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The influence of the SEUROP grade and weight of pig carcasses on lean meat content evaluated using regression equations from 2003 and 2011

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An analysis was made of the differences between the lean meat content of pig carcasses estimated using the current regression equations and those in use in 2003. The influence of the slaughter value of the fattening pigs on these differences was examined as well. The research was performed on 180,988 pig carcasses from 7 slaughterhouses. The regression equations designed in 2011 for manual carcass classification equipment were found to yield 1.51 pp higher lean meat results than the equations used in 2003. Interaction between carcass lean meat class and carcass weight had a statistically significant impact on the size of these differences at $p \leq 0.001$. The lower the lean meat class and the lower the carcass weight, the greater were the differences between the estimates. The final form of the regression equations was influenced by the increased slaughter value of fattening pigs, changes in the testing procedure, and above all by a change in the formula used for calculating meat content in a dissected carcass.

KEY WORDS: pig carcasses / lean meat content / regression equations

Changes in the carcass quality of fattening pigs in the years 2003-2011 have resulted in the need to verify the regression equations for estimating the lean meat content of carcasses using classification devices used in Poland. The results of these studies were published in *Annals of Animal Science* [8]. A study by Zelenák et al. [14] demonstrated that regression equations should be adjusted for different genetic types of pigs when the carcass quality of the mass population of pigs changes. For this reason, each EU member state develops equations for its population, verifying them periodically as the quality of the material changes [6, 10]. In previous studies testing classification equipment, conducted in the years 2002-2003, the mean lean meat content of the carcasses selected for measurement was 52.8% [2], while the national average for carcasses monitored in the meat industry in 2002 was 50.3%, with an average carcass weight of 83.7 kg [7]. In

2011, when the next testing was carried out, the national average carcass meat content had reached 55.4% and their average weight had increased to 87.5 kg [9]. These facts indicate that in less than a decade the carcass quality of fatteners in Poland had improved significantly. Favourable changes in meat content are also confirmed by the results of the assessment of the breeding population of pigs in 2011 [1]. The average lean meat content of gilts ranged from 53.8% (Puławska x Polish Large White) to 62.9% (Pietrain), while that of boars ranged from 53.0% (Puławska) to 63.5% (Pietrain). The dominant breeds among breeding pigs are Polish Landrace and PLW; their average meat content in 2011 was 58.4% and 58.7%, respectively, in gilts and 59.8% and 60.0% in boars. In the production of fatteners, individuals obtained by crossing PLW x PL sows with boars of imported breeds predominate, in addition to crossbred pigs of specific breeding lines such as PIC and Pen-Ar-Lan. In recent years, the increasing share of piglets imported from the Netherlands, Denmark and other countries for fattening on domestic farms has been a major factor contributing to the increase in the meat content of fattening pigs. Another important reason for verifying the equations is changes in the procedures for testing the equipment used to evaluate meat content. In 2006, there was a change in the testing procedure involving the introduction of a new computational formula for determining the meat content of pig carcasses according to Walstra and Merkus [13]. Research conducted in Poland showed that the differences in the results of dissection using the old formula (binding in the EU until August 14, 2006) and the new one (as amended by the Commission Regulation of 7 August 2006) ranged from 1.5 to 2.0 pp of meat content, depending on the level of meat content and carcass weight [12].

The aim of the study was to determine the differences between estimation of the meat content of pig carcasses using the current regression equations [8] and equations from 2003 [2] and to examine the influence of the conformation grade and carcass weight of fatteners on these differences. Student's t-test was also used to verify the differences in means for pairs of objects of the old and new methods for individual weight groups within the meatiness classes.

Material and methods

The study material consisted of 180,988 carcasses from pigs slaughtered in the third quarter of 2011 at 7 different slaughterhouses. Measurements estimating the meat content of the carcasses were made using a CGM device with an optical probe at slaughterhouses A and B (n = 77,039), with an Ultra-Fom 300 ultrasonic device at slaughterhouses C and D (n = 56,139) and using an IM-03 apparatus with a needle-optical probe at slaughterhouses E, F and G (n = 47,810). Measurements of backfat thickness and the longissimus dorsi muscle were used to calculate the meat content in the pig carcasses using the 'old' [4] and 'new' [5] regression equations developed for these three devices, which are as follows:

$$LMC_{CGM\ old} = 50.11930 - 0.6241T_2 + 0.26979M_2$$

$$LMC_{CGM\ new} = 59.42 + 0.1322M_2 - 0.6275T_2$$

$$LMC_{Ultra\text{-}Fom\ 300\ old} = 49.88792 - 0.41858T_1 - 0.22302T_2 + 0.16050M_1 + 0.11181M_2$$

$LMC_{Ultra\text{-}Fom\ 300\ new} = 54.48 + 0.1272M_1 - 0.3090T_1 + 0.0828M_2 - 0.2802T_2$

$LMC_{IM\text{-}03\ old} = 45.07537 - 0.52724T_2 + 0.31380M_2$

$LMC_{IM\text{-}03\ new} = 60.55 + 0.1142M_2 - 0.6292T_2$

where:

T_1 – backfat thickness at the height of the last rib, 7 cm from the carcass division line, measured perpendicular to the longissimus dorsi (LD) muscle

M_1 – thickness of the LD muscle measured at the same point as T1

T_2 – backfat thickness between thoracic vertebrae 3 and 4, counted from the last rib, measured 6 cm (IM-03 and CGM) from the carcass division line, parallel to this line, or measured at a distance of 7 cm from the carcass division line, perpendicular to this line (Ultra-Fom 300)

M_2 – LD muscle thickness measured at the same point as T2

The results of the meat content calculations were compared between the equations given above in each carcass class (SEUROP) and in four different weight groups, i.e. 60-80 kg (group A), 80-90 kg (group B), 90-100 kg (group C) and 100-120 kg (group D).

Statistical analysis of the results of the measurements and calculations was performed, determining arithmetic means and standard deviation, and by two-way analysis of variance [11] for the factors of carcass class and weight group.

Results and discussion

The results of the meat content calculations for the fattening pigs divided into six classes (SEUROP) and four weight groups are presented in Table 1. Analysis of variance (Table 2) taking into account differences in the meatiness of carcasses estimated by the 'new' and 'old' regression equations showed that these differences were highly significantly influenced by the two experimental factors in the interaction of carcass weight group x carcass class ($F = 37.0$, $p < 0.001$). The average meat content calculated using the new regression equations was higher in all carcass classes ($p < 0.001$), while the influence of their weight decreased. In the case of heavy carcasses (100-120 kg) of class S and light carcasses (60-80 kg) of class P, these differences were not statistically significant. These correlations are shown in Figure 1. The greatest differences in meat content between carcass weight groups were noted in class U (2.08 pp), followed by classes R (1.78 pp) and E (1.78 pp). In grades S and O these differences decreased to 1.47 pp. and 0.96 pp, respectively, and in the fattest class P, to 0.10 pp.

Analysis of the effect of the carcass grades on differences in the estimation of meat content by the 'new' and 'old' regression equations reveals an increase in these differences as the quality grade of the carcass deteriorates. In class S, the differences were on average 0.84 pp, and then increased as meat content decreased, to 3.37 pp in class P, while in each class the meat content calculated using the new equations was significantly ($p < 0.0001$) hi-

Table 1
Mean meat content in pig carcasses evaluated using old and new regression equations, according to SEUROP class and weight group

SEUROP class	Carcass weight group	Number of carcasses	New equation		Old equation		Difference in lean meat content (p.p.)	Level of significance (p)
			mean lean meat content (%)	SD	mean lean meat content (%)	SD		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
S	A	10319	61.45	1.110	60.03	1.715	1.42	0.000
	B	13291	61.35	1.093	60.44	1.708	0.91	0.000
	C	10251	61.27	1.061	60.84	1.704	0.43	0.000
	D	2883	61.24	1.080	61.29	1.728	−0.05	0.188
E	A	20765	57.62	1.403	55.40	1.954	2.23	0.000
	B	33094	57.60	1.383	55.99	1.855	1.60	0.000
	C	29259	57.57	1.377	56.53	1.854	1.04	0.000
	D	11487	57.40	1.384	56.95	1.939	0.45	0.000
U	A	8286	52.99	1.378	49.99	2.006	3.00	0.000
	B	12600	53.02	1.373	50.74	1.877	2.28	0.000
	C	12124	52.99	1.372	51.32	1.901	1.67	0.000
	D	6666	52.86	1.406	51.94	2.106	0.92	0.000
R	A	1672	48.29	1.322	44.78	1.908	3.51	0.000
	B	2546	48.19	1.320	45.28	1.794	2.91	0.000
	C	2553	48.12	1.370	45.68	2.008	2.44	0.000
	D	1763	48.10	1.377	46.37	2.279	1.73	0.000
O	A	184	43.50	1.203	39.80	1.498	3.70	0.000
	B	347	43.35	1.255	39.84	1.530	3.51	0.000
	C	395	43.40	1.237	40.48	1.932	2.92	0.000
	D	383	43.28	1.250	40.54	2.223	2.74	0.000

1	2	3	4	5	6	7	8	9
P	A	18	28.04	7.134	24.78	6.456	3.25	0.160
	B	32	33.45	7.250	29.71	6.720	3.74	0.036
	C	27	36.97	4.524	33.62	4.547	3.36	0.009
	D	43	37.66	3.734	34.51	3.796	3.15	0.000
Means for weight groups	A	41244	57.20	3.790	54.96	4.554	2.24	0.000
	B	61910	56.99	3.710	55.33	4.395	1.66	0.000
	C	54609	56.69	3.748	55.55	4.427	1.14	0.000
	D	23225	55.60	4.115	54.94	4.833	0.66	0.000
Means for carcass classes	S	36744	61.34	1.090	60.50	1.753	0.84	0.000
	E	94605	57.57	1.387	56.15	1.954	1.43	0.000
	U	39676	52.98	1.381	50.96	2.054	2.02	0.000
	R	8534	48.17	1.349	45.53	2.057	2.64	0.000
	O	1309	43.37	1.242	40.23	1.901	3.14	0.000
	P	120	34.94	6.464	31.57	6.268	3.37	0.000

Carcass weight group: A − 60-80 kg, B – 80-90 kg, C − 90-100 kg, D − 100-120 kg

Table 2
Results of variance analysis for differences in lean meat content of pig carcass evaluated using new and old regression equations

Specification	Number of degrees of freedom	Sum of squares of deviations	Mean square of deviations	F	p
Meat content class	5	96058.5	19211.7	22307.4	0.001
Weight group	3	4389.0	1463.0	1698.7	0.001
Class x group interaction	15	478.5	31.9	37.0	0.001

gher. Carcass weight had a slightly smaller effect on differences in meat content. The heavier the carcasses, the smaller the differences were: 2.24 pp for light carcasses (60-80 kg) and 0.66 pp for heavy carcasses (100-120 kg).

The results of the study show a very highly statistically significant difference ($p < 0.001$) between the meat content of the carcasses estimated using the 'old' and 'new' regression equations developed for the three classification devices used in Poland. The difference amounts to an average of 1.51 pp for the entire population of pigs in favour of the new equations. The difference is dependent on the interaction of the two test factors, i.e. carcass class and carcass weight ($p < 0.001$). As shown in Table 1, the difference is on average about 3.0 pp among fatty carcasses (grades P, O and R), from 1.5 to 2.0 pp in the group of meaty carcasses (grades U and E), and about 0.8 pp for the highly meaty carcasses (class S). The magnitude of the differences in the meat content estimated in different ways depends on the carcass weight. The lighter the carcasses, the higher the meat content estimated by the new regression equation in comparison with the meat content calculated using the 2003 equation; for example, for carcasses weighing 60-80 kg the difference was on average 2.24 pp, while for carcasses weighing 100-120 kg it was 0.66 pp. Only in two cases did the difference in the subgroups prove to be statistically non-significant, i.e. in the subgroup of heavy (100-120 kg) grade S carcasses ($p = 0.219$) and the subgroup of light (60-80 kg) grade P carcasses $p = 0.161$). In the latter case, the result was probably due to the small size of the subgroup ($n = 18$).

The differences in the estimation of meat content indicate that the carcass quality of the fatteners had a strong influence on the regression equations selected for testing the equipment. Carcasses with an average meat content of 52.8% and an average weight of about 80 kg were used to develop the 'old' equations [2], whereas carcasses with 55.1% meat content and a weight of 88 kg were used for the verification dissection [8]. The effect of carcass quality on the regression equations is confirmed by studies by international teams of researchers [6, 10] as well as a Hungarian study [14]. The regression coefficients obtained in the equations are dependent on the degree of correlation of the features examined

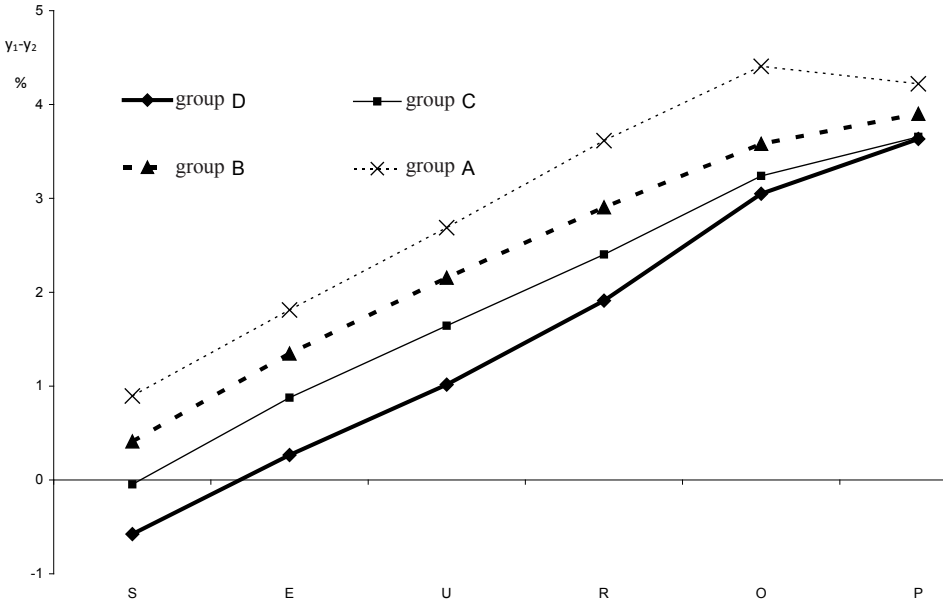

Fig. 1. Graphical characterization of the difference between the new (y_1) and old (y_2) regression equations, depending on the class and weight group of pig carcasses

and their variability. As the pig population improves, the variability of parameters defining carcass quality decreases and regression equations developed using such material are more accurate. It is difficult to explain the difference between the results of the estimation of meatiness by the 'new' and 'old' equations depending on the weight of the carcasses. In the heaviest carcasses, this difference was only 0.66 pp, while in the group of light carcasses (60-80 kg) it was as much as 2.24 pp. These disparities may have been affected by a change in the equipment testing procedure implemented in the European Union in 2006. The formulas used to determine the meat content in a half-carcass during dissection vary quite significantly, as can be seen by comparing them [3, 13]:

Y old formula = 1.3 x 100 x (X + Z) : A

Y new formula = 0.89 x 100 x (X + Z) : B,

where:

X – weight of tenderloin
Z – weight of lean meat of ham, shoulder, loin and belly
A – weight of 12 half-carcass cuts
B – weight of tenderloin, ham, shoulder, loin and belly

Table 3
Results of monitoring of the slaughter value of fattening pigs from the domestic population

Specification	Year		
	2011	2012	March 2014
	before change in regression equations	after change in regression equations	
Mean lean meat content (%)	55.4	56.6	57.0
Mean carcass weight (kg)	87.5	90.0	91.9
Percentage of class S	11.0	15.8	18.5
Percentage of class E	48.6	57.1	58.3
Percentage of class U	30.6	22.5	19.6
Percentage of class R	8.0	4.0	3.2
Percentage of class O	1.5	0.5	0.3
Percentage of class P	0.3	0.1	0.1

The equations have different conversion factors (1.3 and 0.89), as well as different data in the denominators (in the old equation the weight of all cuts, and in the new one the weight of only 5 cuts of the half-carcass). Wajda et al. [12] calculated that the mean dissected meat content, determined in material of inferior quality than that used in the present study, was 50.7% in a comparable carcass weight group (above 85 kg) when the old formula was used and 52.1% when the new formula was used. Thus the difference in meat content was 1.4 pp. The authors of the study [12] also observed that the differences were significantly affected by the weight of the carcasses, i.e. the differences decreased as the carcass weight increased ($p < 0.01$).

The differences in the results of meat content assessment can be tested using the data from monitoring of the carcass quality of fatteners, collected and analysed for all of Poland by the Integrated Agricultural Market Information System of the Ministry of Agriculture and Rural Development [9]. Some of the data from these analyses are presented in Table 3 and illustrated in Figure 2. In 2011, meat content was calculated using the 'old' regression equations, while the 'new' equations have been used since 2012. We can see that the meat content of the carcasses had increased by 1.2 pp in 2012, which is slightly less than in the results obtained in our study. This may have been because the monitored

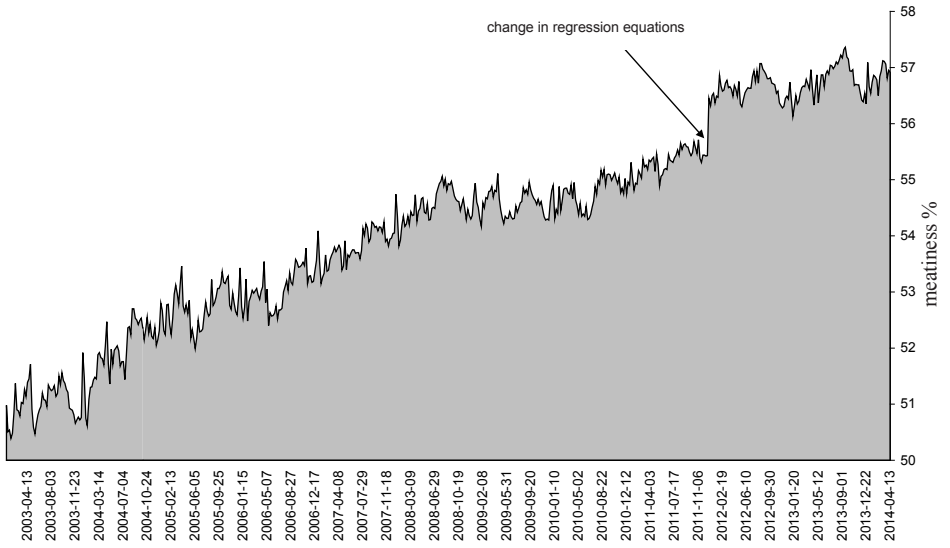

Fig. 2. Results of monitoring of the lean meat content of domestic pigs in 2003-2014 (by ZSRIR, Rynek wieprzowiny)

carcasses had a higher average weight (90 kg) than the experimental carcasses. In March 2014, however, the difference increased to 1.6 pp, indicating further improvement in the carcass quality of pigs in the country. The current class breakdown of carcasses of fattening pigs from the Polish mass population has reached a high level, as carcasses in grades S, E and U account for 96.4%, and fatty carcasses for only 3.6%. The ten-year period of increasing meat content is well illustrated by the data presented in Figure 2. In 2003-2014, the average meat content of domestic fatteners increased from about 51% to about 57%. Figure 2 shows a marked increase in meat content (by about 1.5 pp) from 2012, i.e. since the change in the regression equations.

To sum up, the 'new' regression equations developed in 2011 and implemented in the meat industry at the end of that year estimate the meat content of pig carcasses on average 1.51 pp higher than the 2003 equations. The magnitude of these differences is significantly affected by the interaction of carcass grade x carcass weight ($p < 0.001$). The lower the SEUROP grade and the lighter the carcass, the greater the differences in the estimation. The change in the regression equation formula was necessitated by the increase in the carcass quality of the pigs, as well as by the change in the procedure for testing pork grading

instruments, and above all by the modification of the formula for calculating the meat content of a half-carcasses during dissection.

REFERENCES

1. BLICHARSKI T., PTAK J., SNOPKIEWICZ M., 2012 – Genetic results 2012. Pigs. Polish Pig Breeders and Producers Association ”POLSUS”.
2. BORZUTA K., RASMUSSEN M.K., BORYS A., LISIAK D., OLSEN E.V., STRZELECKI J., KIEN S., WINARSKI R., PIOTROWSKI E., GRZEŚKOWIAK E., POSPIECH E., 2004 – Elaboration of regression equations for estimation of pig carcass meatiness using Ultra Fom 300 and CGM. ***Roczniki Instytutu Przemysłu Mięsnego i Tłuszczowego*** XLI, 95-108.
3. Commission Regulation (EC) No 1197/2006 of 7 August 2006 amending Regulation (EEC) No 2967/85 laying down detailed rules for the application of the Community scale for grading pig carcasses.
4. Decyzja Komisji 2005/240/WE z dnia 11 marca 2005 r. zatwierdzająca metody klasyfikacji tusz wieprzowych w Polsce.
5. Decyzja Wykonawcza Komisji 2011/506/UE z dnia 16 sierpnia 2011 r. zmieniająca decyzję 2005/240/WE zatwierdzającą metody klasyfikacji tusz wieprzowych w Polsce.
6. ENGEL B., LAMBOOIJ E., BUIST W.G., VEREIJKEN P., 2012 – Lean meat prediction with HGP, CGM, and CSB – Image – Meater, with prediction accuracy evaluated for different proportions of gilts, boars and castrated boars in the pig population. ***Meat Science*** 90, 338-344.
7. LISIAK D. BORZUTA K., JANKOWSKI M., 2004 – Wyniki monitoringu mięsności tusz tuczników pogłowia masowego. ***Gospodarka Mięsna*** 8, 18-20.
8. LISIAK D., BORZUTA K., JANISZEWSKI P., MAGDA F., GRZEŚKOWIAK E., STRZELECKI J., POWAŁOWSKI K., LISIAK B., 2012 – Verification of regression equations for estimating pork carcass meatiness using CGM, IM-03, Fat-o-Meat’er II and Ultra-Fom 300 devices. ***Annals of Animal Science*** 4, 585-596.
9. Ministerstwo Rolnictwa i Rozwoju Wsi, Departament Rynków Rolnych. Zintegrowany System Rolniczej Informacji Rynkowej. Rynek mięsa wieprzowego nr 21/2013 (http:www. minrol.gov.pl).
10. NISSEN P.M., BUSK H., OKSAMA M., SEYNAEVE M., GISPERT M., WALSTRA P., HANSSON I., OLSEN E., 2006 – The estimated accuracy of the EU references dissection method for pig carcass classification. ***Meat Science*** 73, 22-28.
11. StatSoft, Inc., 2005 – Statistica – data analysis software system, version 7.1. www. statsoft. com
12. WAJDA S., BORZUTA K., WINARSKI R., BURCZYK E., 2008 – Effect of the new EU reference dissection method on pig carcass classification. ***Roczniki Naukowe Polskiego Towarzystwa Zootechnicznego*** 4 (2), 125-131.

13. WALSTRA P., MERKUS G.S.M., 1996 – Procedure for assessment of the lean meat percentage as a consequence of the new UE reference dissection method in pig carcass classification. Raport ID-DLO 96.014 Res. Inst. An. Sci. and Health, Zeist, Netherland.
14. ZELENÃK L., KORMENDY L., VADA-KOVACS M., 2005 – The effect of animal types on a simple control method used in the calibration procedure for assessing lean content in pig carcasses. ***Journal of Food Engineering*** 69**,** 351-358.