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The influence of weight and meatiness of pig carcasses on the yield of primary cuts

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The aim of the study was to analyse the influence of carcass weight and meatiness classes on the yield of primary cuts of pig carcasses. The study was performed on 145 pig carcasses from the mass population, assigned to groups with different weight and meatiness levels. The meatiness class of the carcass was found to significantly influence the yield of the loin, ham and neck, as well as the total yield of the five analysed cuts. In the case of the loin yield and that of the sum of the five cuts, a significant interaction of classes x weight groups was noted. The yield of loin and ham were highly significantly (P<0.01) positively correlated with carcass meatiness (r=0.71 and 0.60, respectively). Lower correlation coefficients were noted between lean meat content in the carcass and the yield of neck and shoulder (0.31 and 0.20), respectively. The share of pork belly was not dependent on meatiness. The correlation coefficient between the yield of the cuts and carcass weight was low (r<0.2).

KEY WORDS: pork carcasses / meatiness / primary cuts / yield

Meat plants in Poland began to implement post-slaughter classification of pig carcasses based on assessment of meatiness in the early 1990s, which was sanctioned by the amended standard PN-A-82001/A1:1995 [15]. This system was successively implemented until Poland's accession of to the European Union, when it became binding in the entire country. The EUROP system is based on post-slaughter assessment of the content of lean meat in the carcass and is a key factor in the level of remuneration paid to producers for the material they supply [8]. The introduction of the classification has led to an overall improvement in the carcass value of Polish pigs, and in particular to an increase in their lean meat content [3, 9, 11].

Apart from the lean meat content of carcasses, another important parameter determining their trade value is the yield of primal cuts, such as the loin, ham, shoulder, neck and belly. This value is also significantly influenced by the weight of slaughtered pigs [20]. One

means of determining remuneration for pig producers is a system based on post-slaughter evaluation, consisting of assessment of meatiness and hot carcass weight. This system is used in particular at large slaughter plants, which employ various modifications of it, e.g. rewarding or deducting for each percent of meat content above or below a given threshold, or, in an increasingly popular modification, paying a premium for carcasses within a specified weight range [10, 13].

In certain European countries, methods taking into account the yield of primal cuts have recently been used in addition to the EUROP classification in determining remuneration [6, 7]. Therefore research related to this issue has been undertaken to determine what range of carcass meatiness and what carcass weight will ensure better yield of primal cuts, and hence higher remuneration for the material.

The objective of the study was to analyse the effect of hot carcass weight and conformation class on the yield of primal cuts obtained during dissection of pig carcasses, and to determine the correlations between carcass weight and its meat content and the share of selected elements of the half-carcass.

Material and methods

The study was carried out on 145 carcasses of fattening pigs from the mass population, slaughtered at a meat plant in north-western Poland. Transport, pre-slaughter procedures and slaughter were carried out in compliance with meat industry regulations. Gas stunning with carbon dioxide was applied during slaughter.

Forty-five minutes after slaughter the lean meat content of the carcasses was determined on hot, hanging, left half-carcasses using a CGM choirometer with an optical probe, according to the methodology for this device [5].

Hot carcass weight was determined on an electronic track scale, accurate within 100 g. The carcasses were assigned to classes S, E, U and R. Due to the small number of carcasses in class S, one group of carcasses with high meat content was created (E+S). The material was divided into three weight groups: light (<87 kg), medium (87-93 kg) and heavy carcasses (>93 kg). Table 1 presents the number of carcasses in each weight group and conformation class.

The carcasses were chilled by the shock cooling method at –20°C for about one hour, and then further cooled at a process temperature of about 4°C. After cooling for 24 hours the left half-carcasses were again weighed and then dissected according to the plant's internal standard, which is a modification of the Polish standard PN-86-A/82002 [16]. The modification did not involve changes in how the analysed primal cuts were cut, but certain changes in the method of trimming of elements. Individual elements were weighed to within 1 g. The percentage share in the carcass of the most important primal cuts, i.e. the ham, loin, neck, shoulder, and belly, which are characterized in the literature, was determined [12, 14].

The results of the measurements were analysed statistically, including means, standard deviations and two-way analysis of variance with significance of interactions. Means between experimental groups were compared by Tukey's test. Correlations between the weight and meatiness of the carcasses and the share of primal cuts were determined on the basis of linear correlation coefficients [17, 18].

Table 1
Number of carcasses in each class and weight group

Weight groups	Carcass classes (number of carcasses)			
	E+S	U	R	total
Light carcasses (<87 kg)	11	8	21	40
Medium carcasses (87-93 kg)	21	18	15	54
Heavy carcasses (>93 kg)	14	7	30	51
Total (number)	46	33	66	145

Results and discussion

A characterization of the meat content of the pigs is shown in Table 2. The highest meat content (59.09%) was noted in the group of heavy carcasses in class E+S, and the lowest (46.76%) in the light carcasses in class R. In classes E+S and R medium-weight carcasses had somewhat lower meat content in comparison with light and heavy carcasses. The mean meatiness of carcasses was 58.24% in class E+S, 52.79% in class U, and 47.78% in class R.

The analysis of variance for the percentage share of the five primal cuts showed that the percentage of these elements was influenced by the interaction of class x weight group ($F=3.10$; $P<0.05$). The highest share of the five elements combined, 77.11-77.13%, was

Table 2
Average meatiness and carcass weight in the experimental groups

Carcass class	Carcass weight group	Meatiness (%)		Hot carcass weight (kg)	
		$\bar{x}$	SD	$\bar{x}$	SD
E+S	light	58.13	1.46	85.43	0.65
	medium	57.52	1.92	89.25	1.72
	heavy	59.09	1.71	94.43	0.89
	total	58.24	1.70	89.70	1.09
U	light	53.05	1.49	85.44	0.35
	medium	52.27	1.26	89.99	1.78
	heavy	53.04	1.79	94.44	0.60
	total	52.79	1.51	89.96	0.91
R	light	46.76	1.38	80.39	0.72
	medium	47.79	1.38	88.93	1.83
	heavy	47.89	1.51	95.61	2.24
	total	47.78	1.42	88.31	3.26

Table 3
Percentage share of 5 main cuts in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Share of 5 main cuts in half-carcass (%)		
		light carcasses	medium carcasses	heavy carcasses
E+S	$\bar{x}$	77.11^{d}	77.13^{d}	77.13^{d}
	SD	1.71	1.46	1.96
U	$\bar{x}$	75.23^{bcd}	74.76^{bc}	76.23^{cd}
	SD	0.96	2.49	1.46
R	$\bar{x}$	72.55^{a}	73.34^{ab}	72.92^{a}
	SD	1.42	1.86	1.71

Means in rows with different superscripts are significant (P<0.05)

noted in the carcasses in the E+S class (Tab. 3). These values were significantly higher than the percentage of these cuts in the class R carcasses in all weight groups analysed (72.55-73.34%). The lowest percentage of these elements was noted in the light carcasses of class R. In the class E+S carcasses the increase in carcass weight caused no statistically significant changes in the combined yield of the five primal cuts. In class U, the lowest share of the five elements was noted in the group of pigs with medium carcass weight.

Analysis of variance showed that the percentage share of the loin in the half-carcass was statistically significantly affected by the interaction of class x weight group (F=3.98; P<0.01). The highest share of the loin, at 11.49%, was noted in the light carcasses of class E+S (Tab. 4). In all weight groups a significantly greater share of the loin was noted in class E+S than in class R carcasses. A statistically significantly lower share of the loin was noted for the class R carcasses in the group of light and heavy carcasses (9.21% and 9.48%, respectively) as compared to class U (11.14% and 10.62%, respectively). The light pigs in conformation classes E+S and U had a similar percentage share of loin, but in the remaining weight ranges the share of loin was found to increase with meatiness. Studies by other authors have not confirmed this tendency. Blicharski [1] reports that pigs with meatiness exceeding 55% had greater ham and loin weight. Strzelecki et al. [21] showed no significant effect of the weight of pigs on the percentage share of the ham and shoulder in carcasses with meat content above 50%, as well as a lack of effect of carcass weight on the yield of loin in half-carcasses of class E+S. A later study by Strzelecki et al. [22] showed a decrease in the share of ham and of loin and shoulder as meat content decreased, by 0.5 p.p and 0.4 p.p., respectively.

The share of ham in the half-carcass was significantly influenced by the conformation class of the carcasses (F=36.26, P<0.01), but no effect of carcass weight was noted (F=1.72), and no interaction of class x weight group (F=0.35). The highest share of ham with the shank (about 29%) was observed in the class E+S carcasses (Tab. 5). A significantly smaller percentage of ham was noted in the other conformation classes, i.e. U and R, which did not differ significantly from one another.

Table 4

Percentage share of loin in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Light carcasses	Medium carcasses	Heavy carcasses
E+S	$\bar{x}$	11.49^{D}	11.09^{D}	11.3^{D}
	SD	0.67	0.62	1.01
U	$\bar{x}$	11.14^{DE}	10.18^{BCE}	10.62^{CDE}
	SD	1.04	0.78	1.01
R	$\bar{x}$	9.21^{A}	9.90^{ABC}	9.48^{AB}
	SD	0.88	0.77	0.73

Means in columns and rows with different superscripts are highly significant (P<0.01)

Table 5

Percentage share of ham with shank in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Light carcasses	Medium carcasses	Heavy carcasses	All classes
E+S	$\bar{x}$	28.68	28.93	28.88	28.83^{A}
	SD	1.05	1.01	1.35	
U	$\bar{x}$	26.88	27.52	27.00	27.13^{B}
	SD	1.17	1.09	1.2	
R	$\bar{x}$	26.67	27.16	27.23	27.02^{B}
	SD	1.33	0.94	1.02	
All weight groups	$\bar{x}$	27.41	27.87	27.70	–

Means in columns with different superscripts are highly significant (P≤0.01)

Table 6

Percentage share of shoulder with shank in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Light carcasses	Medium carcasses	Heavy carcasses	All classes
E+S	$\bar{x}$	18.00	17.6	17.25	17.62^{NS}
	SD	0.78	0.88	1.8	
U	$\bar{x}$	16.91	17.61	18.04	17.52^{NS}
	SD	2.8	1.07	1.09	
R	$\bar{x}$	16.60	17.28	17.30	17.06^{NS}
	SD	0.77	1.09	0.90	
All weight groups	$\bar{x}$	17.17^{NS}	17.50^{NS}	17.53^{NS}	–

NS – means in last column and row are not significant

Table 7
Percentage share of belly in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Light carcasses	Medium carcasses	Heavy carcasses	All classes
E+S	$\bar{x}$	11.67	11.62	11.67	11.65^{NS}
	SD	0.92	1.01	0.94	
U	$\bar{x}$	12.61	12.24	11.27	12.04^{NS}
	SD	0.88	0.82	0.73	
R	$\bar{x}$	11.87	11.95	11.87	11.9^{NS}
	SD	1.05	1.17	1.00	
All weight groups	$\bar{x}$	12.05^{NS}	11.94^{NS}	11.6^{NS}	–

NS – means in last column and row are not significant

Table 8
Percentage share of neck in pork half-carcass depending on weight and meatiness of carcasses

Carcass class		Light carcasses	Medium carcasses	Heavy carcasses	All classes
E+S	$\bar{x}$	7.77	7.73	7.78	7.76^{a}
	SD	0.45	0.55	0.38	
U	$\bar{x}$	7.90	7.56	7.44	7.63^{ab}
	SD	0.55	0.41	0.36	
R	$\bar{x}$	7.51	7.49	7.26	7.42^{b}
	SD	0.73	0.51	0.4	
All weight groups	$\bar{x}$	7.73	7.93	7.49	–

Means with different superscripts are significant (P<0.05)

The percentage share of shoulder with the shank was not influenced by any of the factors tested (P>0.05), and there was no interaction (F=2.01; P>0.05). The mean yield of this element was slightly over 17% (Tab. 6). The share of belly (Tab. 7) was also not dependent on the class (F=1.48), carcass weight (F=1.97), or interaction (F=1.52), averaging 11.65%. However, the yield of neck with the bone was significantly influenced by the conformation class of the carcasses (F=6.05, significant at P<0.01). A higher percentage share of neck was noted in class E+S, and a lower share in class R (Tab. 8). The yield of neck in class U was between that of classes E+S and R, and not significantly different from these classes.

The relationships observed for the share of primal cuts in the pork half-carcass confirm the results of earlier studies by Lisiak et al. [12] and Strzelecki et al. [19], who report greater yield of loin, neck, shoulder with shank, and ham with shank, by an average of 1.5 p.p., in carcasses with higher lean meat content. The authors also noted a 58.8% share of

these elements in half-carcasses from class E and a 55% share in half-carcasses assigned to class U. The reverse tendency was noted for backfat content and fatty cuts (jowl, flank, and class II meat), which were not analysed in the present study. The yield of these elements was 19% for class E half-carcasses and 23% for class U.

Zybert et al. [24] found no effect of an increase in hot carcass weight from 75-80 kg to 80-85 kg on the percentage share of primal cuts, but did note a positive effect on their weight. Results obtained by numerous authors also confirm an increase in the yield of primal cuts depending on the degree of meatiness [19]. Lisiak et al. [12] noted an increase in ham yield of about 5 p.p. in the carcasses of pigs with 60% lean meat content as compared to carcasses with 45% meat content.

The present study found no effect of carcass weight groups on the yield of most of the primal cuts, i.e. the ham, shoulder, neck and belly. Only in the case of the share of loin was there an interaction of weight group x class, with unambiguous differences observed between classes (the better the conformation, the higher the yield), whereas between weight groups these differences were not always in the same direction. A similar effect as in the case of loin yield was also observed for the yield of all five primal parts combined, with a significant interaction of class x weight group. The carcass class was shown to have a significant effect on the yield of ham with the shank and of neck—the higher the conformation class, the higher the yield of these elements. The yield of shoulder and belly were not influenced by any of the factors tested. The results obtained are confirmed in a study by Borzuta et al. [3], which found a higher percentage of ham and loin in classes with higher meat content, but no such correlation for the share of shoulder and belly. On the other hand, Lisiak et al. [12] reported an increase of about 1 p.p. in the share of belly in carcasses assigned to classes R and O, as compared to carcasses of pigs with lower meat content. A relationship between conformation class and yield of primary cuts in the pork carcass has also been shown in other studies [4, 19, 21, 23]. These emphasize that the share of loin and ham increases with meatiness, and the share of fattier cuts decreases. Characteristically, the conformation class had a greater influence on the share of meat from trimming than on that of primal cuts. Further research by Strzelecki et al. [22], however, found that the conformation class also influenced the percentage share of the shoulder and neck.

Table 9 presents the linear correlation coefficients between the percentage share of primal cuts and the weight and meat content of the carcass. The highest, statistically significant correlation ($P<0.01$) was noted between the percentage share of loin and the meat content of the carcass ($r=0.71$). This may be an indirect result of the method of measuring lean meat content, because the regression equation in manual devices for estimating meat content is based on measurement of the thickness of the backfat and longissimus dorsi muscle. A somewhat lower, significant ($P<0.01$) linear correlation coefficient ($r=0.60$) was observed between the content of ham with the shank and meatiness. Similar relationships, but with slightly lower correlation coefficients, were obtained by Janiszewski [10].

The results obtained in the study suggest that in the case of remuneration for pig producers based on a system taking into account the percentage share of the most valuable elements of the carcass, the greatest attention should be given to increased lean meat content. An increase in carcass weight in the most common range of about 80 to 95 kg does not significantly influence the yield of the five primal cuts analysed. The analysed carcass

Table 9
Correlation coefficients between carcass weight and meatiness and the percentage share of primary cuts

Trait	Carcass weight	Carcass meatiness
Share of shoulder	0.18**	0.20**
Share of neck	–0.19**	0.31**
Share of ham	0.16**	0.60**
Share of loin	0.09	0.71**
Share of belly	–0.09	–0.11
Carcass meatiness	0.14	–

**Significant at P<0.01

weight range corresponds to a body weight of about 105 to 125 kg. It is consistent with the final body weight on the day of evaluation of fattening pigs slaughtered as part of performance assessment of pigs in breeding herds in 2013, conducted by the POLSUS Polish Pig Breeders and Producers Association [2]. The final body weight on the day of evaluation was 105 kg in gilts of the Pulawska breed, and 123 kg for young males of the Polish Large White breed. The mean weight of fattening pigs slaughtered in the industry was similar as well, at 120.5 kg (carcass weight 91.3 kg) in May of 2014 (www.agronews.com.pl).

To sum up, the yield of loin, ham and neck, as well as the five analysed primal cuts combined (these three cuts and the shoulder and belly), was significantly influenced by the conformation class of the carcasses. In the case of the yield of loin and the five primal cuts combined, a significant interaction of class x weight group was observed, with higher means noted for the subgroups in classes with greater meatiness. No such relationship was noted between individual carcass weight subgroups. Of the elements analysed, the yield of loin and ham was most strongly correlated with the meatiness of the carcass (r=0.71 and 0.60, respectively). The correlation between the yield of primal cuts and carcass weight was low (r<0.2).

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