POST-SLAUGHTER EVALUATION OF THE MEAT CONTENT IN PIG CARCASSES. HAM DISSECTION. PART II.

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Abstract. The aim of the present study was to determine the accuracy of estimation of pig carcass meatiness with DLC on the basis of selected ham parameters and the results of their dissections.130 right-side hams were dissected. The dissection results provided the basis for determining the content of lean meat representing different classes, and the percentage of lean meat in hams. An analysis of the tissue composition of hams shows that carcasses belonging to lower EUROP classes (measurement with Ultra Fom and DLC) were characterized by a lower meat content of hams and higher fatness. The results of the present studies indicate that DLC may be applied for a post-slaughter evaluation of meatiness of pig carcasses. This is confirmed by high correlations between the meat and fat content of hams, and carcass meatiness determined with DLC.
Keywords: pigs, carcass meatiness, ham dissection, coefficients of correlation.

POSKERDIMINIS MĖSOS SUDĖTIES KIAULIENOS SKERDENOJE ĮVERTINIMAS. KUMPIO IŠPJAUSTYMAS. II DALIS

Santrauka. Šio darbo tikslas nustatyti kiaulių kumpio mėsos kokybę naudojant DLC. Buvo išpjaustyta 130 dešinės skerdenos puselės kumpių. Skirstant skerdenos kumpius pagal EUROP klases (matavimui naudojant Ultra Fom ir DLC)) buvo nustatyta, kad DLC galima taikyti poskerdiminiam kiaulienos skerdenų mėsingumo įvertinimui.

Raktažodžiai: kiaulės, skerdenos mėsingumas, kumpio išpjaustymas, koreliacinis koeficientas.

Introduction. Modern technologies allow to use the most recent results of research in the fields of physics, mathematics and biology in the designing and production of innovative devices, including those for estimation of the percentage of meat in pig carcasses. The main objective is here to achieve the highest possible accuracy of estimation, and eliminate the element of subjectivity connected with evaluation made by experts. According to Jones (1996), specialists from many countries realize that they need objective methods of carcass quality evaluation. Numerous techniques employed currently are promising, but it seems that only a combination of several methods (electronic, linear, ultrasonic) may bring fully reliable results concerning estimation of meatiness and fatness of pig carcasses.

In most cases the slaughter value of animals is determined employing indirect or direct post-slaughter methods. Direct objective methods of slaughter value evaluation, based on carcass cutting and detailed dissection, are accurate and allow to estimate the actual value of animals. The reliability of results is beyond doubt their major advantage, but these methods are time- and labor-consuming; they also decrease the market and technological value of carcasses. Dissection of the most valuable carcass elements, i.e. ham, shoulder and loin, allows to reduce the costs connected with dissection of whole carcasses.

Objective methods of carcass meatiness evaluation, based on various electronic and ultrasonic devices, help to eliminate subjective grading of live animals and their carcasses. One of them is the electronic-linear method. The above devices are in great demand in the meat-processing industry, i.e. at cold stores, wholesale stores and big retail shops.

The aim of the present study was to determine the accuracy of estimation of pig carcass meatiness with DLC on the basis of selected ham parameters and the results of their dissections.

Material and Methods. The experimental material and methods are presented in Part I of this paper. In order to make a more detailed analysis of the problem discussed, right-side hams were dissected. They were cut between the first and second sacral vertebra, with groins, without legs, knuckles and tails. The tissue elements (meat, fat, skin and bones) obtained after ham dissection were weighed on an electronic balance accurate to 5 g. The dissection results provided the basis for determining the content of meat representing different classes, and the percentage of meat in hams.

The results were analyzed statistically, taking into consideration arithmetic means ($\overline{x}$), standard deviations (s), coefficients of variation (v), and coefficients of simple correlation (r). The differences between the means for groups were determined by a one-factor 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. The results are presented in three Figures and five Tables. The content of particular tissue elements, determined on the basis of ham dissection, is shown in Table 1. The percentage of ham without the knuckle in pig carcasses was 23.61%, and its average weight, 9.58 kg. The average percentage of meat in hams was 73.89%, which indicates good carcass meatiness. As noted by Kubusiak, Jarmoluk (1995) and Wajda et al. (1995), the weight and percentage of ham in pig carcasses grow with an increase in their meatiness.

Table 1. **Arithmetic means ($\overline{x}$), standard deviations (s) and coefficients of variation (v) for tissue elements of hams.**

Specification	$\overline{x}$	s	v
Ham (kg)	9,58	1,24	12,96
Share in the ham (kg) :			
-meat	7,08	0,94	13,32
-fat	1,39	0,48	34,24
-bones	0,78	0,10	12,23
-skin	0,34	0,08	22,81
Percentage share of ham in carcasses	23,61	1,26	5,33
Percentage share in the ham (%):			
-meat	73,89	3,98	5,39
-fat	14,29	4,09	28,59
-bones	8,16	0,87	10,63
-skin	3,58	0,64	17,77

The average fat content of hams amounted to ca. 14.29 %, and was characterized by a relatively high variation, which may be connected with a different degree of fatty tissue deposition, depending on the level of feeding on private farms, and natural predisposition of particular breeds to deposit fat (Borzuta et al. 1988; Grześkowiak, 1996).

In their studies on populations, researchers often do not focus on the values of a given statistical trait only, but investigate the relationships between the values of particular traits, determining coefficients of correlation. The meat content of ham constitutes ca. 28% of meat in the whole carcass. This includes *m. semimembranosus, m. semitendinosus, m. quadriceps femoris, m. biceps femoris*, and gluteal muscles. Table 2 presents the coefficients of simple correlation between the tissue composition of hams (absolute and relative values) and carcass meatiness estimated with DLC and Ultra Fom. Except for fat, there was a low correlation (from r = 0.10 to r = 0.32) between the content of tissue elements (kg) and carcass meatiness determined with DLC and Ultra Fom. The fat content, expressed in absolute values, was highly negatively correlated with carcass meatiness estimated with DLC (r = -0.65) and Ultra Fom (r= -0.74). The data included in Table 2 also show that the highest coefficients of simple correlation were observed between the percentage of fat in hams and carcass meatiness estimated with DLC (r = –0.77) and Ultra Fom (r = -0.83). There was also a high correlation between the percentage of meat in hams and carcass meatiness determined with the above devices (r ? 0.8). The coefficients of correlation between the fat content of hams and carcass meatiness estimated with DLC and Ultra Fom, obtained in the present studies, are similar to those noted by Wajda and Bąk (1996). These authors also confirmed a correlation between the meat content of hams and carcass meatiness determined by partial dissection and linear measurements (r = 0.78), and with Ultra Fom (r = 0.72).

Table 2. **Coefficients of correlation (r) between tissue elements of hams and carcass meatiness estimated with Ultra Fom 100 and DLC.**

Specification	DLC	Ultra Fom
	apparatus	apparatus
	(r)	(r)
Share in the ham (kg):		
-meat	0,32**	0,20
-fat	-0,65**	-0,74**
-bones	0,25**	0,10
-skin	-0,23**	-0,22
Percentage share in the ham (%):		
-meat	0,77**	0,81**
-fat	-0,77**	-0,83**
-bones	0,28**	0,27**
-skin	-0,27**	-0,17

** – P $\geq$ 0,01

To make an in-depth analysis of the problem discussed, the correlations between back fat thickness estimated at various points with DLC and Ultra Fom, and the percentage and weight of tissue elements of hams (Table 3), were calculated. Back fat thickness measured with DLC over loin I and II, and with Ultra Fom at points C_7 and P_2, was highly correlated with the percentage of meat (r $\approx$ -0.8) and fat (r $\approx$ 0.8) in hams. It should be emphasized that the coefficients of correlation between such ham elements as skin and bones (their weight and percentage) and back fat thickness measured with both devices at various carcass points were higher in the case of DLC than using Ultra Fom.

Apart from back fat thickness, the thickness of the gluteal muscle (*m. gluteus medius*) and the dorsal muscle (*m. longissimus dorsi*) also measured during pig carcass grading. Table 3 shows the coefficients of correlation between the weight and percentage of tissue elements of hams, and the thickness of the dorsal muscle (determined with Ultra Fom) and the gluteal muscle (estimated with DLC). It should be noted that the tissue composition of hams was more correlated with the gluteal muscle thickness measured with DLC than with the dorsal muscle thickness measured with Ultra Fom. The highest correlation was observed between the thickness of gluteal muscles and the meat content of hams (r = 0.62). The correlation between the thickness of the dorsal muscle estimated with Ultra Fom and the meat content of hams was at a level of r = 0.26. This seems logical, due to the fact that the above measurements were taken at different carcass points.

Table 3. **Coefficients of correlation (r) between the percentage and weight of tissue elements of hams and carcass measurements taken with Ultra Fom 100 and DLC.**

		Measurements of DLC apparatus			Measurements of Ultra Fom apparatus		
Wyszczególnienie							Depth of m.logissimus dorsi
		on loin I	on loin II	m. gluteus medius	C7	P2	
		(r)	(r)	(r)	(r)	(r)	(r)
Share in the ham							
- meat	(%)	-0,74**	-0,78**	0,22**	-0,80**	-0,80**	0,36**
	(kg)	0,04	- 0,05	0,62**	- 0,16	- 0,08	0,26
-fat	(%)	0,78**	0,82**	- 0,16	0,84**	0,83**	-0,33**
	(kg)	0,80**	0,79**	0,08	0,76**	0,79**	-0,24**
- bones	(%)	-0,49**	-0,44**	-0,25**	-0,33**	-0,36**	- 0,00
	(kg)	- 0,05	- 0,09	0,36**	- 0,11	- 0,04	0,11
- skin	(%)	0,22**	0,24**	- 0,12	0,17	0,19	- 0,09
	(kg)	0,41**	0,38**	0,23	0,25	0,33**	- 0,00

** – P $\geq$ 0,01

As observed by Ostrowski and Blicharski (1999), even small (several per cent) deviations from the actual value of carcass meatiness estimated by various devices are perceived as an argument against grading. Therefore, all apparatus designers aim at achieving the highest possible accuracy of measurement.

Table 4 and 5 present the arithmetic means ($\overline{x}$) and standard deviations (s) for the meat content of carcasses, hot carcass weight, and the tissue composition of hams. They show the slaughter parameters of the experimental carcasses classified in the EUROP system on the basis of measurements taken with Ultra Fom 100 (Table 4) and DLC (Table 5).

Table 4. **Lean meat content of carcasses and the tissue composition of hams from carcasses classified in the EUROP system with Ultra Fom 100.**

Specification	Statistical Measures	Classes E	U	R	O	P	Statistical significance of differences between means for groups
Number		33	27	27	30	12	
Percentage of meat in carcass, (%)	x	58,19	51,91	47,17	43,05	38,21	E>U,R,O,P.**
	s	2,98	1,58	1,38	1,37	2,07	U>R,O,P.**
Hot carcass weight (kg)	x	78,89	78,54	85,70	84,83	87,68	P>E,U**
	s	9,12	11,21	10,15	8,36	9,67	R,O>E,U*
Ham (kg)	x	9,44	9,20	9,85	9,76	9,72	-
	s	1,11	1,43	1,39	1,05	1,14	
Share in the ham Meat (%)	x	78,04	75,64	72,55	70,91	68,97	E>U,R,O,P.**
	s	2,35	2,89	1,92	2,82	2,20	U>R,O,P.**
							R>P.**
Fat (%)	x	10,15	12,37	15,75	17,34	19,91	P>E,U,R,O**
	s	1,76	2,77	1,93	2,88	2,29	O,R> E,U**
Bones (%)	x	8,41	8,32	8,17	8,06	7,36	E,U,R,O > P**
	s	0,78	0,91	1,05	0,65	0,57	
Skin (%)	x	3,40	3,67	3,53	3,69	3,75	-
	s	0,62	0,69	0,58	0,61	0,72	

** – P $\geq$ 0,01

The average percentage of meat in carcasses, determined with Ultra Fom, varied from 58.19% in class E to 38.21% in class P. The highest differences between the mean values for particular classes were noted between classes E and U, and O and P over 5%. Their statistical significance was confirmed by an analysis of variance. The data included in Table 4 show that the lightest carcasses belonged to classes E and U, and the highest – to classes R, O and P. An analysis of variance indicated statistically highly significant and significant differences between the mean values for groups. Despite large differences in the weight of carcasses representing particular EUROP classes, the weights of hams without knuckles did not differ significantly. Carcasses belonging to lower EUROP classes were characterized by a lower meat content of hams (on average by ca. 2.5%) and higher fatness (by ca. 2%). The differences between the mean values for classes were confirmed statistically.

While analyzing the data presented in Table 5**,** it should be kept in mind that they concern the average percentage of meat in carcasses classified in the EUROP system on the basis of measurements taken with DLC. The average percentage of meat in carcasses varied from 57.37% in class E to 39.73% in class P. The difference between the mean values for particular classes was on average 4.5%. The highest carcasses belonged to class P, and lighter – to the other classes. The differences between the mean values for carcasses were confirmed statistically. As regards the weights of hams without knuckles, the experimental carcasses classified in the EUROP system with DLC did not differ significantly. An analysis of the tissue composition of hams shows that carcasses belonging to lower EUROP classes were characterized by a lower meat content of hams (on average by ca. 4% between classes).

Table 5. **Lean meat content of carcasses and the tissue composition of hams from carcasses classified in the EUROP system with DLC.**

Specification	Statistical Measures	Classes E	U	R	O	P	Statistical significance of differences between means for groups
Number		31	60	34	3	1	
Percentage of lean meat in carcass (%)	x	57,37	52,75	47,56	43,23	39,73	E>U,R,O,P.**
	s	1,87	1,28	1,56	1,28		U>R,O,P.**
							R>O,P.**
							O>P.**
Hot carcass weight (kg)	x	80,84	81,46	84,97	84,17	100,00	P>E,U,R,O
	s	9,17	10,73	9,80	7,52		
Ham (kg)	x	9,72	9,46	9,65	9,07	10,70	-
	s	1,15	1,31	1,24	0,83		
Share in the ham Meat	x	78,04	74,06	70,49	69,34	64,18	E> P,O,R**
	s	2,40	3,10	2,46	1,61		U,R>P**
Fat (%)	x	10,43	13,90	18,02	19,81	23,71	P>E,U,R,O,**
	s	2,16	3,12	2,66	1,56		O>E,U**
							R>E**
Bones (%)	x	8,34	8,33	7,83	7,13	7,48	-
	s	0,76	0,83	0,92	0,34		
Skin (%)	x	3,19	3,72	3,66	3,72	4,64	P>E
	s	0,53	0,61	0,57	1,24		

For better illustration of the differences in carcass meatiness estimation between Ultra Fom and DLC, some carcass traits are presented in Figures 1 - 3. Figure 1 shows the average percentage of meat in carcasses estimated with both devices. The average carcass meatiness in classes P – U determined with DLC was slightly higher (up to 1%), compared with Ultra Fom. Only in class E carcass meatiness estimated with Ultra Fom was by 0.82 % higher. Figure 2 shows that the percentage of meat in hams was similar, or slightly higher, in carcasses from classes UROP graded with Ultra Fom compared with DLC. Another tissue element analyzed was the fat content of hams. Figure 3 shows that there were considerable differences in the fat content of carcasses belonging to particular EUROP classes. It should be noted that carcasses representing lower classes were characterized by higher fatness, irrespective of the fact whether the estimation was made with Ultra Fom or DLC. Hams from carcasses which according to DLC represented classes U - P contained more fat: from 1.5% in class U to almost 4% in class P, compared with the percentage of fat in hams from carcasses classified with Ultra Fom.

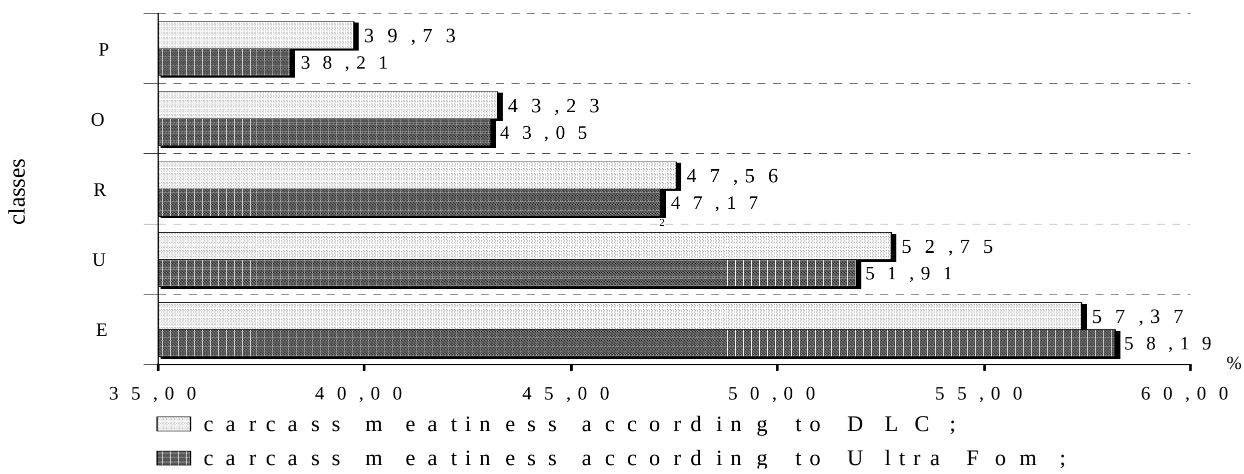

Fig. 1. **Average percentage of meat in pig carcasses belonging to particular EUROP classes, determined with Ultra Fom 100 and DLC**

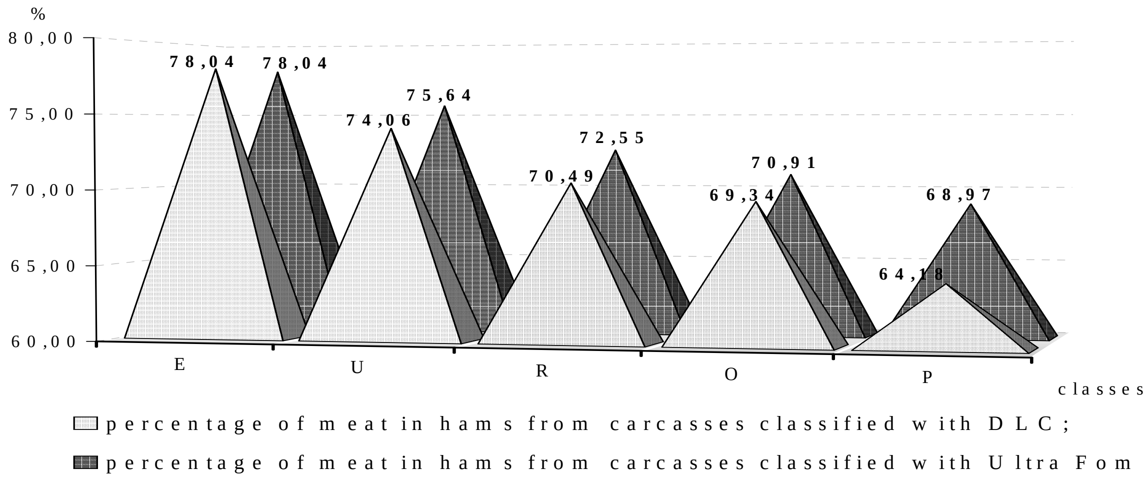

Fig. 2. **Percentage of meat in hams from carcasses belonging to particular EUROP classes, determined with Ultra Fom and DLC.**

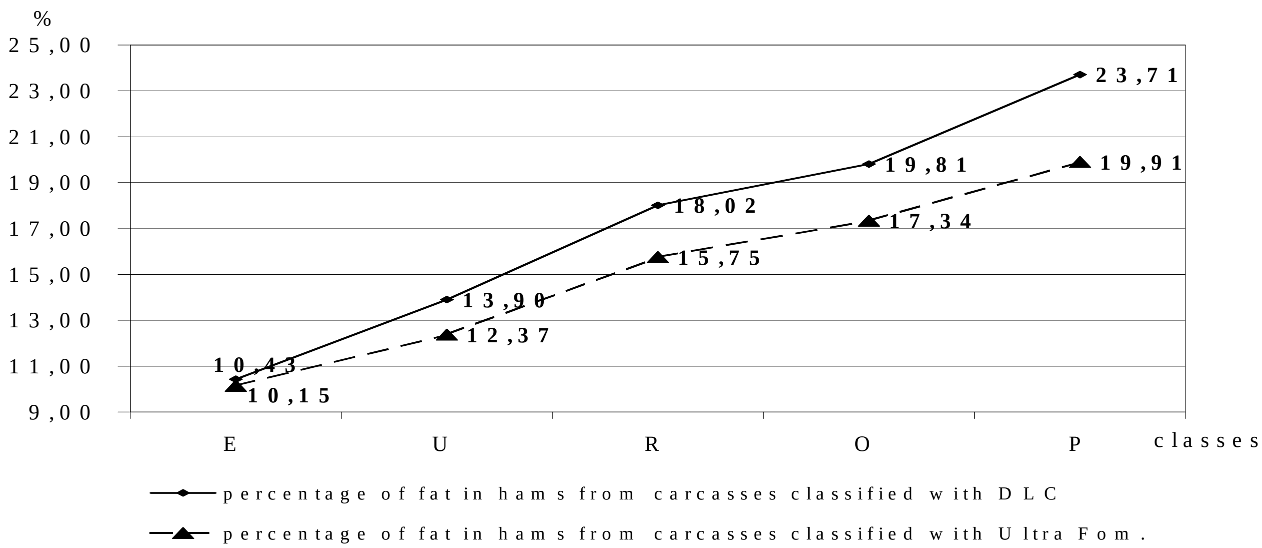

Fig. 3. **Percentage of fat in hams from carcasses belonging to particular EUROP classes, determined with Ultra Fom 100 and DLC.**

Conclusions

1. The fat content of hams, expressed in absolute values, was highly negatively correlated with carcass meatiness estimated with DLC (r = - 0.65) and Ultra Fom (r= - 0.74).

2. A high positive correlation was observed between the thickness of gluteal muscles measured with DLC and the meat content of hams, expressed in kg (r = 0.62). The correlation between the thickness of the dorsal muscle estimated with Ultra Fom and the meat content of hams was at a relatively low level.

3. An analysis of the tissue composition of hams shows that carcasses belonging to lower EUROP classes (measurement with Ultra Fom and DLC) were characterized by a lower meat content of hams and higher fatness. The fat content of hams from carcasses representing particular UROP classes determined with DLC was much higher compared with carcasses graded with Ultra Fom 100.

4. The differences in the percentage of meat in hams between particular EUROP classes estimated with Ultra Fom, were much smaller than in the case of its percentage in carcasses. A tendency like that was also observed in carcasses classified with DLC, but here the differences in the percentage of meat in hams were similar to those in its percentage in carcasses (ca. 4%).

5. The results obtained indicate that DLC may be applied for a post-slaughter evaluation of meatiness of pig carcasses. This is confirmed by high correlations between the meat and fat content of hams, and carcass meatiness determined with DLC, as well as the thickness of gluteal muscles and back fat over loin I and II measured with this device. However, it seems that only combination of several techniques (linear, ultrasonic) of carcass meatiness estimation would allow to limit, or even completely eliminate, measuring errors.

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