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POSSIBILITIES OF USING ULTRASONOGRAPHY IN BREEDING WORK WITH PIGS. PART II – RELATIONSHIPS BETWEEN MEASUREMENTS OBTAINED BY DIFFERENT TECHNIQUES AND DETAILED DISSECTION RESULTS

Mirosław Tyra, Magdalena Szyndler-Nędza, Robert Eckert

Department of Animal Genetics and Breeding, National Research Institute of Animal Production, 32-083 Balice n. Kraków, Poland

Abstract

The aim of the study was to determine the relationship between groups of measurements obtained using different techniques, their dissection counterparts, and carcass meat and fat content. Subjects were 476 gilts of the Polish Large White (n = 151), Polish Landrace (n = 149), Pietrain (n = 84) and Duroc (n = 92) breeds tested in Polish Pig Performance Testing Stations (SKURTCh) and slaughtered at 100 kg body weight. The measurement techniques under analysis were ultrasound measurements used in live testing (PIGLOG 105) and ultrasonographic measurements (ALOKA SSD 500 with a linear probe) taken on live animals and postmortem. Dissection measurements (taken with a caliper and planimeter) and detailed dissection results for weight of meat and fat and their percentage in carcass served as a reference point for these groups of measurements. The relationships found between analogous points were high (0.7–0.9) and the groups of measurements were in the order of postmortem ultrasound measurements > live ultrasonographic measurements > ultrasound measurements. Based on the analysis of the results obtained, it is concluded that ultrasonographic measurements of backfat thickness (U4P, U4D), loin eye area (UOP, UOD) and loin eye height (UWD) are best suited for estimating the meat weight of primal cuts and percentage meat content. Fat weight of primal cuts and carcass fat percentage are best determined by ultrasonographic measurements of backfat thickness (U2P, U2D, U4P, U4D) and fat area (UTP, UTD).

Key words: pig, ultrasonographic measurements, dissection measurements, correlations, ALOKA, PIGLOG

Recent years have seen a remarkable development of ultrasonography – a diagnostic technique used in human and veterinary medicine as well as animal breeding. The possibility of making simple measurements on images frozen on the screen and the accuracy of these measurements enable this type of equipment to be used for live measurements of animals. The practical value of ultrasonographic measurements is determined by noninvasiveness, precision, repeatability of the results, and above all the relationships (correlations) between such measurements and actual (postmortem) measurements or carcass meat and fat content. Many studies of this type have been performed with cattle and sheep, but relatively few with pigs. Special consideration should be given to a paper by Gruszecki (1999), who summarized phenotypic correlations between ultrasonographic measurements and postmortem carcass measurements estimated by different authors in sheep. These correlations range from $r_p = 0.37$ to $r_p = 0.79$ for depth of *m. longisismus dorsi* and from $r_p = 0.40$ to $r_p = 0.87$ for fat depth over loin eye. A similar comparison was made by McLaren at al. (1991) for cattle and pigs, in which the highest coefficients of correlation were found between ultrasonographic measurements of cross-sectional area of *m. longissimus dorsi* and carcass cuts in cattle (0.58–0.87), and of ultrasonographically measured backfat thickness and carcass cuts in pigs (0.55–0.89). Similar findings were reported by Komender et al. (1994), who estimated correlations between carcass meat content and ultrasonographic measurements of live animals. According to these authors, the correlation between carcass meat content and backfat thickness was $r_p = –0.696$, and that between loin eye height and backfat thickness $r_p = 0.467$. The ultrasonographic devices used by these authors were A-mode instruments and were associated with larger error because of measuring limitations. It was not until the introduction of real-time B-mode scanners that operators could keep track of changing images. This made live measurement of animals more objective because the operators of B-mode scanners are able to choose the optimum image to be captured. Because of these solutions, image dimensioning results should be more reliable. The relatively small number of studies involving this technique in pigs also resulted from the lack of a proper measuring probe to capture cross-section of *m. longissimus dorsi* in its entirety. It was not until the introduction of a UST-5011U 3.5 MHz, 12.5 cm linear transducer that studies of this type became feasible.

These technical solutions, coupled with rapidly developing digital video, digital photography and computer-assisted digital image processing, make it possible to record high-quality images and losslessly feed them into the computer. Because of dedicated measurement software, the images archived on data storage media allow the thickness of backfat and the height, width, cross-sectional area and circumference of *m. longissimus dorsi* to be dimensioned. It also enables dimensioning with simultaneous calculation of the area of any shape on the image. The increased accuracy of such measurements should translate into higher correlations between these measurements and actual meat content (Thériault et al., 2009).

The aim of this study is an attempt to determine if ultrasonographic technique based on the latest solutions (ALOKA SSD 500 with software for digital image analysis) is suited for research in animals, including pigs. The practical usefulness will be confirmed by the correlations estimated between groups of measurements obtained using different techniques (ultrasound, ultrasonography) and actual dissection results. The usefulness of this measurement technique for breeding work will be validated by the correlations between these measurements, meat or fat weight, and their percentage in primal cuts or in carcass.

Material and methods

Subjects were gilts (100 kg b.w.) tested in Polish Pig Performance Testing Stations (SKURTCh). A total of 476 animals representing Polish Large White (n = 151), Polish Landrace (n = 149), Pietrain (n = 84) and Duroc (n = 92) breeds were investigated. Animals were fasted a day before slaughter, subjected to body weight and live measurements on the day of slaughter, and to dissection measurements after slaughter. The following live measurements were taken:
ultrasound measurements with a PIGLOG 105 device:
P2 – backfat thickness behind the last rib, 3 cm off the mid-line,
P4 – backfat thickness behind the last rib, 8 cm off the mid-line,
P4M – loin eye height at P4,
ultrasonographic measurements with an ALOKA SSD 500 device and model UST-5011U 3.5 MHz, 12.5 cm linear transducer:
U2P – backfat thickness at P2,
U4P – backfat thickness at P4,
UWP – height of *m. longissimus dorsi* at P4,
USP – width of *m. longissimus dorsi*,
UOP – cross-sectional area of *m. longissimus dorsi*,
UTP – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*.

Animals were slaughtered at 100 kg body weight. After 24-h chilling at 4°C, half-carcasses were again measured ultrasonographically for:
ultrasonographic postmortem measurements with an ALOKA SSD 500 device, taken analogously to live measurement sites:
U2D – backfat thickness at P2,
U4D – backfat thickness at P4,
UWD – height of *m. longissimus dorsi* at P4,
USD – width of *m. longissimus dorsi*,
UOD – cross-sectional area of *m. longissimus dors*i,
UTD – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*.

Right half-carcasses were subjected to several measurements of backfat thickness with calipers, accurate to within 0.01 cm. The contour of the *longissimus* muscle section was traced using plastic film or wax paper on loin at the intersection of the last thoracic vertebra and the first lumbar vertebra, on the cephalic plane. Height and width of *m. longissimus dorsi* was measured on this contour and loin eye area was planimetered. The following measurements were obtained during the dissection:
dissection measurements:
D2 – backfat thickness at D2 (equivalent to measurements of **P2**, **U2P** and **U2D**),
D4 – backfat thickness at D4 (equivalent to measurements of **P4**, **U4P** and **U4D**),
DW– height of *m. longissimus dorsi* (equivalent to measurements of P4M, UWP and UWD),
DS – width of *m. longissimus dorsi* (equivalent to measurements of **USP** and **USD**),
DPO – planimetered loin eye area (equivalent to measurements of **UOP** and **UOD**).

Next, the half-carcasses were cut and all the half-carcass cuts were weighed with an accuracy of 5 g. The primal cuts obtained (neck, shoulder, ham, loin, belly,

knuckle) were subjected to detailed dissection into tissues to estimate carcass meat percentage. The following detailed dissection measurements were obtained:
detailed dissection measurements:
MWP – weight of primal cuts of the carcass,
MMWP – meat weight of primal cuts of the carcass,
MTWP – fat weight of primal cuts of the carcass.

The animal management and measurement methods were detailed in an earlier study (Tyra et al., 2010).

Statistical analysis was performed using the GLM and COR procedure of the SAS statistical package (1989). The measurements obtained were used to estimate basic statistical parameters (means, deviations, coefficients of variation) for the weight of most valuable half-carcass cuts and for the weight of meat and fat from these cuts. The statistical model used in the calculations included the following effects:

$$Y_{ijkl} = \mu + d_i + f_j + \alpha(x_{ijk}) + e_{ijkl}$$

where:
y_{ijkl} – ijklth observation,
μ – overall mean,
d_i – effect of ith breed,
f_j – effect of jth sire,
$\alpha(x_{ijk})$ – covariance on right half-carcass weight,
e_{ijkl} – random error.

Differences between the means for individual breeds were tested at the level of 5% and 1% using Duncan's multiple range test. In addition, the COR module was used to estimate the following relationships between the measurements analysed:
– correlations between dissection measurements and their equivalents obtained using different measurement techniques,
– correlations between measurements of backfat thickness and *m. longissimus dorsi* obtained using different measurement techniques (as above) and weight and percentage of carcass meat and fat.

Results

Table 1 presents data on the mean weight of primal cuts of the pig carcasses and the mean weight of meat and fat in these cuts. The total weight of carcass cuts from gilts of all breeds averaged 35.0 kg, including 22.2 kg of meat and 5.31 kg of fat. The tabular data indicate that weight of the cuts was highest in Pietrain gilts (36.0 kg) and lowest in Polish Large White (34.6 kg) and Polish Landrace gilts (34.8 kg). The weight of cuts from Pietrain gilts was mainly due to the increased amount of meat in the primal cuts. The amount of meat in primal cuts was the highest in the Pietrain breed (24.9 kg) and the lowest in the Polish Large White breed (21.3 kg). The highest amount of fat in the cuts was found in Duroc (5.74 kg) and the lowest in Pietrain animals (4.14 kg).

Table 1. Mean values for weight of primal cuts and weight of meat and fat from primal cuts of the carcass

Measurements	Breeds	x	δ	min – max	v
MWP (kg)	PLW	34.6 B	1.04	31.9–37.3	3.01
	PL	34.8 A	1.09	31.8–37.9	3.13
	Pietrain	36.0 ABC	1.31	33.2–39.2	3.63
	Duroc	35.0 C	1.14	32.2–36.9	3.26
	TOTAL	35.0	1.24	31.8–39.2	3.54
MMWP (kg)	PLW	21.3 B	1.74	17.9–25.5	8.16
	PL	21.5 A	1.62	17.3–25.3	7.53
	Pietrain	24.9 ABC	1.65	20.6–29.1	6.62
	Duroc	21.8 C	1.37	18.6–25.4	6.27
	TOTAL	22.2	2.11	17.3–29.1	9.50
MTWP (kg)	PLW	5.49 C	1.02	1.20–8.23	18.58
	PL	5.59 B	0.96	1.20–7.36	17.17
	Pietrain	4.14 ABC	0.80	1.73–6.18	19.32
	Duroc	5.74 A	0.85	3.42–7.26	14.81
	TOTAL	5.31	1.04	1.20–8.32	19.59

Values with the same letters indicate significant differences between the breeds (A, B... = $P \leq 0.01$, a, b … = $P \leq 0.05$), MWP – weight of primal cuts, MMWP – weight of meat of primal cuts, MTWP – weight of fat of primal cuts.

Table 2 shows the coefficients of phenotypic correlations between the dissection measurements of backfat thickness, height and width of *m. longissimus dorsi*, loin eye area and fat over loin eye area, and their equivalents measured using different techniques. All relationships for analogous points measured using different techniques (marked diagonally with darker colour) were highly significant ($P \leq 0.01$). The relationships between ultrasonographic measurements taken on images recorded after slaughter and their equivalents taken during dissection were the highest and much in excess of $r_p = 0.6$. The correlations in this group of measurements ranged from $r_p = 0.625$ (between measurements of loin eye area DPO and UOD) to $r_p = 0.793$ (between measurements of backfat thickness D4 and U4D). Analogous ultrasonographic measurements taken on live animals showed slightly higher relationships exceeding $r_p = 0.5$. The highest relationships in this group of measurements were found between loin eye height UWP and DW ($r_p = 0.674$), and the lowest between loin eye width USP and DS ($r_p = 0.515$). The relationships between live measurements of backfat thickness taken using a PIGLOG 105 device and dissection measurements were at a similar level to the correlations for live measurements made with an ALOKA instrument. The highest correlations in this group of measurements were observed for backfat thickness at P4 and its dissection equivalent D4 (r_p = 0.612), and slightly lower for the pair of P2 and D2 (r_p = 0.590). For muscle thickness at P4M, the lowest coefficient of correlation with the analogous dissection measurements was found (r_p = 0.462).

Table 2. Coefficients of phenotypic correlations (r_p) between dissection measurements and their equivalents obtained using different measurement techniques

Measurements		Dissection measurements				
		D2	D4	DW	DS	DPO
Ultrasonographic measurements on image recorded postmortem (ALOKA 500 SSD)	U2D	.659	.574	-.027	-.140	-.282
	U4D	.515	.793	-.080	-.139	-.449
	UWD	-.101	-.261	.737	.311	.582
	USD	-.103	-.181	.215	.651	.340
	UOD	-.112	-.443	.482	.312	.625
	UTD	.473	.532	-.363	-.273	-.593
Ultrasonographic measurements on image recorded live (ALOKA 500 SSD)	U2P	.567	.474	-.056	-.089	-.182
	U4P	.451	.635	-.076	-.112	-.374
	UWP	-.093	-.226	.674	.251	.428
	USP	-.087	-.121	.227	.515	.351
	UOP	-.116	-.374	.348	.341	.552
	UTP	.347	.453	-.236	-.269	-.459
Live measurements (PIGLOG 105)	P2	.590	.533	-.038	-.146	-.044
	P4	.545	.612	-.052	-.165	-.062
	P4M	-.098	-.217	.462	.295	.457

P2 – backfat thickness behind the last rib (at the junction of the thoracic and lumbar vertebrae), 3 cm off the midline, P4 – backfat thickness behind the last rib (at the junction of the thoracic and lumbar vertebrae), 8 cm off the midline, P4M – loin eye height at P4, UWP – height of *m. longissimus dorsi* at P4, USP – width of *m. longissimus dorsi*, U2P – backfat thickness at P2, U4P – backfat thickness at P4, UOP – cross-sectional area of *m. longissimus dorsi*, UTP – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*, UWD – height of *m. longissimus dorsi*, USD – width of *m. longissimus dorsi*, U2D – backfat thickness at P2, U4D – backfat thickness, equivalent to live backfat thickness measurement point P4, UOD – cross-sectional area of *m. longissimus dorsi*, UTD – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*, DW – height of *m. longissimus dorsi*, DS – width of *m. longissimus dorsi*, D2 – backfat thickness at P2, D4 – backfat thickness at P4, DPO – planimetered loin eye area.

Low and non-significant correlations were obtained between height and width of *m. longissimus dorsi* determined during dissection and U2D and U4D backfat thickness on ultrasonographics images. No significant correlations were also observed between the measurements of loin (UWD, USD, UOD) and backfat thickness measured by dissection at D2.

Table 3. Correlations between measurements of backfat thickness and *m. longissimus dorsi* taken using different measurement techniques and carcass meat and fat weight and percentage

Measurements		Weight of meat	Weight of fat	Carcass meat (%)	Carcass fat (%)
Dissection measurements (detailed dissection)	D2	- .489	.757	- .754	.751
	D4	- .452	.730	- .712	.747
	DS	.686	- .563	.609	- .439
	DW	.637	- .574	.572	- .453
	DPO	.789	- .585	.681	- .642
Live measurements (PIGLOG 105)	P2	- .572	.691	- .713	.723
	P4	- .496	.658	- .683	.682
	P4M	.533	- .389	.523	- .385
Ultrasonographic measurements on image recorded using ALOKA 500 SSD live	U2P	- .513	.617	- .531	.603
	U4P	- .537	.680	- .711	.681
	UWP	.579	- .585	.534	- .376
	USP	.411	- .279	.407	- .207
	UOP	.668	- .492	.633	- .548
	UTP	- .542	. 639	- .518	.617
postmortem	U2D	- .546	.634	- .557	.645
	U4D	- .552	.692	- .714	.702
	UWD	.591	- .543	.569	- .365
	USD	.485	- .320	.473	- .316
	UOD	.704	- .557	.651	- .543
	UTD	- .560	.686	- .548	.673

P2 – backfat thickness behind the last rib (at the junction of the thoracic and lumbar vertebrae), 3 cm off the midline, P4 – backfat thickness behind the last rib (at the junction of the thoracic and lumbar vertebrae), 8 cm off the midline, P4M – loin eye height at P4, UWP – height of *m. longissimus dorsi* at P4, USP – width of *m. longissimus dorsi*, U2P – backfat thickness at P2, U4P – backfat thickness at P4, UOP – cross-sectional area of *m. longissimus dorsi*, UTP – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*, UWD – height of *m. longissimus dorsi*, USD – width of *m. longissimus dorsi*, U2D – backfat thickness at P2, U4D – backfat thickness, equivalent to live backfat thickness measurement point P4, UOD – cross-sectional area of *m. longissimus dorsi*, UTD – cross-sectional area of fat over loin eye area of *m. longissimus dorsi*, DW – height of *m. longissimus dorsi*, DS – width of *m. longissimus dorsi*, D2 – backfat thickness at P2, D4 – backfat thickness at P4, DPO – planimetered loin eye area.

Table 3 shows the correlations between backfat thickness and *m. longissimus dorsi* measurements taken using different techniques, and carcass meat and fat weight and their percentage in primal cuts or in carcass. All the correlation coefficients were highly significant ($P \leq 0.01$). Of the measurement techniques investigated, the highest correlations with both meat and fat weight and their percentage in primal cuts or in carcass were found for dissection measurement points. Slightly lower values were observed for the ultrasonographic technique that used images recorded on half-carcass after slaughter, and similar values were found for live and ultrasonographic measurements obtained from images recorded on live animals. For dissection measurements, the highest relationships were found between D2 and D4 backfat thickness, carcass fat weight and percentage, and carcass meat percentage, where the correlations exceeded $r_p = 0.7$. The measurements of height and width of *m. longissimus dorsi* were highly correlated with meat weight and meat percentage, but to a lesser extent than the measurement of loin eye area (DPO), for which these correlations were $r_p = 0.789$ and $r_p = 0.681$, respectively.

The measurement of P2 backfat thickness showed the highest correlation with carcass meat ($r_p = –0.713$) and fat percentage ($r_p = 0.723$), and with fat weight ($r = 0.691$). The lowest correlations were characteristic of the ultrasound measurements of muscle thickness. Live measurements of the thickness of *m. longissimus dorsi* (P4M) correlated most highly with dissection weight of meat ($r_p = 0.533$) and carcass meat percentage ($r_p = 0.523$).

Discussion

The usefulness and practical applicability of ultrasonographic instruments in animal breeding can be determined first of all based on the relationship between ultrasonographic measurements of backfat and muscle thickness on the carcass and analogous measurements made during dissection of half-carcasses. In the case of postmortem measurements of backfat thickness, the highest correlations in the present study were obtained between ALOKA measurements (U4D) and linear dissection measurements (D4). This result is close to the findings of Lopes et al. (1987), who obtained correlations higher than $r_p = 0.80$ for the same measurement sites in different breeds of pigs, and agrees with the findings of Moeller et al. (1998), who observed higher correlations between backfat thickness measured ultrasonographically and during dissection ($r_p = 0.84$). A higher relationship between ultrasonographic measurement of backfat thickness behind the last rib and its dissection counterpart was observed by Busk (1986), where this parameter was $r_p = 0.90$. In our study, the lower correlations between corresponding dissection (D2) and ultrasonographic points (U2D and U2P) are probably due to the problem of imaging in some high-lean animals (Pietrain and Duroc) (Tyra et al., 2010). This problem results from the construction of the measuring probe, which prevents close fitting of the probe to the surface measured on the animal's back. The inability to adjust these two surfaces is the reason for less accurate measurements at U2D and U2P, which are equivalents of the points measured during dissection (D2).

Analysis of the postmortem loin eye measurements showed that in this group of measurements, the correlations for height of *m. longissimus dorsi* measured with an ALOKA device (UWD) and determined by dissection (DW) were the highest ($r_p = 0.737$). The other relationships between these two measurement techniques concerning the width of muscle (USD and DS) and loin eye area (UOD and DPO) were slightly lower. Forrest et al. (1989) and Moeller et al. (1998) reported lower correlations for loin eye area measured ultrasonographically and by dissection (r_P = 0.58 and r_P = 0.68, respectively). The higher correlations obtained for our measurements compared to those reported by the authors cited above are due to the increased precision of measurement and the possibility of dimensioning the images obtained using specialist software. This possibility was not available to the above authors, whose equipment restricted the dimensioning to linear measurements on the display screen of the ultrasonographic device, while the loin eye measurement was limited to the possibility of placing a mask (having different degrees of elliptical shape) on such an image. For this reason, the results obtained using this method had relatively large errors. This is particularly true for the measurement of loin eye area, which had a direct effect on the level of the correlations with this measurement and the resulting differences, compared to our own results.

When analysing the coefficients of simple correlation between live measurements of backfat and *m. longissimus dorsi* thickness and postmortem measurements of backfat and *m. longissimus dorsi* thickness taken at corresponding half-carcass points, it was found that, as expected, the correlations were high at all measurement sites. These results are consistent with the findings of other authors (Moeler and Christian, 1998; Vilchez and Chavez, 1998), who reported the highest correlations of 10th rib backfat thickness and loin eye area measured *in vivo* with an ALOKA instrument with the measurements taken at corresponding sites after the gilts were slaughtered. These correlations were r_P = 0.69 and r_P = 0.76 for backfat thickness, and r_P = 0.57 and r_P = 0.55 for loin eye area, respectively. Also Szyndler-Nędza and Mucha (2005) and Vaclavovsky et al. (2002) obtained similarly high correlations when analysing the relationships between live measurements taken with a PIGLOG 105 device and analogous measurements performed during dissection of gilt carcasses. The relationships obtained for backfat measurements ranged from r_P = 0.59 for P2 (Szyndler-Nędza and Mucha, 2005) to r_P = 0.81 for P4 (Vaclavovsky et al., 2002). For the measurements of *m. longissimus dorsi*, these correlations were lower and ranged from r_P = 0.47 (Szyndler-Nędza and Mucha, 2005) to r_P = 0.45 (Vaclavovsky et al., 2002). As noted in the introduction, the PIGLOG 105 ultrasound device and most ultrasonographic devices produced in the 1980s and until the mid-1990s are A-mode instruments. B-mode instruments, including the ultrasonographic device used in the present study, have the advantage of allowing the observations of changing images in real time. This takes on special significance during measurements of live animals, because the operator can observe these changes as they happen and decide to grab (archive) the image that appears most often on the screen, thus making the data obtained more objective. This possibility is not available to the operator of A-mode instruments, who can only make a series of measurements and average the result obtained, or eliminate the extreme values of the measurements.

The measurement points correlated most strongly with the actual amount of meat or fat obtained during dissection or with carcass meat and fat percentage will be most useful in practice. Literature reports of a similar level of correlations of live backfat measurements with meat weight and carcass meat percentage as in our study (Cisneros et al., 1996; Vaclavovsky et al., 2002; Szyndler-Nędza and Różycki, 2004; Tait et al., 2005). Slightly higher coefficients of correlation between percentage of meat from primal cuts and ultrasonographic measurements (r_P = –0.75 for measurement point behind the last rib and r_P = –0.69 for measurement point over the first rib) were reported by Terry et al. (1998). As regards the relationship between measurements of *m. longissimus dorsi* obtained with an ALOKA instrument and carcass meat percentage, many authors showed lower correlations than those obtained in the present study. When measuring fattening pigs of different breeds, Liu and Stouffer (1995) obtained correlation coefficients of r_P = 0.21 between loin eye height and carcass meat content and of r_P = 0.35 between loin eye area and carcass meat content. Similarly low relationships for these measurements were obtained by Cisneros et al. (1996) and Tait et al. (2005) (r_P = 0.33 for loin eye area). The correlation obtained by Terry et al. (1998) for the measurement between loin eye area, measured ultrasonographically behind the last rib and carcass meat percentage (r_P = 0.62) was similar to our result. Only Hick et al. (1998) estimated a high correlation (r_P = 0.81) between *m. longissimus dorsi* thickness and carcass meat weight.

To evaluate the usefulness of the ultrasonographic measurement technique in relation to the ultrasound method (PIGLOG 105) that is currently used for live evaluation and dissection measurements for station testing, it would be necessary to analyse groups of correlations for analogous measurements. These analogous measurement groups are (P2<->U2P; D2<->U2D), (P4<->U4P; D4<->U4D), (P4M<->UWP; DW<->UWD), (DS<->USD) and (DPO<->UOD). Analysis of the results contained in Table 3 indicates that the measurements made on ultrasonographic images (ALOKA SSD 500) recorded postmortem were characterized by lower correlations in relation to the dissection analogues with meat and fat weight or percentage estimated based on detailed dissection (D2<U2D, D4<U4D, DW>UWD, DS>USD and DPO>UOD). When comparing coefficients of correlation for live measurements obtained with an ultrasonographic (ALOKA) and ultrasonic devices (PIGLOG), higher correlations were only found for measurement of P2 backfat thickness (P2>U2P). For the other two measurements, the ultrasonographic measurement technique gained an advantage (P4<U4P, P4M<UWP). The results obtained lead us to believe that at the present level of sophistication of ultrasonography, its use in place of station testing based on dissection to determine carcass fatness or muscling is not feasible because the results of such evaluation will probably be associated with greater error compared to dissection measurements. Such a replacement would be possible for the live measurement method, where it would increase the accuracy of estimating carcass fatness or muscling compared to the current measurement method based on ultrasonic measurements. In this case, the only objections can be raised against the lower correlations of ultrasonographic measurement for U2P in relation to the corresponding measurement point P2. However, as noted before, the low correlations for this measurement technique are due to technical reasons ("imperfect" measuring probe). The technical "imperfection" of the measuring probe resulting from the adaptation of the measuring device for animal measurements could be limited by using curved gel pads. This will ensure better alignment of the measuring surfaces at the cost of greater suppression of ultrasonic waves and less accurate in-depth imaging (Tyra et al., 2010). Probably, these two shortcomings could be eliminated by double imaging of the same measurement site. The first imaging, without a curved gel pad,

would be used for in-depth imaging and dimensioning of loin eye (area, height and width) and fat area. The second imaging with the curved gel pad would be used to obtain surface measurements (backfat thickness, etc.). However, the applicability of this measurement technique will be ultimately determined after analysing the possibility of developing accurate regression equations for estimating carcass meat content using these ultrasonographic measurements and after comparing their accuracy with that of the equations currently used in station and live testing, which will be the subject of further analysis.

In summary, it is concluded that of the measurement techniques under discussion, the highest correlations with carcass meat and fat weight and their percentage in primal cuts or in carcass were observed for the measurement points of the dissection method. For the ultrasonographic measurements performed on images recorded postmortem (ALOKA), these values were slightly lower. It is believed based on the results obtained that measurements of backfat thickness (U4P and U4D), loin eye area (UOP and UOD) and loin eye height (UWD) are most suitable for estimating carcass meat percentage using both live and postmortem ultrasonographic measurements (ALOKA). Measurements of backfat thickness (U2P, U2D, U4P, U4D) and fat area (UPT, UTD) will be most useful for determining carcass fat weight or percentage. At the present level of sophistication of ultrasonographic equipment, it would be beneficial to replace the current ultrasound measurement device (PIGLOG 105) used for live estimation with an ALOKA SSD 500 ultrasound instrument. This conclusion is supported by the higher correlations obtained for most of these measurements with carcass weight and percentage of meat and fat from primal cuts for ultrasonographic measurements (ALOKA) in relation to the analogous ultrasound measurements (PIGLOG). However, this statement will be validated by the regression equations for estimating carcass meat content based on these measurement points and their accuracy.

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MIROSŁAW TYRA, MAGDALENA SZYNDLER-NĘDZA, ROBERT ECKERT

Możliwości zastosowania techniki ultrasonograficznej (USG) w pracy hodowlanej nad trzodą chlewną. Cz. II – Zależności pomiędzy pomiarami wykonanymi różnymi technikami pomiarowymi a wynikami dysekcji szczegółowej

STRESZCZENIE

Celem badań było określenie zależności pomiędzy grupami pomiarów wykonanymi różnymi technikami pomiarowymi a ich odpowiednikami dysekcyjnymi oraz zawartością mięsa i tłuszczu w tuszy. Materiałem badawczym było 476 loszek następujących ras: wbp (151 szt.), pbz (149 szt.), Pietrain (84 szt.) i Duroc (92 szt.) ocenianych w stacjach kontroli (SKURTCh) i ubijanych po osiągnięciu masy ciała 100 kg. Analizowanymi technikami pomiarowymi były: pomiary ultradźwiękowe stosowane w ocenie przyżyciowej (PIGLOG 105), pomiary ultrasonograficzne (ALOKA SSD 500 z sondą liniową) dokonywane przyżyciowo i poubojowo. Punktem odniesienia dla tych grup pomiarów były pomiary dysekcyjne (pomiary wykonywane suwmiarką i planimetrem) oraz wyniki dysekcji szczegółowej określające masę mięsa i tłuszczu oraz ich procentowy udział w wyrębach podstawowych. Stwierdzone zależności pomiędzy punktami analogami były wysokie (pomiędzy 0,7–0,9) a grading grup pomiarów był następujący: pomiary USG poubojowe > pomiary USG przyżyciowe > pomiary ultradźwiękowe. Na podstawie analizy uzyskanych wyników można sądzić, że do szacowania masy mięsa wyrębów podstawowych i procentowej zawartości mięsa spośród pomiarów USG najbardziej predysponowane są pomiary grubości słoniny (U4P, U4D), powierzchni „oka" polędwicy (UOP, UOD) oraz wysokość „oka" polędwicy (UWD). Do określania masy tłuszczu wyrębów podstawowych lub procentowej zawartości tłuszczu predysponowane są natomiast pomiary USG grubości słoniny (U2P, U2D, U4P, U4D) i powierzchni tłuszczu (UTP, UTD).