscle (*m. longissimus dorsi*) is also measured to evaluate the slaughter value of pigs. It has already been used in previous research, and constitutes one of the basic indices applied in regression equations concerning modern devices for carcass meatiness estimation, both before and after slaughter, such as Piglog 105, Ultra Fom 100, 200 and 300; PG-200; Ultra-Meter, Dramiński System, Dramiński Mini System, COMBO, Porkitron (Blicharski and Ostrowski 1996a; Blicharski and Ostrowski, 1999; Borzuta, 1998; Borzuta, 1999; Ostrowski *et al*. 2000; Bąk and Denaburski, 2000). Attention should be paid to lower coefficients of correlation between the thickness of *m. longissimus dorsi* (measured by means of ultrasounds and a slide caliper) and carcass meatiness determined with Ultra Fom (r = 0.5).

Another muscle whose measurements are widely applied for objective carcass classification is the gluteal muscle (*m. gluteus medius*). Its thickness is measured by such devices as PQMI-TP and PLE. A correlation between the thickness of *m. gluteus medius* and carcass meatiness, both determined with DLC, was 0.52.

According to Blicharski and Ostrowski (1996), it is not possible to eliminate measurement of thickness of *m. longissimus dorsi*, as it is used in selection procedures. Wider application of measurements of lumbar and gluteal muscles seems necessary, due to the presence of pig breeds characterized by high meatiness (e.g. Pietrain) which guarantee a high ham content of carcasses. In the case of these breeds, back fat is very thin and the dorsal muscle is thick, which was also observed by Borzuta (1997). That is why a new regression equation formulated for Ultra Fom 100 was corrected for pig breeds characterized by high meatiness and fatness.

The data included in Table 2 indicate the highest practical applicability of back fat thickness measured over loin I and II, and at points C_7, C, D, P_2, as it was highly correlated with carcass meatiness estimated after slaughter with Ultra Fom and DLC. The correlation between carcass meatiness determined with these two devices and measurement of *m. longissimus dorsi* and *m. gluteus medius* was much lower.

For better illustration of carcass linear measurements, Table 3 presents the coefficients of correlation between actual back fat thickness and its values determined with Ultra Fom and DLC. The value of back fat thickness measured with a slide caliper in the plane perpendicular to the carcass midline may be applied to verify the accuracy of measurements taken with various devices for estimation of the percentage of meat in carcasses. The actual values of back fat thickness (Table 3), measured on hot carcasses in the plane perpendicular to the carcass midline (C_7, P_2, C, D), were highly correlated with back fat thickness at point C_7, measured with Ultra Fom (above 0.8). The results included in Table 3 also suggest that back fat thickness measured with a slide caliper over loin I and II was very highly correlated with measurements taken with DLC at the same points of the gluteal muscle. The correlation between the loin eye measurements and the thickness of *m. longissimus dorsi* at point C_7,determined with Ultra Fom, was over twice lower than that between back fat thickness measured with this device and a slide caliper at the same point.

Table 3. **Coefficients of correlation between measurement of the thickness of back fat and the dorsal muscle taken with a slide caliper and the devices analyzed.**

	Backfat thickness estimated by DLC apparatus		Backfat thickness (C_7) estimated by Ultra Fom apparatus
Specification	on loin I	on loin II	
- Backfat thickness calculated by a slide caliper -on back	0,68**	0,67**	0,62**
- at point C_7	0,82**	0,79**	0,84**
- at point. P_2	0,81**	0,84 **	0,89 **
- on loin II	0,89**	0,94**	0,81**
- on loin I	0,95**	0,9**	0,81**
- at point C	0,82**	0,78**	0,85**
- at point D	0,81**	0,82**	0,85**
m. LD thickness estimated by Ultra – Fom apparatus			
Measurement of loin "eye": (mm) -at point A (widht of loin "eye" calculated by a slide caliper)			0,32 **
-at point A (depht of loin "eye" calculated by a slide caliper)			0,36 **
-loin "eye" area, (cm^2)			0,42 **

** – $P \geq 0,01$

m. LD – *musculus longissimus dorsi*

Conclusions:

1. The percentage of lean meat in pig carcasses determined with DLC was on average by 3% higher than their meatiness estimated with Ultra Fom 100. As a result, the number of carcasses which belonged to class U according to DLC was over twice higher (46.5%) compared with the measurements taken with the ultrasonic device (20.2%).

2. The actual values of back fat thickness, measured with a slide caliper in the plane perpendicular to the carcass midline (C_7, P_2, C, D) and above the mid-part and edge of the gluteal muscle, were highly correlated (0.8) with carcass meatiness determined with both Ultra Fom and DLC. The correlations between carcass meatiness estimated with Ultra Fom and the thickness of *m. longissimus dorsi*, and between carcass meatiness determined with DLC and the thickness of *m. gluteus medius*, were much lower (ca. 0.5).

3. The values of back fat thickness, measured over loin I and II with DLC, were similar to the actual measurements. The thickness of the dorsal muscle determined with Ultra Fom was on average by 8 mm lower than the actual values.

4. Wider application of the measurements of lumbar and gluteal muscles may be useful in selection aimed at increasing carcass meatiness, especially in the case of pig breeds characterized by a high ham content of carcasses.

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